

WATERSOLUTIONS

Water & Waste Water Technologies



INTERVIEW

Water Framework Directive (WFD)

EXPERT NETWORK

German Water Partnership

SPECIAL

IFAT 2018

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... and that is not just an empty slogan by the German Water Partnership (GWP), Germany's internationally orientated water association – it is, instead, a promise made by its around 350 members, German plant engineers, pump and components manufacturers, consulting and operating companies and also by the scientific community, all of whom are contributing, alongside the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the KfW bank and international donor institutions, to improving the global water situation.

The large movements of refugees in recent years have abruptly accelerated the still unsolved global problem of equitable access to water and the adequate management of waste water into the world's headlines. Shortage of water, whether the result of climate change, pollution, overuse or military conflicts, is one of the primary causes of population displacement and migration. No water, no life – an age-old truism. We live in a globalised world, we are digitally networked at the push of a button – and we all share just one environment.

Sustainable and forward-looking action is needed in the management of our water resources. And this action must start at home. The contributions made by the German water industry on its own initiative, in terms of energy optimisation and of the replacement of conventional sources of energy with sewage-treatment gas to reduce CO₂ emissions, are exemplary. Water-loss rates of 6.6 percent, coverage rates of practically 100 percent, for both potable-water supply and waste water disposal, and 24/7 assurance of high-quality water supplies, set standards for other nations. Our interaction of modern, technological infrastructures, strategic investments, realistic, cost-covering charges, highly capable water management companies and sagacious legal frameworks provides a model for success.

Given intelligent management and the involvement of other sectors of the economy, such as agriculture, chemicals and pharmaceuticals, even the current challenge of “micropollutants” can be sustainably and lastingly tackled to reduce water pollution. This

will, however, require political courage, readiness to enter a dialogue on the part of the polluting industries and willingness from all of us – as consumers – to rethink our behaviour. Healthy eating, healthy soil, healthy water – all of these are interrelated.

The Water Action Plan could be set to become an export hit. This concept, developed by GWP members, is even received in the new government's coalition agreement and is intended to make a tangible contribution to know-how and technology transfer. Its central element is the idea of developing operator partnerships between German and international water management companies and of overcoming challenges by means of equitable cooperation.

Discussion of all these topics with each other, and the visualisation of tangible solutions – these are the main reasons for visiting the IFAT in Munich, the world's largest forum for this industry. The IFAT permits direct contact every two years, whereas the GWP, with its committees and projects, is a continuous and evolving network that offers numerous worthwhile opportunities around the globe for internationally orientated water industry companies and for water science.

The technical journal Water Solutions delivers expert technical knowledge on all facets of global water supply and waste water disposal plus on the prevention of water pollution. It is an ideal communication platform for interchange. I therefore cordially invite all readers to play an active part, either by means of an article or by becoming a member of German Water Partnership.

Wishing you fascinating hours and days at the fair (and especially on our booth!),

Yours
Gunda Röstel



Gunda Röstel

Chairperson of GWP e. V.
GELSENWASSER AG

SPECIAL

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IFAT 2018

Key facts about IFAT 2016 at a glance

- 3,087 exhibitors from 59 countries
- 136,885 visitors from 169 countries
- An exhibition space of more than 230,000 square meters

A platform for innovations

More than 3,000 exhibitors attend the World's Leading Trade Fair for Environmental Technologies to showcase their pioneering technologies, innovations, and strategies and solutions tailored to meet the requirements of the market in question.

Attendance of all companies relevant to the industry

As the industry platform for innovations, attending IFAT as a trade visitor will give you the chance to meet with the entire industry – ranging from a system provider operating on a global scale to highly specialized medium-sized enterprises.

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Presentation of the entire range of environmental technology products available

IFAT covers the areas of water, sewage, waste, and raw materials management, so as a trade visitor you will receive a comprehensive overview.

High-quality supporting program

The unique supporting program at IFAT makes it a trade fair of opinion, discovery, experience, knowledge, and vision, with platforms being provided by the forums that include special country-specific events, talks by specialists, podium discussions, and company presentations. In practical live demonstrations, associations and highly professional operators show-case machines, systems, and vehicles in action.

Inspirational and spectacular live demonstrations at IFAT

Complex processes are brought to life during practical live demonstrations:

- End-of-life Vehicle Recycling (BDSV)
- Demonstration Days: Biomass Preparation Technology (VDMA)
- Demonstration Days: Minerals Preparation Technology (VDMA)
- Piper Fitting Challenge (DVGW / rbv)
- Truck in Action (VAK)
- Water Treatment and Flood Control (THW)
- Water Skills—Professional Competitions (DWA)

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WATERSOLUTIONS

Water & Waste Water Technologies



Ausstellungsspektrum / Exhibition sectors

- Mess-, Steuer- und Regelungstechnik / Analyse- und Labortechnik
Process measuring and control technology / Analysis and laboratory techniques
- Armaturen
Fittings
- Bau und Instandhaltung von Wasser- und Abwassernetzen
Construction and maintenance of water supply and sewerage systems
- Pumpen
Pumps
- Leitungen, Rohre und Kanäle
Ducts, pipes and sewers
- Energiegewinnung aus Sekundärrohstoffen und Abfällen / Abgas- und Abluftreinigung, Luftreinhaltung
Generating energy from secondary raw and waste materials / Flue-gas scrubbing and air extraction, air-pollution control
- Dienstleistungen – Abfallverwertung und -entsorgung / Beratungs- und Ingenieurleistungen / Informationstechnik
Waste recycling and disposal services / Consulting and engineering services / Information technology
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Construction of water and wastewater treatment plants / Hydraulic engineering and well construction
- Fahrzeuge und Aufbauten / Straßenreinigung, Straßenbetriebs- und -winterdienst
Vehicles and superstructures / Street cleaning, maintenance and winter road services
- Abfallbehandlung und Recycling / Rückgewinnung, Aufbereitung und Verwertung von Sekundärrohstoffen / Altlastensanierung und Bodenaufbereitung
Refuse treatment and recycling / Recycling, conditioning and utilization of secondary raw materials / Decontamination of old sites and soil treatment
- Abfallsammlung und -beförderung
Refuse collection and transport
- Live-Demonstrationen / Live demonstrations**
- LIVE-DEMO Water Skills – Berufswettbewerbe (DWA) und Leitungsbau Challenge (DVGW/rbv)
Water Skills—Professional Competitions (DWA) and Pipe Fitting Challenge (DVGW/rbv)
- LIVE-DEMO Wasseraufbereitung und Hochwasserschutz (THW)
Water Treatment and Flood Control (THW)
- LIVE-DEMO Truck in Action (VAK)
- LIVE-DEMO Altfahrzeug-Demontage (BDSV)
End-of-Life Vehicle Recycling (BDSV)
- LIVE-DEMO Praxistage: Biomasse und Mineralik Aufbereitungstechnik (VDMA)
Demonstration Days: Biomass and Mineral Preparation Technology (VDMA)

IFAT 2018: Water sector follows the digitalization trend

The provision of affordable drinking water in top quality is one of the most important tasks of the water sector. To be able to do that, the industry needs continuous innovations in order to maintain the high standards for the future. The latest developments in the field of drinking water preparation and distribution will be on show at the upcoming trade fair IFAT. The 'World's Leading Trade Fair for Water, Sewage, Waste and Raw Materials Management', takes place at the Messe München exhibition center in Munich from May 14 to 18, 2018. Silvia Fritscher, Exhibition Director of IFAT at the trade-fair company, has observed that for some years now more and more of the innovations presented at IFAT are to do with the key topics of digitalization, automation and Water 4.0. This is a trend that will further strengthen in 2018.

Analysis sensors as part of the network

"The greatest progress in digitalization in the drinking water sector is seen currently in the areas of pump controls, measurement technology and drinking water analysis," says Julia Braune, Managing Director of the German Water Partnership (GWP), an industry and research network. She continues: "While digital integration of pump controls is already well advanced, there is still much potential in the connecting up of system components using sensors, for example for analysis. Ever better communication between the various parts of the water production process – for example, springs, waterworks and the drinking water network – can both enhance the security of the supply and also optimize energy and resource efficiency."

Opportunities from a "digital twin"

Even more extensive scope for digitalization lies in setting up a "digital twin". This is a data model which depicts a machine, a system or even a complex infrastructure with all its information and interdependencies. Christian Ziemer, Siemens AG and

Head of the GWP Working Group Water 4.0, sets out one possible application in drinking water and waste water: "With a digital twin we can do real-life simulations, completely without risk, to test various approaches and optimize them."

Better identification of customer needs

The importance of digital change has been recognized in the field of municipal water supplies – that was a clear finding in a survey of its members conducted by the Verband Kommunaler Unternehmen (VKU – the German association of public utility companies): More than two thirds of the companies rated digitalization as of high or very high relevance. And already one in two companies are either planning or implementing a digitalization strategy. "Digitalization underlines the benefit to customers and citizens as a central impetus for change," points out Michael Beckereit, President of the VKU. He adds: "Analysis of large volumes of data means we can recognize more easily what the customers need and better understand the processes. This in turn forms a good basis for developing new and even more suitable products and strategies."

'Maturity Model Water Supply 4.0' in development

In order to give support to companies in the water supply sector on digitalization, the Deutscher Verein des Gas- und Wasserfaches (DVGW – German Association for Gas and Water) commissioned in autumn the development of a 'Maturity Model Water Supply 4.0'. "We hope that this model will give us a valid overview of the current practices in digitalization in the water sector. Ideally we will be able to derive improvement measures from this and then introduce them in a sensible sequence," explains Dr. Dirk Waider, Vice President Water at the DVGW.

Further information:

www.ifat.de



GreenTec Awards finalists have been confirmed

The online vote on the GreenTec Awards 2018 finalists has ended: the three most innovative projects have been selected from every category's top 10 list. On May 13, the GreenTec Awards for the eleventh time will distinguish the best innovations in the fields of environmental protection and sustainability. The exclusive gala evening is the prelude to IFAT. For every category, the jury chose two finalists, the third was determined in the online voting – with votes from more than 130 countries worldwide. “To only have three innovations in the finals often seems to be unfair,” says Sven Krüger, Initiator of the GreenTec Awards. “Over and over again, we are impressed with the commitment of individual people and the high level of the many projects submitted.” Stefan Rummel, Managing Director of Messe München and organizer of IFAT adds: “We watch the finalists of the GreenTec Awards with great interest. New ideas and concepts in environment protection are enormously important to find the answers to the most significant questions of tomorrow.”

The finalists at a glance

The top 3 in Construction & Living are the projects of DAW SE (sustainable wood care products based on camelina), CONTAINERWERK eins (conversion of used sea freight containers into living space) and Werkgemeinschaft Böhme Hilse Diplomingenieure Freie Architekten (housing area with surplus energy, district-power and e-mobility).

In the Energy category, Fraunhofer ISE (18 % more power through innovative solar cell design), MWK Bionik (self-cleaning coating for PV plants) and sonnen (produce, store and share own and clean energy) were selected.

The three finalists in the Galileo Wissenspreis category are Biolab Eberswalde (sustainable mushroom-based materials to reduce plastic use), AES (sustainable energy system to supply a single-family home) and REelectronics (to allow an ecological and economical recycling of electronic scrap).

In Lifestyle, tip me (tip for product manufacturers), Relenda (the environmentally conscious generation: renting and using over buying) and aha-Zweckverband (Hannoccino: innovative reusable cup system) took the three places in the final.

In the category of Mobility, DiniTech GmbH (charging of electric cars on any conventional power socket), paper planes e.V.

(Radbahn under Berlin's U1) and Alstom (CO₂ emission-free train that runs with a fuel cell) are the three best innovations.

The finalists of Resources & Recycling by Veolia are creapaper GmbH (grass paper), Enactus RUB (a profitable, ecological alternative to burning electronic waste) and the Association of Lady Entrepreneurs of India (turning industrial waste into a business opportunity).

In the Sports by Jack Wolfskin category, SunnyBag GmbH (The Leaf+ solar panel charges all devices on the go), VAUDE (sustainable outdoor gear) and Solarskilift Tenna (world's first solar-powered winter sports) were chosen.

einhorn products (fair and sustainably produced condoms), CONTAINERWERK eins (see above) and Fresh Energy (fighting power guzzlers: eco-friendly, low-cost, data-driven) compete for the Special Prize Start-up.

The finalists in Sustainable Development are BIO-LUTIONS International (biodegradable packaging made of 100 % agricultural waste), SUNfarming (agro-solar greenhouses) and Land Life Company (combat against desertification).

The Water & Sewage category's top3 are Unimatec Chemicals Europe GmbH (portable water filter), Enactus Regensburg e.V. (cost-effective water filter for Africa) and Enactus Hochschule Bochum (Roots Up green house with its own water-production).

The jury meeting

On February 21, the selection committee has defined the winners for all categories. The jury consists of representatives of economy, politics and media, including Prof. Dr. Claudia Kemfert (German Institute for Economic Research), Marco Vollmar (WWF Executive Director Communications) and Anna Loos (actress and musician), thus covering all socially relevant fields.

Further information:

www.ifat.de

www.greentec-awards.com

GreenTec Awards

- ▶ Since their foundation in 2008, the GreenTec Awards have become the world's most significant environmental award and have been the stepping stone to success for many sustainable projects. In 2018, the GreenTec Awards are the prelude to IFAT, the leading trade fair for environmental technology in Munich. The gala event will take place on May 13, 2018.

New future platform “experience.science.future.”

This year's IFAT – the World's Leading Trade Fair for Water, Sewage, Waste and Raw Materials Management – will come up with a novelty: under the banner of “experience.science.future”, from May 14 to 18, 2018 the Munich exhibition center will be a platform for science & research, education & training, jobs & career and start-ups – in short, for thought leaders and junior staff in the environmental sector.

For IFAT's Exhibition Director Silvia Fritscher it is essential to promote ideas and young professionals, especially in the environmental industry: “The growing discussion about environmental and climate protection entails an increasing demand for qualified specialists and pioneering innovations. experience.science.future. is our response to this demand,

bringing together the sector's smart and emerging minds.” Amidst the IFAT events and activities, experience.science.future. will complement the exhibition and its supporting program in Hall B4, where it will pool universities, start-ups, associations and NGOs on more than 1,000 square meters, offering space for the most innovative technologies, strategies and research projects in the environmental field. In a networking lounge, pupils and students will have the opportunity to catch up on “green” occupations and get in touch with prospective employers.

Further information:
www.ifat.de



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A4 139/238

Global water solutions – made in Germany

German Water Partnership (GWP) is the strong network of the German water sector representing 350 members from water industry and research. The network includes:

- Commercial enterprises
- Governmental organizations
- Non-governmental organizations
- Scientific institutions
- Water-related associations
- Water utilities

Covering the complete water cycle, GWP is the central point of contact for foreign partners and is being actively supported by five German federal ministries.

The main goal of GWP is to establish German expertise and quality worldwide and to position German water competencies in international markets. Thus, integrated and sustainable approaches meet the problems and challenges of water management all over the world and the use of innovative German technologies and German know-how is being improved worldwide.

GWP's members are organized in 15 regional sections, each of which focuses on a specific country or region. Objectives of

these regional sections are to cultivate contacts with partners and decision makers in those countries, to kick off projects and work out custom-tailored solutions in water management. These regional sections are the central contact point for all enquiries placed by foreign businesses, organizations and governments. Furthermore, GWP offers its members the participation in working groups, to work at different aspects of water management. Currently there are six working groups:

- Water 4.0 (Digitalization),
- Water and Energy,
- Innovation and Scientific Cooperation,
- Industrial Water Management,
- Financing and Capacity Development.

As to projects and international cooperation, GWP pursues an interdisciplinary approach with all parties involved acting on equal terms. This requires the integration of decision makers and stakeholders from politics and industry. The head office in Berlin is the central point of contact for any international enquiries regarding German water solutions and expertise.

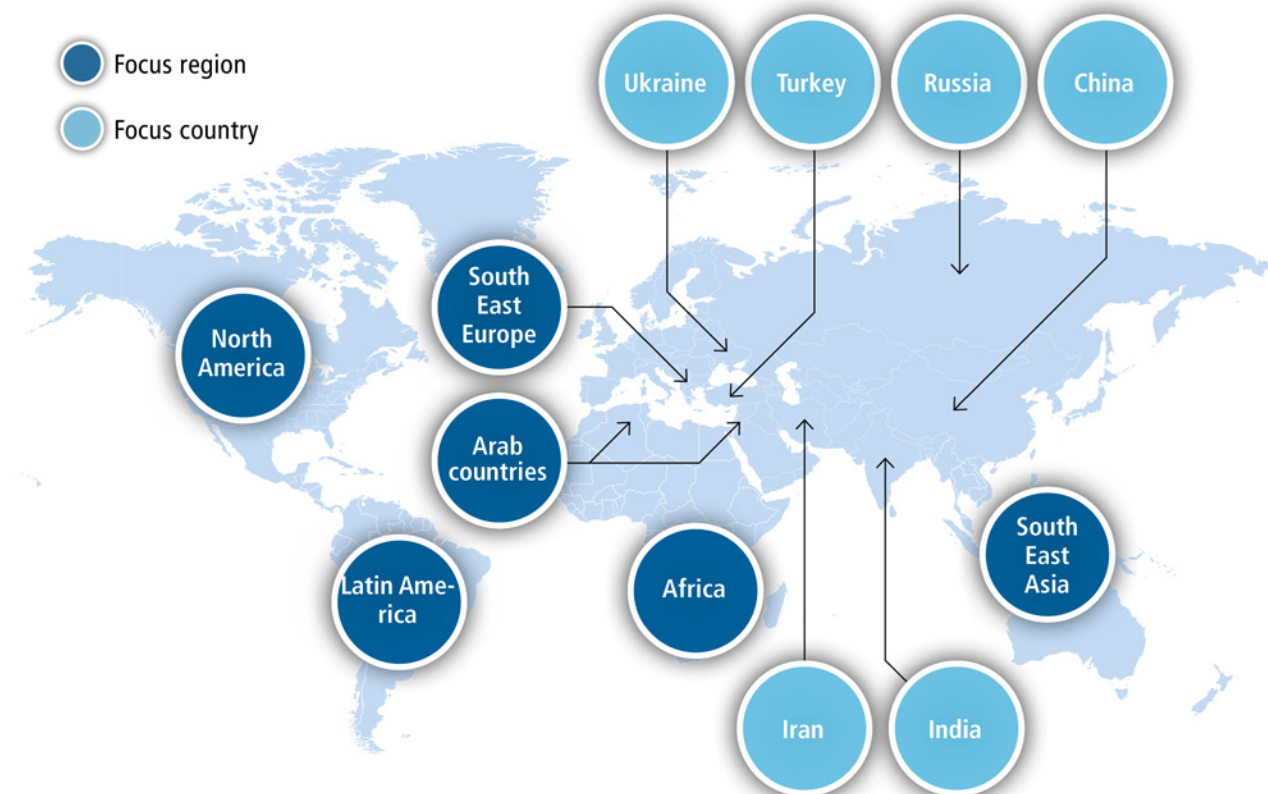


Figure 1: GWP's members are organized in 15 regional sections

German Water Partnership: Working group “Water 4.0”

GWP’s understanding of WATER 4.0

WATER 4.0 puts digitization and automation at the center of a strategy for resource-efficient, flexible and competitive water management. In doing this, WATER 4.0 incorporates the same main features and terms of the industrial revolution INDUSTRY 4.0, such as “networking of machines, processes, storage systems and resources”, “smart grids”, “Internet of Things and Services”, and brings them together in a systemic, water management context. In the implementation of WATER 4.0, Cyber Physical Systems (CPS) are drivers of the optimal networking of virtual and real water systems, with planning, construction and operation being largely done by software. This allows the intelligent networking of water users (agriculture, industry, and households) and components in a sustainable water infrastructure with the environment and the water circuit and follows a holistic approach along the value-added chain. Furthermore, WATER 4.0 allows a high degree of transparency for water users, thus covering current needs, and provides opportunities for sustainable, creative activity areas in water management.

GWP’s visions on behalf of WATER 4.0

The pursuit of the WATER 4.0 topic within GWP is intended to strengthen and support the German water industry in national and international competition. WATER 4.0 offers what is presently a unique opportunity to define a progressive and promising approach to addressing the water problems of the future and to pooling the innovations of the companies in the German water industry. Ideally, unique selling propositions (USP) will be created within existing business opportunities and completely new areas of activity will also emerge. WATER 4.0 offers new prospects and opportunities for collaboration between GWP companies, for example, working in flexible cooperative relationships that can provide the customer with innovative services in virtual joint ventures as part of a cyber physical water system (CPWS). A download of the GWP brochure “Water 4.0” is available on www.germanwaterpartnership.de.

10 years of GWP

This year German Water Partnership is celebrating its 10-year anniversary with a festive celebration and a high-level conference together with its members and partner institutions. The overall goal will be to discuss visions and next steps regarding the future work of German Water Partnership in respect of already preminent and dawning global challenges in the water sector.

On the evening of June 27th, German Water Partnership invites for a festive celebration of its 10-year anniversary at the “Spreepeicher” in Berlin. The festive evening will celebrate past achievements with high level speakers attending and will offer the unique opportunity to network with the internationally active German water community. Guests will also have the opportunity to get to know the work of the Neven Subotic Foundation, social society partner of GWP in 2018.

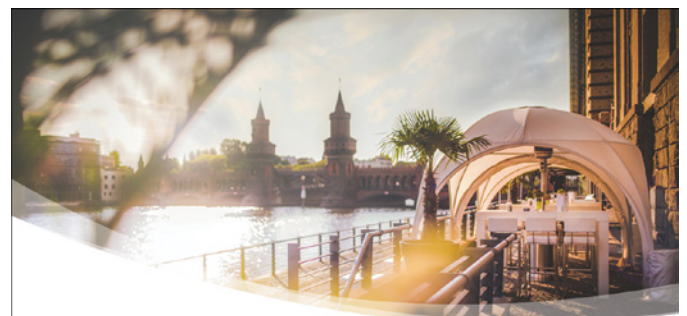


Figure 2: Julia Braune, General Manager of German Water Partnership e. V.

The conference on June 28th aims to discuss current and future water related challenges in the world. Together with representatives of the GWP partner ministries and high-level guests from politics, economics and science attendees are invited to discuss the future focus and strategic position of the German water sector with the aim of contributing to the achievement of the SDGs and thus to the availability of fair and sustainable water provision worldwide. For registration and further information visit: www.germanwaterpartnership.de

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info@germanwaterpartnership.de
www.germanwaterpartnership.de



Save the Date

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German Water Partnership at the IFAT

At the world's leading trade fair for water, sewage and raw materials management the GWP joint booth with more than 25 GWP-Members can be found in IFAT's central water hub, Hall B2, Booth 227/326. A visit to the GWP booth will allow visitors to get in contact with a wide range of companies from the German water sector or get advice on how to navigate the trade fair when looking for Water Technology made in Germany.

Also, for German companies and institutions interested in joining the network: a special event for new members takes place on Wednesday, May 16th, at 3 pm.



Figure 3: GWP-booth at IFAT 2016

GWP's Program of the Week during IFAT 2018

Monday, May 14th 2018		Where
12:30-13:30	DAAD Delegation: University Siegen	GWP-booth
16:00-17:30	DAAD Delegation: University Duisburg-Essen	GWP-booth
Tuesday, May 15th 2018		
09:15-13:15	Mexican Delegation	Room B22
10:30-12:00	Iran Special	Forum B2
12:00-14:00	MENA/Jordan Special	Forum B2
13:30-15:00	Mexican Delegation: Tour of the booth	GWP-booth
14:00-16:00	Sustainable Utility Partnerships Special	Room B22
15:00-16:00	Lebanese Delegation	GWP-booth
16:00-18:00	India Special	Forum B2
Wednesday, May 16th 2018		
09:00-13:00	Matchmaking Singaporean Delegation	Room B22
09:30-10:30	TU Berlin Delegation	GWP-booth
10:00-12:00	RAWW Delegation	GWP-booth
10:30-12:30	South America Special	Forum B2
11:00-11:40	KfW-lecture: TSV Delegation	GWP-booth
14:00-15:00	GIZ – Presentation of Program	GWP-booth
15:00-16:00	GWP Information Event for New Members	GWP-booth
16:00-18:00	Industrial Water 4.0 - Digitalization in the water sector (VDMA)	Forum B2
16:00-22:00	GWP-Get-together	GWP-booth
Thursday, May 17th 2018		
10:00-11:00	Delegation Canadian Pavillion	GWP-booth
11:00-12:00	Iranian Delegation Industrie	GWP-booth
Friday, May 18th 2018		
10:00-11:00	TU Berlin Delegation	GWP-booth

Utility engagement sought on real-time monitoring

Water companies invited to share their needs with new technical group

British Water is calling on water companies to share their real-time monitoring needs with a new focus group in preparation for the next five-year Asset Management Plan (AMP). The trade association has added a Real-Time Monitoring Focus Group to its portfolio of technical forums and is encouraging the utilities to engage directly with the supply chain.

Group convenor Joanna Kelsey, who is also principal consultant at Stantec, says water utilities in England and Wales are facing key regulatory challenges in AMP7 (2020-25) and need new approaches.

“Ofwat has placed some key challenges on the utilities in terms of customer service, resilience, innovation and affordability,” she said. “Rather than using heavy capital investment to meet those targets, utilities have to find better ways to use existing assets. “Real-time monitoring gives water companies immediate information about how their assets are performing and what’s happening in the network or at the treatment works. It makes them more resilient to heavy rainfall and climate change, for example.

“As real-time sensors and monitors become routinely available, there is a recognition that the industry needs to work together to get a broad view of what the needs of the water companies are

and how they can be best met. This makes it an exciting time for the sector and the perfect time for the end-user utilities, consultancies and technology developers to come together to share knowledge.”

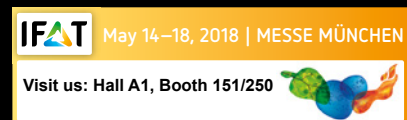
British Water technical manager Mar Batista said: “British Water’s portfolio of technology focus groups is strengthening all the time. Interest in the new Real-Time Monitoring Focus Group is already very strong and the first meeting, which took place last month, was over-subscribed.

“We initially surveyed members of British Water’s Technical Forum to find out which areas needed extra focus and real-time monitoring came out on top. We now have a total of seven focus groups where members can share specialist knowledge, make new connections.”

The next Real-Time Monitoring Focus Group meeting is in London on 9 May 2018 and utilities wishing to take part should email mar.batista@britishwater.co.uk.

Further Information:

www.britishwater.co.uk/focus-groups.aspx



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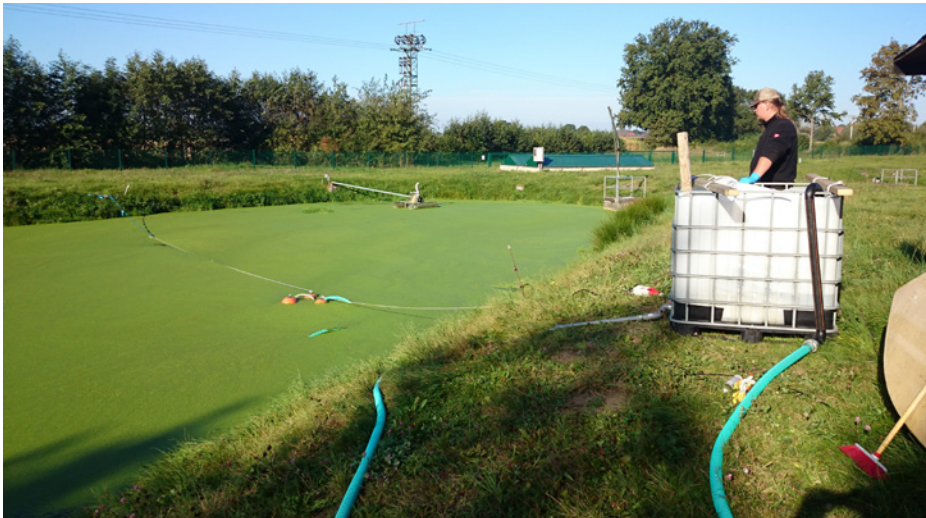
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Standing waters suffer in the summer

Source: Tsurumi



Green duckweed has completely taken over this water body: A Tsurumi 8-FSP skimmer pumps the water plant into the provided collection tank

What to do if standing waters run out of oxygen? This is a question that is posed a lot in the warm summer months. The use of mobile skimmers and submersible aerators is a proven way of biologically reactivating water reservoirs. Pump manufacturers like Tsurumi even hire out these devices.

Lots of ponds and water bodies become stagnant in the summer: If a green layer of small duckweed (*Lemna minor* L.) closes the surface of the water, it is often no longer possible to use the water. This swimming plant flourishes in waters that are relatively still and rich in organic nutrients. If the oxygen content drops below a certain level, the water can become biologically stagnant and turn into a hostile environment.

Therefore specialists recommend using a surface skimmer. The pump manufacturer Tsurumi, whose European headquarters are based in Düsseldorf, has the model 8-FSP in its program. “This is a kind of floating pump that removes the coating from the upper water layer”, explains Andreas Rössig who works for the manufacturer. After three hours of skimming, the 500 m² water body was transformed beyond all recognition: Seven cubic metres of duckweed were suctioned off into the waiting tank, and the surface of the water was clear again. The suction unit, which only weighs 38 kg, and its three red floats, achieves an

intake rate of around 250 l/min. The submersion depth of the suction opening can be adjusted; 50 mm is usually adequate. This method is comparatively inexpensive, especially as the pump only requires a motor output of 750 Watt. However, to restore the biological balance again and to avoid repeat eutrophication, oxygen needs to be added to the water. This can be achieved with submersible aerators with efficient pumps. Instead of one large one, several smaller units can be used at the same time. For instance, Tsurumi’s starter model of the TRN series with a 0.75 kW motor output. The aerators, which only weigh 55 kg, blow the ambient air into the water to enrich it with oxygen. One special advantage of units working in parallel is that the water is mixed more evenly.

These aerators could easily work continuously in the summer months and be activated as required during the other months. The devices are mobile and are therefore not attached permanently in the tank. Compared to other aeration methods, the TRN models stand out thanks to the low overall costs and almost maintenance-free operation. For more information, please visit Tsurumi.de online.

Further information:
www.tsurumi.eu/



Source: Tsurumi

Infuses oxygen and prevents biological stagnation of water: Submersible aerator TRN by Tsurumi, here are three small devices that stand freely on the base of the tank – the water has been pumped out for simultaneous restoration of the tank

British Water boosts international business mentor team

Industry association British Water has strengthened its team of International Business Mentors with the appointment of Shaun Stevens, business development manager, EPS Water. Stevens is making his experience of the markets in Ireland, Jordan and Oman available to other British Water members.

British Water international director Lila Thompson said, “Our International Business Mentors are a fantastic resource, making exporters with experience of particular regions directly available to our members. We are the only association offering this service in the UK water sector and I’m delighted to welcome Shaun Stevens to this expert team.” Shaun Stevens said, “I’m pleased to have the opportunity to provide advice and assistance to British Water members looking to grow their businesses in the markets of Ireland, Jordan and

Oman. The first-hand experience that I and the other mentors can offer is invaluable to companies exploring new markets and seeking to grow their exports.”

International Business Mentors can help companies navigate regulations, logistics and trading tariffs. They can also help with networking, including identifying suitable local contacts and signposting projects and opportunities. Thompson added, “With Brexit there is a renewed desire to explore international markets and the Government is keen to look at new trade deals. This presents important opportunities for the water industry supply chain, especially SMEs.

“Smaller companies are not always comfortable taking advantage of the full range of opportunities, often because of the perceived risk involved. By meeting others, who have been there before, the route to new markets becomes clearer and they can learn more about achieving success and the pitfalls to avoid.”

British Water is the lead representative and business development organisation for the UK water industry supply chain.

Further information:

British Water
www.britishwater.co.uk

Source: British Water



Shaun Stevens

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Water 4.0 – advanced solutions for plant constructors and operators

Technical projects in water management have to meet the increasing demands of cost effectiveness, processing times and complexity. Plus, they have to handle challenges like climate change and a lack of specialists. The objective to provide water safely and economically worldwide does not only demand political willingness and financial resources. Digitalization and automation are essential according to the concept “Wasser 4.0”: They go easy on resources and keep the plant operators flexible and competitive. To this end the whole value chain of a plant’s lifetime is scrutinized with a holistic system assessment – to exploit potential for improvement by means of new methods and with innovative ideas. Data is the gold of the 21st century – for water management, too. The wealth of digitalized information enables new solutions, but on the other hand generates new questions for plant operators: Which tools help us open the treasure chest to make this information available to our employees? How can we prevent the degradation of data throughout the plant’s lifetime? How can we manage our digital data to turn it into one Single Source of Truth every employee and project participant can access? How can we use this information for the benefit of our employees?

Object-oriented consistent data repository

To answer these questions let’s take a closer look at potentials and options along the entire lifetime of a plant. Exceedingly few water management plants are developed homogenously in an object-oriented digital planning system. Typically data collection and data repository follow the individual construction phases. However, object-oriented bundling of all data and the integration of diverse planning tools can generate significant time savings and synergies – provided that from the very beginning all participants work with a jointly created data-pool or synchronize their data on a regular basis. Fitting systems to work with such a consolidated data base are state of the art. The next possibility of optimization is the transition from planning to construction. Given that object-oriented data is available in a consolidated manner, all project participants can access the entire documentation of the planning phase via mobile applications. In the field mobile devices can be used to report on the construction and commissioning process digitally.

Data consolidation versus data degradation

After successful commissioning, the degradation of data handed over by the plant manufacturer poses a problem that

Source: PWT Wasser- und Abwassertechnik GmbH



The modern way for information management on plants

should not be underestimated. Due to a lack of time, very often small and seemingly insignificant changes are neither documented nor corrected in the inventory of planning data. This gradually opens a gap between the actual and physical composition of the plant and the original as-built documentation. This gap can be prevented by regular consolidation of the data by an automated step integrated into the workflow.

Easier and safer work with computer-aided Augmented Reality

Data in the form of informal knowledge of experienced staff is essential for safe and economical plant operation. Augmented Reality (AR) - the computer-assisted extension to reality perception - takes over an important part. To support the operations personnel on the job and in combination with a mobile device (tablet or smartphone) this technology can provide important specific data to operators in the field including them into the picture of the real surroundings on a display. Through role-based allocation, every employee can receive exactly the information which helps them in every single situation. Likewise, AR makes it possible to put important safety instructions in front of risky process steps which first have to be acknowledged by the employee.

Due to the globally growing importance of water, the industry now faces a new problem: as supply and disposal facilities for communities are paid for and built with the assistance of international donors, highly trained staff are enticed away within a short time by private enterprises which can pay higher salaries. This makes it difficult to operate the plant in a standard compliant manner and to maintain it in the long term. An AR supported operation including prefixed safety instructions can reduce risks for personnel and facilities significantly which experience a high turnover of trained staff.

Offline mode: indispensable – even in a connected world

Thick walls, sturdy basement ceilings or an instable wireless network in the field – in practice it very soon becomes apparent that another benefit of a digital system is indispensable: Even in a server client architecture the client must always be able to work without connection to the server. The solution: before the operator leaves the reception area all data is transferred from to mobile device at the touch of a button. All data which is generated or changed in the following offline phase, is marked with a time stamp and transferred automatically to the source system after the operators return to the reception area.

With all these technologies and methods water management can fully benefit from the rich treasure of its own data. The mobile operations management system PRAMOS® by PWT offers a technical realization of the portrayed potential. It is a software system developed to provide the added value of connected people and systems to the plant operator during the entire life cycle of the facility. It can be experienced and tried out live at the presentation of PWT Wasser- und Abwassertechnik GmbH at booth A1.133 at IFAT, world's leading trade fair for water, sewage, waste and raw materials management, from May 14 to 18 in Munich.

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Remote monitoring system for water

VINCI Facilities has won an innovation award for its work in the Royal Parks using advanced water level monitoring technology and cloud-based data management from OTT Hydrometry to improve the management of the Longford River. The VINCI Facilities Innovation Awards competition takes place every two years covering 12 regions throughout the world. Celebrating innovation and advanced technology, it is one of the ways in which the company recognises and showcases the creativity and entrepreneurial spirit of its c.200,000 staff from around the world.

The UK and Ireland Regional Innovation Awards Ceremony took place in 2017, evaluating 167 projects from which 34 were shortlisted at the Regional Jury in May 2017 and, of those, 12 made it to the award ceremony in London. Five winning entries were selected, including a project conducted by VINCI Facilities working in partnership with the Royal Parks. VINCI Facilities manages around 37,000 assets in the Royal Parks ranging from fountains and statues to special features such as royal memorials in Hyde Park, Richmond Park, Regent's

Park, Kensington Gardens, Greenwich Park, St James's Park, Bushy Park, Green Park and Brompton cemetery.

This work has been ongoing for over ten years, and the award was given in recognition of the advanced management practices and cost savings that have been implemented on the Longford River - a 12 mile stretch of river which feeds the water features of Bushy Park and Hampton Court Palace, with outlets to the River Thames. Built for King Charles I in 1638/39, the course of the Longford River has been diverted in recent times to accommodate the growth of London Heathrow Airport. The river passes through residential and industrial areas so the maintenance and ongoing management of the river helps to protect local residents from flooding and preserve the ecological status of the river.

In the past, VINCI Facilities has employed 3 staff to continually check the status of the river. "This has involved visual inspection by individuals that had to frequently walk the length of the river," comments James Lyall, VINCI Facilities' account manager for the Royal Parks. "They were constantly

Source: OTT Hydrometry



River cleaning

looking for changes in water levels that could arise from heavy rain, weed growth or from illegal dumping of waste such as mattresses and sofas.”

James believed that the process could be more efficient and that cost savings could be achieved if his team was able to monitor water levels remotely. He therefore contacted a number of potential technology providers, reviewed the available options, and chose OTT Hydromet as the preferred supplier. “In addition to robust, reliable water level measurement technology, we also needed a system that would provide easy access to data including historical trends, and issue alerts when water levels approach pre-set alarm levels,” James explains. “One of our key requirements was a web-based portal – providing a facility for our staff, our client’s staff and the public.”

OTT supplied, installed and commissioned the monitoring network, and provides ongoing maintenance with 6-monthly visits. OTT’s Robin Guy has been involved from the beginning. He says: “Much of our equipment is deployed in remote locations, so it is designed to be extremely robust and to operate on very low power. The ecoLog 500, for example, which was chosen for the Longford River, is drift-free and does not require recalibration, so our service engineers are mainly looking for any damage or blockages in the stilling well that might affect the measurements.

“We initially installed 4 monitors as a trial, but the plan is to install more – near Bushy Park and further up the river towards Heathrow airport. The beauty of our data management system ‘Hydromet Cloud,’ is that it is almost infinitely expandable – we have customers with over 100 monitoring ‘nodes’ collecting and viewing data such as water level, water quality, rainfall and even webcams.”

Deployed in a secure lockable stilling well which is attached to the bank of the river, the OTT ecoLog 500 combines a ceramic pressure transducer and temperature sensor in a sealed housing with an internal datalogger. Lithium batteries provide power for 3 to 5 years, and a modem with a sim card facilitates GPRS, 3G or 4G communication with Hydromet Cloud.

Hydromet Cloud provides the ability to process, display, and store measurement data from nearly any remote monitoring station via a cloud-based data hosting platform.

Designed for flexibility, the system enables users to create their own dashboard to quickly collate frequently viewed data, which can be displayed as plots, tables or values, and exported in a variety of formats, which enables the analysis of trends. This facility to create a bespoke display is enhanced by a map view with colour-coded map pins (for alarm status), current data values and colour-coded parameter values highlighting alarm status. Alarms are user-defined for values, rate of change etc. and alarm messages are issued automatically by email, text or push notification on a mobile phone. Separate limits can be set for both warning and critical levels, and users can also create alarm distribution groups for notifications.

The Hydromet Cloud mobile App provides a quick and easy opportunity to view the status of an entire network or an individual monitoring station, with options to send/share



Source: OTT Hydrometry

The old method of monitoring

data directly from a smartphone or tablet (iOS or Android). It is also possible to create and save ‘My Plots’ to quickly recall common plots of one or more parameters graphically illustrating recent data.

“The ability to analyse trends is a major advantage,” James says. “It provides us with a greater understanding of the river’s behaviour under different conditions, and enables us to implement remedial action faster than was previously possible.”

Alarms have been set on the Longford River for both high and low water levels. High level alarms enable James’s team to implement measures to prevent the flooding of local residential and industrial properties, and low level alarms help to prevent the loss of water to gravity-fed water features such as the Diana Fountain in Bushy Park. James says: “High water levels across all of the monitors are usually caused by heavy rainfall, but a high level alarm from one monitoring point indicates a localised problem such as a grill blockage. So, the monitoring system helps us to identify the source of the problem much faster.

“Low level alarms can be remedied by requesting more water from Heathrow, but we need to give them plenty of notice, so again, advance warning is a major advantage.”

Summarising, James says: “It was great to win the innovation award, but our success is simply a reflection of the benefits that we have managed to achieve for our client. The implementation of a remote river monitoring system has resulted in savings of over £100,000, and this has been used to further improve river management through initiatives such as desilting, weed removal and other river enhancement measures.”

“This success could not have been achieved without the close working relationship that we established with the Royal Parks and OTT Hydromet.”

Further information:

OTT Hydrometry Ltd
www.ott-hydrometry.co.uk

Pump technology for major lock expansion in Belgium

Being part of a complex project to expand the Lanaye Locks in Belgium, water and wastewater solutions company Xylem has designed a state-of-the-art water pumping solution. The locks are a vital route between Northern and Southern Europe. Xylem's Flygt pumps and turbines will regulate water levels in the canal network and harness energy from excess water. Located on the Belgium-Netherlands' border, the Lanaye Locks link the Albert and Juliana Canals, the latter of which is a side canal of the River Meuse. Three locks have operated alongside each other since 1964 but, as two of these are too narrow to accommodate even smaller convoy, the larger lock had over time become a serious bottle neck for canal traffic.

The addition of the new fourth Lanaye lock (225 meters x 25 meters) quadruples the lock system's convoy capacity from 2,000 to 9,000 tons. "The construction of the fourth Lanaye lock is one of the largest civil engineering projects of the

decade in Wallonia," said Patrick Delperdange, Senior Operations Manager BESIX Civil Works. "The works required the on-site production of over 220,000 cubic meters of concrete. BESIX finished this ambitious project within the agreed time-frame, while also coordinating the electromechanical works, among them the realization of the hydroelectric power and pumping plant."

A pump system to maintain water levels

Xylem was commissioned by the project consortium BESIX Sanotec-Balteau to develop a compact solution to address challenges associated with seasonal water level changes in the lock. Therefore, five Flygt 500 kilowatt (kW) submersible pumps were used with a flow of 18 cubic meters per second (m^3/s). They pump water back into the Albert canal, maintaining adequate levels to accommodate canal traffic during dry weather spells.



© All pictures: Xylem

The Lanaye Lock at the Belgium-Netherlands border



Careful working was required while placing the turbines

Recovering lost energy

For most of the year, high water levels in Northern Europe require water in the canal network to be directed towards the Netherlands, where it flows into the sea. A major objective of the lock project was to recover some of the lost energy associated with this process. Xylem delivered five Flygt turbines each with an output of 460 kilowatts (kW) to harness energy and ensure minimal losses. Energy generated by the turbines flows into the electrical network.

“Inflow conditions in the turbines must be carefully regulated in order to avoid disruption to canal traffic in the main channel,” said Daniel Van de Gucht, EMEA Key Account Manager, Public Utilities for Xylem. “Turbulence in the system can also result in energy losses and reduce the lifetime of the turbines.”

A balanced flow with minimal energy losses

Xylem’s solution was based on a reduced pipe network, which ensures a perfectly balanced flow and minimal energy losses. The system ensures lower energy consumption by the pumps and more power generated by the turbines. The reduced pipe network also means fewer components are subject to wear, which increases the lifespan of the turbines.

Adrien Theunissen, Senior Manager at BESIX Sanotec, said, “Thanks to the engineering capabilities of BESIX Sanotec, CMI Balteau and Xylem, we could propose an alternative to the original scheme that was very attractive for the client. This resulted in enhanced efficiency and a reduction in construction and maintenance costs. The synergy between the partners contributed to a fruitful cooperation at all stages of the project.”



Each of the machines was built into a pipe barrel

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Water for Atlanta

A major lighthouse infrastructure development program was started to increase drinking water supplies for more than one million residents of Atlanta, Georgia, USA and its surroundings. The former Bellwood granite quarry northwest of the city is to become one of the biggest water storage facilities in the United States. Thanks to its technically superior, innovative, and economical solution in regard to energy consumption, sustainable reliability but also significant lower lifecycle costs, ANDRITZ was awarded this strategically important contract to supply three submersible motor pumps complete with peripheral equipment for Quarry Pump Station. One of the most important technological advantages of the suggested ANDRITZ solution to meet the special technical requirements is the use of submersible motor pumps in double-suction design. For this purpose, two impellers rotating in opposite directions are arranged one above the other and driven continuously by a pump shaft. This compensates in full for the axial thrust, regardless of the rotation speed. The hydraulic thrust forces acting on the pump, the motor, and the axial bearings, are completely.

The former Bellwood granite quarry northwest of Atlanta, Georgia, is to become one of the biggest water storage facilities in the United States as part of a major infrastructure development program to increase drinking water supplies for more than one million residents of the city and its surroundings. As the capital and the most populous city in the state, Atlanta has intensified its efforts to alter the city demographics, politics and culture to become a pioneer in enhancing safe and stable supplies of potable water for its citizens.

Atlanta has been striving to modernize its infrastructure and revitalize its neighborhoods since the 1996 Olympic Games. One of the most prestigious and important projects is set to dramatically increase the city's drinking water supplies.

Bellwood quarry – northwest of Atlanta's downtown district – is going to become one of the biggest water storage facilities in the country, storing some 2.4 billion US gallons of water (9.1 billion liters) as part of this program. This expansion of the city's raw water storage capacity will provide Atlanta with a reliable supply of drinking water for the next 100 years and increase the emergency raw water reserve from just three days to 30 days. The Department of Watershed Management, which is in charge of the water supply of about 1.2 million people in Atlanta and its surrounding area, is investing about US\$ 300 million in this project.

Converting a 300 ft (91.4 m) deep quarry into a water storage facility and recreation area includes blasting two circular pump station shafts near the quarry, one 35 ft (10.7 m) diameter and 200 ft (61 m) deep and the second with a 20 ft (10.6 m) diameter and 300 ft (91.4 m) deep. Five further 6.3 ft (1.9 m) diameter pump shafts are to be constructed, along with a new power substation and various improvements to existing infrastructure. Central to this project are the 136 million gallons per day (mgd; 21,451 m³/h) Hemphill Tunnel Pump Station with four vertical turbine pumps and the 200 mgd (31,545 m³/h) Quarry Pump Station with four vertical turbine pumps and three submersible turbine pumps.

The quarry will be filled through a five-mile-long (7 km) tunnel that will connect it with the Hemphill and Chattahoochee Water Treatment Plants and the raw water intake and pump station at

Source: Andritz



ANDRITZ was awarded this strategically important contract to supply three submersible motor pumps complete with peripheral equipment for Quarry Pump Station

the Chattahoochee River, the city's primary water source. The work also involves boring this 10 ft (3 m) diameter tunnel, as well as the mechanical, electrical and SCADA systems associated with the pump stations.

Drilling is being done by an impressive 400 ft-long tunnel-boring-machine (121 m), which arrived in Georgia in July 2016 on 70 trucks and assembled directly on-site.

After a public naming contest, the tunnel-boring-machine was named "Driller Mike" as a tribute to Atlanta resident Michael Render, aka "Killer Mike", a famous rapper, actor and activist. The artist is honored to be associated with this project.

After completion of the project, the city plans to develop a 300 acre (1.2 km²) recreation area at the site – the Westside Park. It will be the largest park in Atlanta and will be designed with public input in accordance with the Department of Watershed Management requirements.

The strategically important contract to supply the submersible pumps, including associated equipment for the low level pumping station, was awarded to ANDRITZ on the basis of a technically superior, innovative, and very economical solution. Offering a turn-key solution provides a sustainable, low-maintenance service concept with low follow-up costs. In contrast to previous projects, direct contact between the engineering company and the owner was possible. Consultation and engagement with the owner during the early development stages was a major advantage.

As water is withdrawn and the water level drops to very low levels, the system requires that each submersible motor pump has a constant capacity rated at 30 mgd (4,842 m³/h), even under fluctuating water surface levels ranging up to 120 ft (36.6 m). between minimum and maximum. To achieve this system requirement whilst operating under this submergence differential the submersible motors are driven by a variable speed drive, which enables the motors to run at varying speeds between 885 rpm and 1,081 rpm. Variable speeds change the axial forces on the rotating unit, which results in varying shaft elongation and ultimately in undefined dynamic loads on the axial thrust bearings.

One of the major benefits of the proposed ANDRITZ solution using double suction submersible motor pumps is the full compensation of the axial thrust independent of the rotational speed. This characteristic neutralizes the load on the pump, the motor and its thrust bearings. With this technology, two contra-rotating submersible motor pumps are arranged on top of each other and driven by a continuous pump shaft. Each of the two pumps transports half of the capacity to the middle of the pump at full pressure. This significantly reduces wear and tear, increasing service life to up to 20 years and more and provides the maximum possible

Technical data:

Output:	1.65 MW
Primary Rated Capacity:	30.7 mgd
Primary Rated TDH:	160 ft
Rated Motor Power:	2,210 HP, 60 Hz, mx. Speed 1,081 rpm

3 × Double Suction Submersible Motor – Pump Units with discharge piping and variable speed drives

1 US gal. = 3.78 liters, 1 ft = 0.3048 meters, 1HP = 0.75 kw,
1 acre = 4,046 m²

operational reliability. The division of work between the two pumps not only achieves the complete compensation of axial thrust, it also halves the suction velocity at the pump inlets. This protects the well walls around the intake openings and minimizes the intake of abrasive solids and silt.

ANDRITZ HYDRO received this important order – the largest pump order for ANDRITZ in North America to date – from the Joint Venture PC Construction and H.J. Russell. It marks an important step into this growing market. The ANDRITZ team, comprising engineers and specialists from the US as well as Europe, are proud to prove the high quality of ANDRITZ pumps and equipment and are pleased to contribute to the future supply of hundreds of thousands of people with fresh drinking water.

The completion of the project is scheduled for 2019 and will address Atlanta's goal of achieving a sustainable water infrastructure for future generations and flexibility in systems operation. In the event of a crisis or loss of water service, it provides redundant water storage and can save the city millions of dollars per day.

An abandoned granite quarry west of Atlanta – world famous from its appearance in television dramas such as "The Walking Dead", "The Hunger Games", and "Stranger Things" – is on its way to becoming a communal amenity for Atlanta.

Further information:

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The ANDRITZ GROUP

- ▶ ANDRITZ is a globally leading supplier of plants, equipment, and services for hydropower stations, the pulp and paper industry, the metalworking and steel industries, and for solid/liquid separation in the municipal and industrial sectors as well as for animal feed and biomass pelleting. Other important business segments include automation and service business. In addition, the international Group is also active in the power generating sector (steam boiler plants, biomass boilers, recovery boilers, and gasification plants) and in environmental technology (flue gas cleaning plants) and offers equipment for the production of nonwovens, dissolving pulp, and panelboard as well as recycling plants. The publicly listed technology Group is headquartered in Graz, Austria, and has a staff of approximately 25,200 employees. ANDRITZ operates more than 250 sites in over 40 countries.



Water crisis is the new trending topic:

Cape Town, Namibia, Sao Paulo, California: these are only a few examples of locations which are currently going (or have just gone) through drought crisis. The good news is, through the improvement of standard processes and the development of new techniques, it is possible to work around the problem. In this issue such techniques were given the importance they deserve. But what about developing countries? The lack of water supply systems in rural areas seasonally causes water shortage. In many cases hand pump wells, as shown in the picture, dry out during dry season.



“The path taken with the entry into force of the WFD needs to be continued”

Interviewed by Water Solutions, Raymond Erpelding, director of Luxembourgish intermunicipal sanitation company S.I.A.CH. and president of the Luxembourgish water association ALUSEAU, stresses the positive effects the European Water Framework Directive had so far, even if implementation caused some problems and the required good water status cannot be reached until 2027.

Introducing the Water Framework Directive 17 years ago, the European Parliament aimed to reach “good status” for rivers, lakes, transitional and coastal waters, and groundwater by the year 2027 at the latest. Actually, what status do European water bodies have today?

Erpelding: With the implementation of the Water Framework Directive (WFD), it is very sure that the state of waters in Europe has improved significantly since then. The WFD introduced key elements for water management like for example cross-boundary river basin districts as the basis for decisions, a regular monitoring of the different water bodies according to EU-wide methods, standards and evaluation procedures or the pursuit of a scientifically derived target

horizon for good status of waters. All these measures have proven their effectiveness.

... but nevertheless, most waters are far from the required “good status”.

Erpelding: At least the status of the most water bodies in the EU has been monitored and therefore the knowledge of the different water bodies has improved significantly. The direction taken with the introduction of the WFD needs to be consistently pursued. Reaching a good status of all water bodies is, however, a very challenging target. This work will exceed the time horizon of one generation. Even where the implementation of the WFD is ambitiously pursued there is a high chance that the good water status will not be achieved EU-wide until 2027.

What do you reckon are the biggest problems implementing the Water Framework directive?

Erpelding: In Luxembourg one of the biggest problems has been to set up a complete new Water Management Administration called Administration de la Gestion de l'Eau to bundle practically most of the competences regarding water management who had before been in many different state ministries with their respective agencies. After that the transposition of the directive in national legislation took also huge time. I presume that this transposition took even more time in bigger member states with a much more complex state organisation.

Problems were also encountered to finalise the regular monitoring processes of the different water bodies according to EU-wide methods, standards and the evaluation procedures which had also to be defined previously. After that the adoption of the river basin management plans containing the proposed measures with the involvement of all interested parties in the



implementation of the WFD could only be approached. All these rather administrative and formal proceedings had been important, but in real this didn't contribute on the field to a real improvement of the water bodies. The implementation work of the measures only started with a real delay regarding the timetable of the WFD.

Do you think, there is a kind of Luxembourg point of view concerning WFD? Does Luxembourg have some special problems or advantages, e.g. because of its size?

Erpelding: On one hand Luxembourg has the advantage that due to its small size, the national Water Management Administration has facilities to have a very good overview of the general status of the different water bodies. On the other hand, the Luxembourgish authorities are not able to afford specialists in each specific domain addressed by the Water Framework Directive. Being member of the river commissions of the two river basins, Rhine and Meuse, allows important knowledge exchange between the experts of the different member countries.

I see a big problem for Luxembourg just because this small country lies on the watershed of the two river basins, which entails that Luxembourg has mostly very small water courses. Discharging water from

“The polluter pays principle must absolutely apply for the elimination of new substances found in water bodies.”

regions with a very high density of population and huge economic and industrial activities can lead to big problems in these small creeks. To reach and maintain a good water quality, the treatment standards for wastewater and even rainwater have to be very high.

Do you think new water treatment technologies like for example membrane filtering, ozonation technology and activated carbon powder have influence on reaching the aims of the Directive?

Erpelding: All these nominated techniques are technologies for treating water pollution. These technologies are mainly used to eliminate micro pollutants from water in order to produce drinking water or to eliminate these pollutants from wastewater before discharging it into the nature. I think that control at source of these pollutants would be much more efficient in order to prevent that they enter into the water cycle. This would be more effective as such “end of pipe” treatments.



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Lying on the watershed of the two river basins Rhine and Meuse, Luxembourg has mostly very small water courses, Raymond Erpelding explains

“The previous implementation process shows insurmountable discrepancies between the targets set and the chances of realisation in between the current timeframe. This needs to be corrected, but without an increase of requirements.”

So, no “end of pipe” treatment at all?

Erpelding: In several regions it might be necessary to use such treatment technologies in order to reach the good status of the water bodies, but these will be very costly measures. These treatment technologies are today mandatory for the production of drinking water from surface water. But due to a lack of protection of the groundwater resources, in many regions such treatment technologies are nowadays also necessary to produce drinking water of good quality from groundwater resources. This makes a big economic difference compared to the former distribution of abstracted untreated groundwater.

Regarding the costs you mentioned, who has to pay for it?

Erpelding: These exploding costs are the result of the more sophisticated treatment needs. As stated before it would be more efficient to prevent the entering of such micro pollutants in the water cycle by control at source. With an “end of pipe” treatment approach, it would be the final user or customer who pays for these costs. This is not in line with the polluter pays principle required by the WFD.

Which role play ubiquitous substances in this context?

Erpelding: For the so called ubiquitous substances, e.g. mercury or PAH, more differentiated rules, for example with graded environmental quality standards staggered over time, should also apply so as to be able to solve the problem of the unavoidability of exceeding values in these parameters in a practical way. Also in Luxembourg several of these ubiquitous substances have been measured countrywide in practically every water course! As it is even not clear at the moment from where these substances are occurring, the Water Management Administration is not able to propose measures in the management plan. This means at the moment that for all the concerned water bodies it is not clear how the good status could be reached!

Critics say while on the one hand achieving better water quality, the required “good ecological status” can’t be reached and river basins keep their red markings. Does the WFD allow too less space for gradations or differentiations?

Erpelding: Effectively, the WFD in its actual form does not allow any space for gradations or differentiations. In relation to the problems with the ubiquitous substances problem in Luxembourg and in many other regions, the river basins will effectively keep their red colour.

What impact do better measuring methods have on the assessment of water bodies’ state?

Erpelding: It’s very clear that better measuring methods leading to the identification of new substances in the water bodies will have an impact on the assessment of the water bodies’ state. An impact assessment before bringing new substances to the market and a better control at source of such substances will prevent these substances from discovering later on in the water bodies. The polluter pays principle must absolutely apply for the elimination of such new substances.

Regarding the WFD, are there any differences between eastern and western, northern and southern European countries?

Erpelding: There are huge differences between these European countries, regarding for example the conditions of the water bodies, the weather conditions, the risk of water abundance or scarcity, the distribution of competences in water management between federal, regional or local level, etc. Personally, I think that the methodologies introduced by the WFD are so general, that these differences can be taken into account. Depending on these differences, the management plans and the programmes of measures can selectively address the targets which could also diverge depending on real conditions in between these different regions.

Do we need a multi-speed Europe even concerning water bodies or is it most important not to leave anybody behind?

Revision of WFD

In 2018 and 2019 the Water Framework Directive has to be revised. According to the European Water Association EWA, there is much need for modification. Being member of the European Policy Committee Raymond Erpelding states the most crucial points.

- The ultimate objective of the WFD must remain to achieve the good status of all waters. But this goal can only be achieved gradually. There should be set realistically achievable intermediate targets in between the different management cycles in order to gradually improve the status of the different water bodies. This approach would allow to make the success of the considerable efforts in water protection and water quality improvement more visible.
- The “one out – all out” principle often masks the view of the success of water management activities and therefore is an obstacle when it comes to presenting effective measures for water protection. Therefore, the review process should include considerations how improvements in individual evaluation components can be made more visible in the future.
- The review process should be used to make the important instrument of deterioration prevention more practical with regard to the uses of water. The rulings passed by the European Court of Justice are leaving a number of open questions regarding the non-deterioration principle. Under the non-deterioration principle, it also has to be possible to grant authorisations to discharge without increasing the requirements and or having to resort to derogations. For surface waters additional efforts should be made to extend the spatial frame of reference of the deterioration prevention from the individual water body to larger areas of consideration.
- According to the ruling of the European Court of Justice on the non-deterioration principle, the derogation provision fixed in article 4 para. 7 WFD is to be applied so that, in individual cases, intentions can be permitted which collide with the non-deterioration principle but which are in the public interest. Here, in particular, water management tasks should be taken in consideration which are required by other European laws, such as the provision of drinking water and disposal of waste water, energy supply and infrastructure. In order to avoid de facto prohibitions of any activity with an impact on water bodies, the exceptions to the management objectives for the ecological status according to article 4 para. 7 WFD also have to be applied accordingly to the chemical water status. However, this is not undisputed. In order to create legal certainty, it is advisable to adapt the WFD at least for the sake of clarification. This would make it also possible to weigh up interests in favour of intentions with material water changes.
- In article 2, the WFD distinguishes between an ecological status that emphasises the quality of the structure and functioning of aquatic ecosystems in connection with surface waters and a chemical status that describes the material properties of surface waters with regard to the priority substances listed in Directive 2013/39/EU. Appendix V of the WFD that, among other things, determines the quality components for the classification of the ecological status abandons this systematisation. Because this also names specific pollutants as components for this classification which are discharged into water bodies as other substances (river basin-specific pollutants) in significant quantities or as priority substances. The classification of surface waters by chemical status should, therefore, be consistent with the definition in article 2 no. 24 WFD. Appendix V of the WFD needs to be amended so that in the future, all environmental quality standards for the assessment of the chemical status of surface waters are applied and not only the requirements for priority substances and priority hazardous substances as was previously the case. In addition, the river basin-specific substances are to be used for the assessment of the chemical status.
- On the other hand, it seems to be systematically misguided and technically unfounded that, according to the WFD, the exceedance of even one EQS from the category of river basin-specific pollutants leads to classification of the ecological status of waters as, at best, moderate regardless of the possibly objective-compliant assessment of the biological quality components. The aim should be the strict separation of substances and water ecology in water management laid down in the WFD. This would provide clarity and facilitate enforcement for all stakeholders in the water sector without the need to compromise on the requirements level of the directive.
- The regulation on ending the emission of so-called priority hazardous substances has not gained any practical significance since the WFD entered into force. An agreement at EU level on measures to the phasing out obligation was not possible. It is therefore recommended to review the development of the requirements for the phasing-out process.
- A stronger integrative consideration and harmonisation of the existing European regulations with the WFD should be foreseen. This task offers great opportunities for improving water protection and reducing bureaucracy and should already be carried out within the upcoming review process, if possible. The harmonisation of substance-related regulations is considered to be an important partial aspect here. Specifically, this also means harmonising the regulations for the assessment, approval and use of substances as they result from, for example, the REACH Regulation, CLP Regulation, Biocidal Products Regulation and phytosanitary or pharmaceutical legislation, more closely with water law. It is necessary to bring the differences between the different sets of rules together in a comprehensive, integrative solution. When harmonising the WFD with other existing European regulations, for example, flood risk management, also EU agricultural policy and its subsidy programmes and energy policy need to be taken into account.

“It would be very important to provide planning security for the water sector. Therefore, the European Commission should accelerate the review process and implement its results as fast as possible.”

Erpelding: We have anyway a multi-speed Europe regarding former water policy. Before the WFD, EU water policy addressed important pressures on the aquatic environment through the adoption of, for example, the Urban Waste Water Treatment (UWWT) and the Nitrates Directives, which are now daughter directives of the more recent WFD. These directives provide water protection with respect to nutrients pressures associated with agriculture and urban developments and contribute significantly to the WFD objectives.

Implementation of these directives are relatively advanced in the older member states (EU15), but significantly less in the member states that joined the EU since 2004 (EU12) which enjoyed different transitional periods. When even the older member states (EU15) are late with the implementation of these “older” directives and therefore have pending cases at the European Court of Justice (ECJ), it might be clear that the member states who joined since 2004 (EU12) will even have more delay regarding these implementations because of their transitional periods.

When considering that a correct implementation of these daughter directives is seen as a basic condition for reaching the goals of the WFD, it is very clear that there might also be a multi-speed Europe regarding the implementation of the WFD.

Many citizens – and even some politicians – may say we have some more important issues to focus on in Europe than reaching “good status” for some water bodies while Europe is breaking up. What do you answer?

Erpelding: Reaching the good status of all water bodies means to secure the water resources for all the citizens and for all kinds of activities. Even if Europe has actually several political problems, hopefully nobody will abandon the principle that preserving our water resources isn't a highly important issue. Without that protection, Europe would be much less secure and even today people all over the world are leaving their country or region because of a lack of water resources.

As you pointed out earlier, the aims of WFD can't be reached by 2027. So, how to go on with the directive?

Erpelding: I'm convinced, that the path taken with the entry into force of the WFD needs to be continued. The previous implementation process shows insurmountable discrepancies between the targets set and the chances of realisation in between the current timeframe. This needs to be corrected, but without an increase of requirements. A continuation of the WFD as a basis for water management beyond the current deadline of 2027 is absolutely needed. The WFD should be adapted taking into account the practical experience while maintaining its level of requirement. It would be very important to provide planning security for the water sector – especially regarding the next management cycle – and therefore the European Commission should accelerate the review process and implement its results as fast as possible.

Interviewee

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Team approach solves water problems at major airport

When one of Scotland's busiest airport needed a reliable flow measurement, Katronic were tasked with providing the solution. The airport operator was faced with the considerable problem of having a one hundred year old 18 inch water pipe running directly under the runway feeding water to several local towns. According to the available information the pipe (**Figure 1**) was originally installed in 1910 and there were serious concerns about its physical integrity over a century later. With up to 8 mega litres of water flowing under the runway each day, it was crucial that the operator was able to monitor, measure and act upon any changes to the flow to avoid major incidents. A pipe rupture would not only have caused inconvenience to householders, it would have potentially closed the runway and consequently the airport.

Initially the customer contacted a company called Syrinix, a recognised market leader in



Figure 1: One hundred year old 18 inch water pipe running directly under the runway of major airport



Figure 2: The KATflow 100 clamp-on ultrasonic flowmeter with a robust design for permanent installation

data and to identify points for permanent sensor mounting (**Figure 3**). This preparatory work was also useful as it set an initial baseline flow reading to act as a starting point for the eventual fixed installation flowmeters. The compact KATflow 200 was perfect for measuring in the confined conditions under the runway where space was at a premium.

Once Processplus had completed the survey, they installed two KATflow 100 clamp-on flowmeters at the key locations. Katronic then assisted Processplus with the configuration of the process outputs and the connection of the meters to the Syrinix Pipeminder. This device is programmed to alarm should there be an unexpected or sudden change in the flow rates seen by the Katronic meters. The Pipeminder is also connected to pressure caps on fire hydrants either side of the airport and will alarm in case of a rapid pressure loss. The information from these combined instruments will allow the user to monitor changes in the pipe condition. Crucially the system will give an



Figure 3: Engineer using a portable KATflow 200 ultrasonic flowmeter to obtain provisional flow data

intelligent pipeline and leakage solutions. They in turn recommended the use of one of their Pipeminder systems to constantly monitor the pipe condition and give an early warning of any potential issues. Syrinix selected the local company Processplus in order to support them with a package of process instrumentation needed to link raw data to the Pipeminder. Processplus are very experienced in the area of flow measurement instrumentation and are a trusted supplier to the Scottish water sector. They contacted Katronic to supply two KATflow 100 clamp-on ultrasonic flowmeters (**Figure 2**) as the source of the flow input into the system. These meters were selected as the non-invasive nature of the technology was ideal for retrofitting onto a pipe of this age.

Before settling on a final solution to the issue, engineers from Processplus used a KATflow 200 portable flowmeter to conduct a site survey and ensure that the proposed measurements were viable. The portable meter was installed at two locations with positive results enabling them to obtain provisional flow

advanced warning of any potential pipe burst and provide the customer with peace of mind for the years to come.

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Over 255 billion euros yearly to be invested in water infrastructure globally

The World Water Council (WWC) urges Governments, investment banks and funds worldwide to prioritize financing for adapting and mitigating water infrastructure to increase resilience to climate change effects. Dealing with climate change is at the core of the World Water Council's goal to strive for the availability of safe water for all and to help increase water security at large. The WWC groups over 300 member organizations worldwide who, together, further global dialogue and international cooperation to adapt to and mitigate the effects of climate change on water security.

The UN 23rd Conference of Parties (CoP23), presided by Fiji, was held in Bonn from 7th to 18th November 2017. The CoP23 featured water security as a connector for human development and a vector for climate change adaptation. The summit designated November 10th as Water Action Day within the Marrakech Partnership for Global Climate Action Programme and coordinated by members of the #ClimatelsWater initiative.

#ClimatelsWater was launched during CoP21 and is coordinated by the World Water Council. Its members include WWC, AGWA, SIWI, INBO, IUCN, the French Water Partnership, the Moroccan Ministry for Water, the Bill and Melinda Gates Foundation, UNESCO, the French Water Academy, IWRA, Water Aid and Women for Water Partnership, as well as 50 other member organizations from around the world.

The focus on financing is key to overcoming hurdles to achieving the UN Sustainable Development Goal 6 (SDG6) to make safe water and sanitation a universal reality by 2030 and was addressed by a CoP23 High Level Panel on Water and Climate

Financing. Unlocking and tapping into financing was not only a key focus for CoP23 but also for the triennial World Water Forum, held in Brazil from 18 to 23 March 2018.

Crucial to public health and economic development, the water sector faces major challenges in obtaining sufficient funding to meet investment requirements. According to UN publications, 80% of countries report insufficient financing to meet national drinking-water and sanitation targets, despite a rise in domestic budget allocations. Access to financing is a crucial step in the fulfilment of the UN Sustainable Development Goal 6 (SDG6) to ensure availability and sustainable management of safe drinking water and sanitation for all. The financing gap has been identified as one of the greatest barriers to achieving this target. Financial investment in water infrastructure would need to triple to 255 billion euros per annum, taking into account operating and maintenance costs to reach the United Nations SDG6.

With the aim of raising international awareness on water and climate change, documents, discussions and recommendations were compiled within the Water and Climate Blue Book as a tool to foster action. The Blue Book was developed by the Moroccan Ministry of Water, the French Ministry of Environment and the World Water Council for CoP22. A second edition with updates on progress and recommendations, including on financing water infrastructure, was presented at the Moroccan Pavilion during CoP23. Financing water infrastructure was a key element of the report. David Hebart-Coleman, African Development Bank expert on climate change and water, underscored the importance of adequate



M. Großmann / pixelio.de

100 billion euros a year are needed for adequate new water infrastructure and at least another 155 billion euros are needed to renew and improve equipment to adapt and climate change and mitigate global warming

access to existing climate change funds for water infrastructure financing: “Initially climate change was just seen as something we had to deal with. Now it is increasingly seen as an opportunity to push water up the agenda because we believe that most water supply and sanitation actions are climate resilient.”

“As part of the World Water Council, we seek to encourage continued dialogue between the water and climate communities as well as state and non-state actors for better water management and infrastructure financing within the uncertainty posed by climate change,” said Dogan Altinbilek, Vice President of the World Water Council.

Many of the discussions during this global environmental summit paved the way to the world’s biggest water related event, the 8th

World Water Forum which took place in Brazil from 18th to 23rd of March 2018. World Water Council President Benedito Braga commented: “It is in water where we will find the best manner to adapt or mitigate the effects of climate change. We are united in our dedication. As the organizer of the World Water Forum together with the Brazilian government, we were looking forward to catalyzing change for a water-secure world during the 8th World Water Forum, which united over 30 000 stakeholders at the world’s largest water related event.”

Further information:

www.worldwatercouncil.org

About the World Water Council:

- ▶ The World Water Council (WWC) is an international multi-stakeholder platform organization, the founder and co-organizer of the World Water Forum. The World Water Council’s mission is to mobilize action on critical water issues at all levels, including the highest decision-making level, by engaging people in debate and challenging conventional thinking. The Council focuses on the political dimensions of water security, adaptation, and sustainability, and works to position water at the top of the global political agenda. Headquartered in Marseille, France, and created in 1996, the World Water Council brings together over 300 member organizations from more than 50 different countries. More on www.worldwatercouncil.org @wwatercouncil #wwatercouncil



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Condition Assessment of Pipelines as part of asset management

An online database provides digital support for the gargantuan task

The renewal of pipelines is a major cost factor in the budget of any water company. Dedicated condition assessment can help determine the optimal timing for such investments. One of the challenges is to find the right tool for each specific project from the plethora of available solutions. The Isle CATwizard bridges this gap: An online Database built for choosing technologies and for a global exchange of experiences for experts in condition assessment of drinking water pipelines.

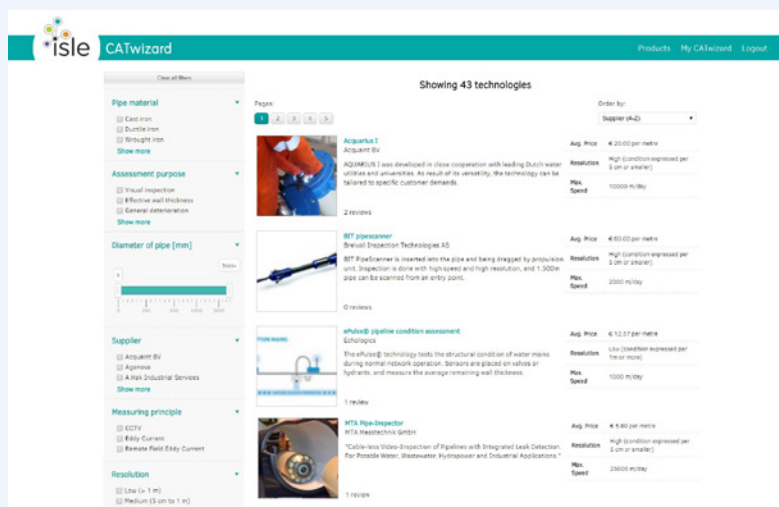
Aging infrastructure – a global challenge

The maintenance of ageing underground infrastructure is amongst the most demanding and cost-intensive tasks in the water industry. For water companies, two main aspects are in focus: Preventing uncontrolled losses, known as non-revenue water (NRW), and the optimization of investment strategies. In some countries, NRW can be as high as 50%, thus detection and repair of leakages is of major concern [1]. In regions where infrastructure leakage levels are low, companies are keen to know about the exact condition of their pipes in order to implement predictive maintenance and pro-active renewal of pipes. The determination of the point in time to

implement such measures is of major importance for investment cycles and the economic figures of a company. In the EU alone, there is a total length of 3,6 million km of drinking water pipes laid underground, with an estimated value of 958 billion € [2]. In the light of these figures, the value of an integrated asset management approach is obvious.

In some way, most global water utilities are addressing this concern in their asset management strategy, relying on theoretical remaining life time prediction models. These models are typically a function of static data like pipe material, age, water chemistry, soil condition and in rare cases also one or two dynamic parameters such as failure history. Although utilities rely heavily on these models when it comes to prioritising their pipe replacement strategy, often a crucial validation link is missing. Assessing the actual condition of red-flagged pipelines before these are replaced can radically impact the efficiency of the asset management cycle.

Benefits of applying condition assessment technologies for underground pipelines include: Reallocate asset renewal budgets to pipelines that are a real risk; limit to partial replacement instead of complete renewal and – crucially – close the asset management loop by feeding back the condition assessment findings into learning rules of applied life-time prediction models.



“The CATwizard allows me to understand very quickly which tools are suitable and available, ensuring I can choose the best tool, first time. It has the potential to streamline project planning, reduce complexity in product selection and increase the likelihood of success in the field.”

Anthony Brown, Innovation Delivery Project Manager bei Yarra Valley Water, Australien

“We will use this platform to disclose the results of our ongoing pilots with inspection technologies, and to learn about the experiences of other water utilities. We are confident that this will bring us one step further in building an effective and efficient asset management system for our pipeline infrastructure.”

Bart Bergmans, Senior Advisor Innovation & Policies bei Evides Drinking water company, Niederlande

Figure 1: Screenshot of the online database and testimonials by users. (<https://islecatwizard.com/>)

Condition assessment – a growing market

Parallel to the increasing concern of the ageing underground infrastructure of water utilities, new innovative technologies are developed and come to market to assess the condition of water pipelines. As result of the versatility of the globally applied pipelines (pipe material, diameter, failure mechanism, external factors) and the constraints of using condition assessment tools in different regions, there is a wide and continuously expanding offer of techniques to choose from. Next to the variety of pipeline variables, there is also a large range of assessment principles being applied in condition assessment technologies (see [3] for an overview) that in some cases have similar claims when it comes to, for example, measuring resolution, target failure mechanism and pipe material compatibility. The question arises:

Which technology is most suited for my project?

And how can I use existing resources most effectively? This challenge has been tackled by Isle Utilities in its typical collaborative approach – when during a TAG session in London (see box) at the end of 2016, several water companies expressed the wish for a comprehensive and independent comparison of available technologies integrated with a platform for expert discussions, the CATwizard (Condition Assessment Technology wizard) was born. Since its market entry in 2017, 100 users from 20 global utilities (from the EU, USA, South America and Australia) have signed up and are using the platforms. New technologies and reviews are constantly added, meaning that the database is always up to date.

Technology databases – bringing together information and expertise

Based on interviews with asset management specialists and suppliers of condition assessment technologies, an online space has been created where technologies are listed and specifications are described in a uniform way. Inspired by many other online search-and-compare platforms, an intuitive design was created including a dynamic filter column enabling the user to quickly find the right tool for each specific project (Figure 1).

By selecting filter criteria related to the pipe (e.g. material, diameter), the desired tool capabilities (e.g. measuring principle, resolution, invasiveness) or project limitations (e.g. excavation need, impact on water supply) a list of matching technologies is presented dynamically. Each technology is characterized in more detail when selected including pricing, video material, white papers and contact details. Next to the static content, specialists from water utilities can leave user reviews at each technology for the consideration of other water utilities. It is stimulated that reviews consist of a factual part describing the project and a more subjective part handling the user experiences of the technology used and service delivered. The goal of the user group is to enable a rational decision making in choosing the right tool every time – in line with a globally connected water service industry. After the CATwizard, Isle is currently programming the next databases – due to go online in Q2 2018 will be further platforms on rapidly evolving topics, such as online bacteria monitoring in drinking water and phosphorous recovery from sludge and ash. An essential part of the approach will be the recurring organisation of meetings and close interaction with users, making sure the tools are designed in a way most suited to their needs.

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Further Information:

www.isleutilities.com

www.islecatwizard.com

Check the references:



www.water-solutions.info

About Isle Utilities:

- ▶ Isle Utilities (Isle) is a globally active independent consultancy in the field of technological innovation for the water and wastewater sector. By scouting for new technologies and connecting stakeholders early on, the company empowers its customers to know the state-of-the-art of tomorrow already today and facilitate bringing promising technologies into application. With a broad network of suppliers, utilities, industries and investors, the company brings technologies to life.

Isle's Flagship event series, the Technology Approval Group (TAG) has been running since 10 years and is made up of >140 global utility members. Together the members discuss, assess and collaboratively test upcoming technologies. With periodic TAG sessions in the EU, US, Australia, the Philippines and sub-Saharan Africa, Isle aims to have a positive impact by bringing innovation to the global water sector. Since its founding, the company has evaluated more than 4500 technologies, accompanied 200 of them into commercial application and mobilized the raising of > 1 billion US\$ in external investment.

Interim pipelines in ductile cast iron are the best

Secure, economical, quick to install and reusable

Uwe Hoffmann and Lutz Rau

When supply pipelines or sewage systems still in operation need to be replaced, renovated or even repaired, the engineering involved for ensuring a secure supply or disposal service in the meantime is not to be underestimated. In branched local networks supplying drinking water, the section concerned can usually be closed off and the water diverted away from the area affected by a bypass. After a new construction however, it must be borne in mind that the time frames for connecting up a new section are small. But shutting down and diverting is often not possible, and pipelines laid below ground (e.g. in gravity sewers) or above ground, referred to as “flying” or interim pipelines need to be constructed so as to be able to continue transporting the media in question while the work is being carried out.

In normal usage, these interim pipelines are often seen as workarounds. However, the term is more appropriately interpreted as temporary engineering works which need to be planned, constructed and operated in their own right.

Rules and practical examples

To date there are no generally applicable requirements for the planning, construction, operation and deconstruction of interim

pipelines, meaning that as a rule, technical solutions have been worked out as each individual case arises.

Information on the construction of pipelines above ground and on special requirements for piping systems constructed above ground can be found in DVGW W 400-2, chapter 15.2 [1], EN 805 [2], chapter 5.4 (protection of systems) and in the draft of prEN 598 [3].

DVGW work sheet W 400-2 applies to the construction and testing of water distribution equipment for drinking water supply. Chapter 15.2 describes additional requirements for the construction of pipeline systems above ground. There are descriptions of the requirements for pipe joints, the installation of pipeline components, thermal insulation, corrosion protection etc. through to pressure testing and commissioning. Basically, the requirements described there are to be observed when planning interim pipelines.

In EN 805 [2] from the year 2000 there is the following statement:

With respect to terrorist attacks, vandalism and other illegal acts, keen attention is to be paid to the protection of water supply systems. Underground systems are safe in general, but particular attention needs to be paid to sections of pipeline above ground.



Figure 1: Excavation pit with a DN 800 interim pipeline coming out of it and onto a pipe bridge over the River Mulde



Figure 2: The route of the DN 800 interim pipeline over the dike between the pipe bridge over the River Mulde and the Canitz waterworks



Figure 3: The straight section of the interim pipeline along the construction road to the Canitz waterworks

As a possible consequence, the reaction to fire of structures has been included as an essential characteristic in the EU regulation for determining harmonised conditions for the marketing of construction products. This also relates to pipe systems which, in future, must be assigned to fire classes [4].

But also, different network operators have many years of experience in the use of ductile iron pipe systems as interim pipelines which can be drawn on in order to formulate requirements for interim pipelines.

Documented examples are:

- The setting up of an emergency supply at Maifeld during the conversion of the Olympic stadium in Berlin using DN 250 ductile iron pipes and BLS® restrained push-in joints. Because angular deflections of 3.5° are possible with the BLS® joint, it was possible to install the interim pipeline along the curve of the stadium wall [5].
- The use of a 2,000 m long DN 600 interim pipeline for the South Saxony water supply association. The ductile iron pipes and fittings were used a total of three times in order to allow the renovation of a 6,000 m long section of pipeline [6].
- The installation and reuse of a DN 150 interim pipeline with BLS® restrained push-in joints to maintain the supply of water to the districts of Eimelrod and Hemminghausen in Willingen/Upland by the Upland water supply association [7].

In addition, there are two current practical examples from Leipzig and Berlin. The experiences from these projects can also be used in order to formulate requirements for interim pipelines.

Interim pipeline between the Canitz waterworks and a pipe bridge

A flood prevention dike runs between the River Mulde and the waterworks at Canitz which has been protected against future floods by the regional reservoir administration by means of sheet pile walls. The communal waterworks of Leipzig took this work as an opportunity to renovate two DN 1000 grey cast iron water transport pipelines running in parallel which supply the city of

Leipzig with fresh water from the waterworks at Canitz and Thallwitz, by pulling in DN 800 ductile iron pipes with BLS® restrained push-in joints.

The two waterworks at Canitz (commissioned in 1912) and Thallwitz (commissioned in 1943) feed their water into the two strings of the 23 km double transport pipeline in the direction of Leipzig. The section of the double transport pipeline to be renovated is located between the pipeline junction at Thallwitz/Canitz in the immediate vicinity of the Canitz waterworks and a pipe bridge over the River Mulde. At this point the pipelines run underneath the flood prevention dike.

The first step was to construct a DN 800 interim pipeline with BLS® restrained push-in joints between the Thallwitz/Canitz junctions and the pipe bridge and put it into operation.

Once the interim pipeline had been commissioned, one of the two DN 1000 pipelines to be renovated was taken out of operation and the DN 800 pipe was pulled in. Then this new pipeline was put into operation and the interim pipeline was decommissioned. The pipes and fittings of the interim were then used again so that the second DN 1000 could be renovated.

When this pipeline was reassembled, the used TYTON® DN 800 sealing rings were replaced with new sealing rings of the same type. The interim pipeline was 208 m long. The section of the Thallwitz pipeline which was pulled in was 178 m, with a total length of 199 m, and the length of the pipe pulled into the Canitz pipeline was 185 m, with a total length of 203 m.

In all cases, drinking water pressure pipes with restrained BLS® push-in joints, DN 800, wall thickness class K 9, with cement mortar lining to EN 545 and a 400 g/m² zinc/aluminium coating plus a blue epoxy finishing layer to EN 545 and DIN 30674 were used. In addition, various fittings in ductile cast iron, nominal size DN 800, were installed.

The joints of the newly constructed pipelines were produced in each case with restrained fittings and valves at the Thallwitz/Canitz junction and on the West side of the pipe bridge (Figures 1 - 3).



Figure 4: Interim pipeline along the route of the sewage pressure pipeline to be renovated in the approach path to Berlin Tegel Airport



Figure 5: A bridge of steel pipes to maintain access to the forest

Renovation of a wastewater pressure pipeline in Berlin Tegel Forest

An old DN 1000 wastewater pressure pipeline in asbestos cement along the external West and North fence of Berlin Tegel Airport was to be replaced by DN 800 ductile iron pipes to EN 598 with BLS® restrained push-in joints. The new pipeline was to be installed along the same route. This meant that wastewater from the old pressure pipeline had to be routed parallel to it through an interim pipeline constructed above ground (**Figure 4**). The removal and relaying of the wastewater pressure pipeline was done head-on in a number of installation stages.

In the first stage of the work, an approx. 870 m long section of the interim pipeline was constructed along a forest road. In addition to the steel inserts at the beginning and end of the wastewater pressure pipeline, pipe bridges in steel pipes were used where paths or roads branched off or crossed the route, in order to allow extinguishing vehicles unhindered access to the forest in case of fire (**Figure 5**).

In the second stage of the project, the interim pipeline above ground was first of all dismantled and assembled again in the same way at the new section of pipeline. Because of the tight space conditions in this section, the constructing of the interim pipeline parallel to the route of the wastewater pressure pipeline was not possible and so the pipeline was laid along an existing forest road (**Figure 6**). Once complete, the interim pipeline was 1,300 m long.

No disruptions in operation occurred throughout the entire construction phase. Also, the construction and dismantling of the pipelines was, as usual, uncomplicated (**Figure 7**). It is planned that the pipes of the interim pipeline will also be used again for securing the receiving water course in the next stage of construction. While the interim pipeline through the Jungfernheide Forest was in operation, it was shown that the sentence formulated in EN 805 – “but particular attention needs to be paid to sections of pipeline above ground” – proved to be true, although in a future revision of EN 805 this should be supplemented with a reference to effects due to climate change.

The specific case occurred while the interim pipeline was in operation. In 2017, the Berlin city area experienced the effects of local bad weather events on many occasions. Heavy rain resulted in flooding and squalls took away roofs and uprooted trees.

During the latest storm in October 2017, dozens of trees were uprooted in Jungfernheide Forest and a decades-old oak fell onto the interim pipeline. But this did not cause any interruptions to the operator’s services. Once the oak had been removed from the pipeline then, as expected, it was seen that the pipeline in robust ductile cast iron had withstood the powerful impact of the tree without damage. There were not even any detectable alterations to the surface of the pipe (**Figures 8 and 9**).

Requirements for interim pipelines

Based on many years of experience in the planning, construction and dismantling of interim pipelines of ductile cast iron pipes, fittings and valves, the following general requirements can be formulated for interim pipelines constructed above ground:



Figure 6: Environmentally friendly and space saving construction of the interim pipeline along a forest road

- the choice of a piping system consisting of pipes, fittings and valves
- a robust, non-flammable, impermeable piping system with a high level of resistance to external influences (e.g. fire and mechanical stresses)
- able to be supplied in a wide range of nominal sizes
- suitable for delivery even under restricted site conditions
- thrust-resistant joints connecting all pipeline elements parts
- the possibility of flexible routing of the pipeline which can be adapted to e.g. structural and/or topographical conditions
- fast, easy and secure assembly, as well as dismantling, even under the worst weather conditions (temperatures in the minus range) without additional expense
- the possibility of using system components again once dismantled without any particular preparation work
- efficiency and environmental compatibility

Interim pipelines of thrust-resistant cast iron pipe system

For ductile iron pipe systems, pipes, fittings and valves are available in a wide size and pressure range for different liquid media such as fresh water (see EN 545 [8]) or wastewater (see EN 598 [9]). The individual components of the robust, non-flam-



Figure 7: The 6 m long pipes are delivered direct to the construction site by truck

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Figure 8: An uprooted oak tree which fell onto the interim pipeline did not result in any operational disruptions



Figure 9: After the oak had been removed there was no sign of damage or even any alteration in the coating

mable and impermeable pipe system are protected against contamination during transport and can be transported on e.g. open trucks and unloaded by excavators.

The 6 m long pipes are delivered direct to the construction site by truck where they can be taken off the back of the low-loader by excavators. The pipes can then simply be stored on timbers, sealed in the socket area. Once the sealing ring is in place, the pipes are assembled using pipe-laying equipment/chain hoists or construction machinery.

Then locking bars or segments are inserted via the openings in the crest of the BLS® socket which are arranged around the circumference in the thrust resistance chamber of the socket in front of the welding bead at the spigot end and then quickly adjusted and the joint is extended slightly.

After this, the pipe joint can be angled horizontally and vertically, depending on its nominal diameter, in order to adapt it to the contours of the route.

In the event that directional changes are necessary which exceed the bending capability of the socket joint, socket fittings with BLS® restrained push-in joints are used. If necessary, it is possible to resort to the diverse range of flanges. When it comes to dismantling the pipeline, the pipe joints are easily released and the locking bars or segments for thrust resistance are pushed up to the opening in the crest of the socket and removed from there. They do not come into contact with the medium in the pipeline and can be handled from outside in front of the socket.

Environmental compatibility is also a decisive criterion for the general framework conditions. A robust ductile cast iron pipe system not only offers security against damage and fire as already mentioned. The fast assembly of an interim pipeline required for a specific time, along with the small amount of space needed for site equipment means minimal disturbance of fauna and flora. Low noise levels (no power generators necessary) and no additional fire prevention regulations to be observed add to the list of arguments, so that even from the point of view of those responsible for woodland and countryside preservation, ductile iron pipe systems should be used.

Outlook

Interim pipelines are temporary engineering works which enable fluids flowing through the sections of pipeline under renovation to be diverted during the construction phase, so enabling the renovation to be completed without disruption to the service. No general requirements are available for the planning, construction, operation, dismantling and reuse of interim pipelines and this can lead to uncertainty among planners and operators. This is exacerbated by current political development (risks of terrorism), the effects of climate change and changes in the requirements for piping systems (reaction to fire).

Against this background, some requirements for interim pipelines have been formulated on the basis of experience and these should be able to be included e.g. in future regulations.

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DT-240 Mini Crawler is the latest innovation in robotic water inspections

When the Canadian team at Deep Trekker began dreaming about robotics systems to explore the underwater world, they could not have imagined just how vast and complex the water and water management ecosystem could be. With a desire to make the oceans, lakes and rivers accessible to the masses, the team began in earnest, nearly eight years ago, to build robust and easy to use remotely operated vehicles, or 'underwater drones'. The original vision of a tool for exploring wrecks, reefs, and underwater marine life soon became much more, as their robots were quickly adopted for use in potable and wastewater inspections.

"About a year after we sold the first ROVs to Norway for aquaculture inspections I got a phone call from a company in Florida," explains Sam Macdonald, President of Deep Trekker Inc. "The company specializes in pipe inspections for water management, and had found our portable ROV, the DTG2, on the internet. Asking why he wasn't using a traditional CCTV pipe inspection tool, he explained that they could not use a large truck, and the access points were only accessible by golf cart. He loved the one-man deployment and hand-held controller on our swimming robots."

This served as an important moment for the company, and they began looking at how to take the principles of rugged,

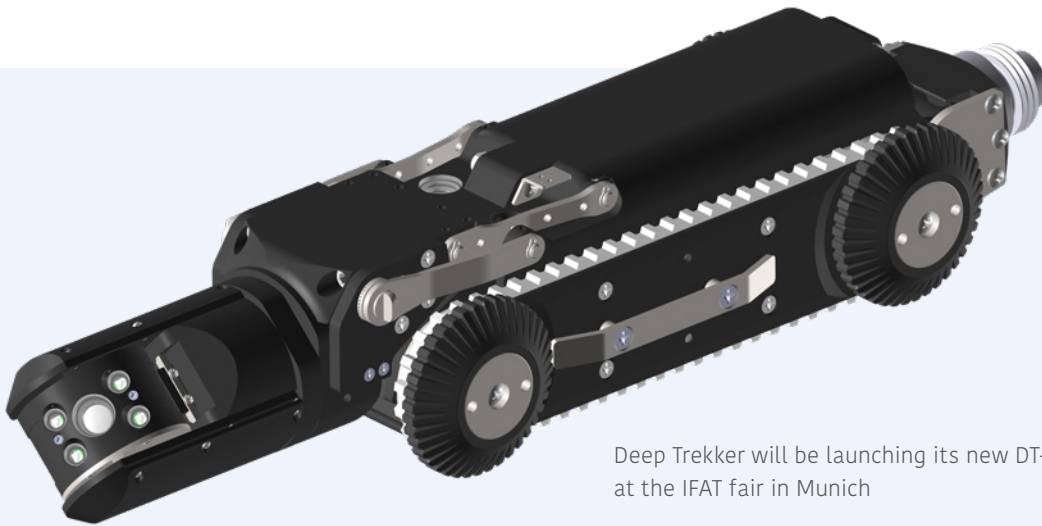
portable and easy-to-use technology, and bring them to a purpose-built pipe crawler. Like their underwater drones, Deep Trekker focuses on building a system that is fully integrated, meaning it has batteries on board the crawler, and doesn't require the use of any third-party equipment, including computers, monitors, or generators.

As the design process for the portable pipe crawler took underway, it became evident that Deep Trekker would be able to take advantage of the many components and technologies being used in their underwater ROVs. With a mature supply chain and proven designs, the company was able to bring significant technology via tethers, batteries, monitoring and control systems to the new robots. Furthermore, with extensive experience in underwater environments, Deep Trekker was able to come out of the gate with a fully submersible crawler, with a depth rating of 50 metres.

Deep Trekker has distributed its initial pipe crawler, the DT-340, to many customers around the globe. The company has found a niche in supplying cities and municipalities with their own systems. This has enabled the operations and engineering teams of these cities to be both proactive in their inspections, as well as to be immediately reactive when problems arise. Without the need to mobilize a full CCTV



Adopted for use in potable and wastewater inspections: deploying the portable DT340 pipe crawler into a storm pipe



Deep Trekker will be launching its new DT-240 mini system at the IFAT fair in Munich

About Deep Trekker Inc.

- ▶ Deep Trekker Inc. was founded in 2010 with a mission to create portable, affordable, and easy to use harsh environment robotic inspection tools. The company is headquartered in Ontario Canada, with engineering and manufacturing all completed in house. Based on a clean sheet design, the premiere product, the DTG2 ROV was introduced in August 2011. Since that time, Deep Trekker Inc has developed five robot lines including two ROVs, two submersible crawler systems and subsurface surveillance cameras. With sales in over 80 countries, Deep Trekker robots can be found in industries ranging from aquaculture to municipal contracting, military, search and rescue, shipping, infrastructure and more.

truck, or wait for contractors, the operators are able to address issues in a timely fashion, often without needing to close the streets. "I really liked the versatility of being able to send one guy in a truck to figure out exactly what we need to do," exclaimed John Longo, Supervisor of the Water Distribution & Wastewater Collections Division for the City of Brantford. "No waiting on expensive emergency services or going in blind with our cutters, it just makes a lot of sense for us."

Lane Cleroux, Engineering Technician for the Town of Renfrew, expressed his satisfaction in the flexibility that the Deep Trekker DT-340 offered to his small municipality. "Not only did it make financial sense for us to own our own DT-340 pipe crawler, we opted to purchase the equipment so we can deploy the camera on our schedule rather than waiting on a contractor."

Deep Trekker has built a strong distribution network in North America, and now looks towards the European Market for continued growth. Understanding that much of the infrastructure in Europe is built on a system of smaller diameter pipes than in North America, the company looks forward to launching its second line of portable crawlers, the DT-240 mini system, at the IFAT fair in Munich this coming May. Specifically designed with the European Market in mind, the new system will bring all of the benefits of the premiere product, but be able to inspect pipes as small as 130mm.

Further Information:
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Force-fitted solution for lined pipes



Source: Funke Kunststoffstoffe GmbH

Installation of the CONNEX Liner Connection System. The sealant is applied through a hole in the distance ring

The reintegration of lateral connection lines is still one of the most delicate aspects involved in the retrofitting of sewer pipes with pipe liners. For years now, a range of different procedures and systems have been used – with limited success. The CONNEX Liner Connection System and HS Glue-on Saddle for liners are part of the latest generation of modern components that help to provide reliable, professional and cost-effective connections to main pipes retrofitted with pipe liners (GRP liners or needle-felt pipe/synthetic fibre liners). The wide range of applications and the choice of when to use which fitting depend on a number of parameters, including the size of the core hole, the nominal diameter of the lateral pipes and the nominal diameter of the main pipe.

The CONNEX Liner Connection System is available in three variants. The DN/OD160 (162 mm bore hole) version can be used to main pipes sized DN250 and DN300, while the DN/OD160 (200 mm bore hole) version can be connected to main pipes sized DN400-1500. The DN/OD200 Liner Connection with a 200 mm bore hole can be used in main pipes sized DN250-1500 and higher. Installation is carried out from the outside using a work window cut into the main or existing pipe with a suitable tool, such as an angle grinder. In order to prevent damage to the liner, Funke recommends using a Funke Limit Stop Washer. Once the liner has been exposed,

the separating films must always be removed. Funke dual-component sealant is then applied in order to create a force-fitted connection to the liner that compensates for any unevenness in the liner due to the design (≤ 2 mm). The packaging of the Liner Connection is marked in red in order to make it distinguishable from the standard CONNEX connection.

The brown HS Glue-on Saddle is also a solution for integrating lateral pipes into main pipes that have been fitted with a pipe liner. It is available in nominal diameters of DN/OD160 and 200, and is suitable for use in main pipes sized DN200 to 500. Variants for large ranges of nominal diameters are also available on request. The built-in VARIO coupler, which can be adjusted from 0° to 11°, offers a high level of flexibility at the installation point. A construction trench is required for installation. First, a work window matching the size of the curved saddle base plate must be cut into the main pipe to expose the tube liner. The component can then be glued into place. This is done using a dual-component adhesive. There's also an extra bonus: The Glue on-Saddle can also compensate for slight unevenness or wrinkling in the liner.

Further information:
www.funkegruppe.de

No longer a dream?

Wastewater treatment plants as resource recovery factories



Transforming municipal wastewater treatment plants (WWTP) from net power consumers into energy neutral or even energy positive service providers is no longer a dream.

Today's cutting-edge technologies, such as Resource Recovery Factories, have become more affordable for many cities and regions, empowering urban areas with a new source of flexibility in their energy system while also facilitating their commitment towards climate goals. Discussions around innovations that enable these new Resource Recovery Factories will be at the core of two-day IFAT-conference, which will feature recognised experts. Delegates will learn of the European and energy framework in which the WWTP as a renewable energy source operates, whilst also investigating the market deployment potential.

Committed to working in close collaboration with both academia and the industry, each topic has been developed and shaped to meet the IFAT audience expectations: to learn, be questioned and challenge the discussions.

The main topics will be: innovations (enhanced carbon extraction, new nitrogen removal strategies for main and side-stream treatment and Power-2-Gas & Heat-2-Power Technologies), European policy framework (regulatory drivers and benefits for valorisation of renewable energy from WWTPs, climate and environmental benefits and circular economy) and market potential (energy trading scheme and energy audits).

The conference will take place on 16-17 May at the IFAT Trade Fair in Munich, Germany. It is organised in the framework of the H2020 POWERSTEP project that has received funding under the European Union HORIZON 2020 - Innovation Actions - Grant agreement n°641661.

Registration and further information:

<http://powerstep.eu/powerstep-final-conference>

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Wire to water

For the first time, the Japanese company Tsurumi will be presenting its new BP sewage water pumps to the market. With the high-performance motors and extremely efficient hydraulics in a very durable design, it wants to set new standards. The formula here is 'Wire to water'. These immersion units, that can also be installed in dry locations, are part of a sewage campaign that the largest construction pump manufacturer started last year. This new product can pump up to 225m³ sewage an hour and achieves delivery heads of up to 68 m. The series includes several versions with motor outputs ranging from 2.9 to 11.5kW. A special scraper mechanism on the impeller prevents blockages. The casing is also resistant to aggressive media. It measures up to 1.35m in the largest free-standing model. Numerous safety features, for instance double shaft seals and capillary water protection, are standard for this series.

Efficiency plus durability

"The entire design focusses on high efficiency and durability," says Birger Schmidt who works in the sales team at the manufacturer's company in Düsseldorf. "We are pushing the limits of what is feasible." The design work focussed on the technology formula 'wire to water': The development goal was to achieve

a top ratio of applied electrical energy and the resulting kinetic output.

The achieved improvements are 'substantial'. According to Schmidt, it is relatively easy to build motors with IE3 efficiency and a high MEI, and this alone is not a unique quality feature. Also, an efficient hydraulics system combined with standard motors is not enough to make them stand out. "The real challenge is to develop a pump with a highly efficient motor and equally efficient hydraulics", all in an extremely durable model as demonstrated in the construction dewatering pumps by the manufacturer. This design principle has been transferred to the latest sewage pumps. This is why the BP is a 'best performance' overall package and a real innovation at the IFAT. The new BY sister series also has this DNA, says Schmidt.

Other highlights on the stand include the sewage pumps of the UY and GY series, and Tsurumi's LSC residual water pump. The Japanese company is also presenting its TRN aerator for sewage cleaning and preliminary clarification which outdoes conventional membrane plants, amongst other things, in terms of maintenance and procurement aspects.

For further information visit Tsurumi at IFAT booth B1.444 or at Tsurumi.eu online.



Source: Tsurumi

New pump BP for sewage by Tsurumi: Sturdy design like the construction dewatering pump by the market leader combined with excellent motor and hydraulic efficiency

Breton biogas plant to be stepped up to 500 kW

Together with its French partner WELTEC Agripower, German biogas plant manufacturer WELTEC BIOPOWER was working on an extension AD project in Iffendic, Brittany. The biogas plant in Iffendic had already been built back in 2014, and by now its capacity is being doubled. The biogas plant generates 500 kW a day, enough to supply almost 1,000 households. The expanded plant went online after a building time of only a few months.

Operator Samuel Morand already had the idea of extending the plant when the original biogas plant was being built. However, as he only had a limited amount of cattle manure, pig manure, whole crop silage, cereal debris and apple pulp at his disposal, he initially decided to implement just one 2,625-m³ stainless-steel digester and a 250-kW CHP. Nevertheless, WELTEC proactively designed the other plant components, such as the dosing feeder and the pumps, for the double plant size. The robust input system MULTIMix was also implemented in such a way that it can now easily supply a second digester. The MULTIMix ensures efficient shredding of long-fibre and sticky substrates such as cattle manure and whole crop silage, thereby enabling use of the full energy potential.

Over the past years, the operator has successfully enlarged his agricultural business and now has a greater amount of cattle and pig manure at his disposal. Moreover, an apple juice manufacturer is now able to supply Morand with more waste from his production. This increase in the available substrate forms the basis for the plant extension by an additional 2,625-m³ digester and an additional 250-kW CHP. Another benefit for French farmers: in December 2016, the feed-in tariff for power from agricultural biogas plants was raised, especially for the input of liquid manure. Moreover, the maximum compensation period has been increased five years to a total of 20 years. Both the term and the amount of the tariff ensure more planning and investment security in the industry. Another positive aspect for Samuel Morand's operations is that he can use the exhaust heat from the CHP unit for his pigsties and digestate drying.

In this way, this measure means a win-win situation: France is approaching the goal of stocking up the proportion of renewable energies to 30 percent by 2030. The figure currently amounts to 19 percent, and especially the contribution of biogas to energy production can be further expanded.

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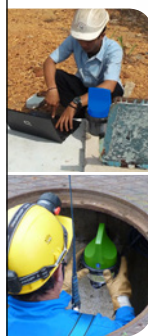
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Glassfiber reinforced plastics: a sustainable solution for sewer networks

The rapidly growing populations and aging infrastructure in urban areas bring sewer networks to the limits of their capacities. This forces cities to expand and renew their networks sustainably, designers to plan for generations to come, and contractors to install in limited spaces with little to no downtime. All to prevent system failures, which can be catastrophic for both people and the environment. A crucial question in this regard concerns the sewer pipelines' material: it needs to allow for a reliable long-term operation. Glassfiber reinforced plastics (GRP) challenges traditional pipe materials with its outstanding characteristics and extremely long lifetime. And most importantly, GRP is sustainable for our environment, society, and economy.

Since the 1950s, GRP has gained a firm foothold in the construction of pipelines. The range of applications covered by GRP piping solution today is broad: from sewer systems and potable water lines to storage tanks, drainage pipes, hydropower penstocks, industrial pipe systems, as well as rehabilitation solutions with special non-circular pipe profiles, to name just a few. The methods by which the pipes can be installed are just as manifold and include open trench, above ground, on suspensions, underwater, and by means of trenchless technologies such as relining and microtunneling. In general, plastics are assumed to be unsustainable for the environment. PVA and PVC for example break down very fast in outdoor environments and pollute the ground through their quick absorption into the earth. The thermosetting resins used in GRP are far stronger and more durable than other plastics: some products have a lifespan of more than 150 years, which results in the product being considerably better for the environment. At the end of its lifecycle, GRP waste can be shredded and transported to e.g. cement plants to be energetically recycled in a furnace, thus replacing fossil fuels. GRP pipes are sustainable in manufacturing, transport, and installation. They feature a small carbon footprint in production, low transport costs, and allow for a fast installation and efficient operation. They easily tackle all kinds of challenges

such as soil and traffic loads. GRP pipes preserve resources and protect the integrity of networks thanks to their excellent leak-tightness under external and internal pressure, corrosion and abrasion resistance, weather and root infiltration resistance, as well as buckling resistance.

The long lifetime and durability of GRP products also prove beneficial with regard to business budgets: they are a trouble-free long-term investment and a cost-effective solution for all shareholders involved in a project. GRP products save time and money in that they do not require any heavy lifting gear or on-site welding works, feature an exceptionally long and generally maintenance-free service life, and low lifetime cost. And not least, the contribution of GRP pipes to society and social development is also remarkable: they ensure the secure transport and availability of water, play a significant role in agriculture and industry (the biggest users of water), they form leak-tight sewer networks and help manage floods and droughts through water storage and retention tanks as well as customized solutions for wastewater treatment plants.

Sustainable Sewer Solutions

A pioneer and leader in the GRP pipe industry, Amiblu has helped a number of cities and clients around the world make their existing



Figure 1: In the surroundings of Toulon (France), 2714 GRP half-shells were installed to rehabilitate an aged sewer system



Figure 2: A new GRP Combined Sewer Overflow chamber separates suspended solids from the wastewater network in Castel San Pietro (Switzerland)

sewer network more sustainable. Three recent projects that have been realized with centrifugally cast (Hobas) and filament wound (Flowtite) GRP pipes showcase the broad range of applications that can be realized with the high-performance material.

Sewer relining with non-circular GRP pipes in France

288,000 people living in the surroundings of Toulon in Southern France are connected to a 6.4km long sewer channel leading from Chateaubanne to the Cap Sicié's Amphitria Sewer Treatment Plant in La Seyne sur Mer. The resulting 22millionm³ wastewater per year of course require a perfectly functioning discharge system. Built in the middle of the 20th century, the structure of the old local sewer had deteriorated considerably over the years. In 2014, a complete renovation of the aged channel was therefore initiated. The project was challenging: very limited space conditions on site, flexible deliveries due to the urban environment, a channel depth of more than 100 m in some places – and the demands of building an efficient, corrosion-resistant system that will reliably last for at least half a century was also very ambitious. GRP experts from Amiblu came up with a solution that took everything into account: easy to handle, light-weight non-circular pipes with a high chemical resistance against hydrogen sulfide, excellent mechanical and hydraulic characteristics, and a very long lifetime.

The French construction specialist SADE started with the installation in November 2015. A total of 2,724 GRP half-shells, 1500x1678 mm with 2.35m length each, were delivered to the construction site successively and strictly on time at defined hours. They were inserted into the old sewer channel with the help of lifting rings and a transport cart and then connected to each other with pre-mounted EPDM joints to assure a leak-tight system (**Figure 1**). Once all works will be completed by mid-2018, the people around Toulon can rely on a perfectly efficient sewer system for at least the next half century. In September 2017, at the International Society for Trenchless Technology conference in Medellin/Colombia, SADE was even presented with the prestigious Rehabilitation Project Award for their work.

GRP sewer overflow structure installed in Switzerland

When rain, stormwater runoffs, and municipal wastewater flow together in a combined sewer channel, strong precipitations can lead to critical situations: wastewater treatment plants are overloaded and large amounts of polluted water run into ecologically sensible lakes and rivers. Overflow structures offer a solution for this problem. With the CSO (Combined Sewer Overflow) chamber, Amiblu provides a particularly reliable and efficient option. In October 2017, a CSO chamber was installed in the municipality of Castel San Pietro in the Swiss Canton of Ticino in merely one day (**Figure 2**). The municipality was looking for a solution to manage overloads of its combined sewer during heavy rainfalls in an effi-



Figure 3: The GRP retention tank supplied for the FASA Renault Suppliers Park in the Spanish city of Valladolid holds 1,450 m³

cient and environmentally friendly way. Amiblu produced a CSO chamber of GRP pipes with 8m length, which consists of a main pipe DN800 and an overflow pipe DN450. Additionally, a GRP valve chamber DN1200 was supplied to throttle the outlet to the WWTP. The structure now reliably separates suspended solids from the wastewater transported in the local combined sewer network.

GRP stormwater retention tank installed in Spain

In late 2017, Amiblu supplied a 1,450 m³ GRP retention tank to the FASA Renault Suppliers Park in the Spanish city of Valladolid (**Figure 3**). The tank consists of three 120m long GRP lines DN 2200 that are connected to a 12m long module DN2600, a vertical man-hole DN3000 that is linked to the pipe network, and three additional chambers for cleaning. Installed by the UTE ARCOR-COPSA for the ICE Institute for Business Competitiveness of the Junta de Castilla y León, the tank retains stormwater flows when they reach their maximum level and regulates the runoff. Amiblu once again provided a sustainable solution with the unbeatable advantages of GRP: Corrosion resistance, leak-tightness, excellent hydraulic and chemical properties, light weight, and quick and easy installation.

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About Amiblu

- ▶ Amiblu is a 50:50 joint venture whose goal is to develop and deliver fully sustainable water solutions. Amiblu combines Amiantit Europe and its Flowtite Technology, and Hobas Europe, part of WIG Wietersdorfer Holding, and is the specialist in drinking water, irrigation, storm- and wastewater, hydropower and industry.

German start-up invented variable sewer system

Today's sewer system has to cope with different wastewater levels every day. It is, however, not able to do so because of its non-adaptability. The cross-section of a conventional sewer pipe cannot be changed in size. Once underground, the dimensioning is fixed for many years. An innovative solution to this problem has recently been invented by a young start-up duo in Middle Hesse, Germany: VARIOKAN, the first system that can react to the different wastewater levels by automatic adjustment of the sewer cross-section.

About 20% of all sewers in Germany are damaged and need to be restored. When Pierre Büttner became aware of these remarkable figures during his Master of Engineering studies at the Mittelhessen and Frankfurt University of Applied Sciences, the ball was set rolling.

In the study module "Project Infrastructure Management" he came up with the idea to develop a variable sewer system. Meanwhile, the 29-year-old has gained practical experience as a civil engineer in the field of urban water management and invented VARIOKAN, the world's first sewer pipe with flexible features. Together with economist Ivana Hrisova, his Czech life and business partner, he pushed forward his business idea to the present prototype.

VARIOKAN is more than just a sewer pipe

Modern times confront the sewage system with enormous challenges such as climate change with increasingly heavy rainfall or prolonged droughts; changes in the demographic

population structure due to urbanisation and rural exodus or the water-saving trend.

Little wastewater in the sewer decreases the flow rate of the sewage and deposits arise. These lead to additional maintenance costs. On the other hand, much wastewater congests the sewer pipes. Especially when it comes to heavy rains, the sewer system quickly reaches its limits. Annual environmental damages of approx. € 500 million are the result in Germany alone. According to calculations of the Potsdam Institute for Climate Impact Research, these damages will rise to € 2.5 billion each year without further investments.

This is precisely the point where VARIOKAN takes effect. The patented variable sewage system is a hose. This is introduced into an existing or new sewage pipe, thus reaching flexibility of its cross-section (**Figure 1**). In case of low wastewater volume, VARIOKAN reduces the cross-section of the sewer so that the wastewater can drain off faster without depositing. If the volume of wastewater increases, VARIOKAN enlarges the cross-section of the sewer automatically and energy independently, so that huge quantities of wastewater can be discharged without causing any damage. In addition, VARIOKAN allows simultaneous rehabilitation of damaged sewer pipes.

VARIOKAN has been developed in three different product variations (**Figure 2**). First variation for renovations using the open-trench method or new construction projects, consisting of a conventional sewage pipe made of PP plastic with a keder strip with three fix-



© Erhard Jakobs/THM

Start-up duo Ivana Hrisova and Pierre Büttner with a model of their VARIOKAN system

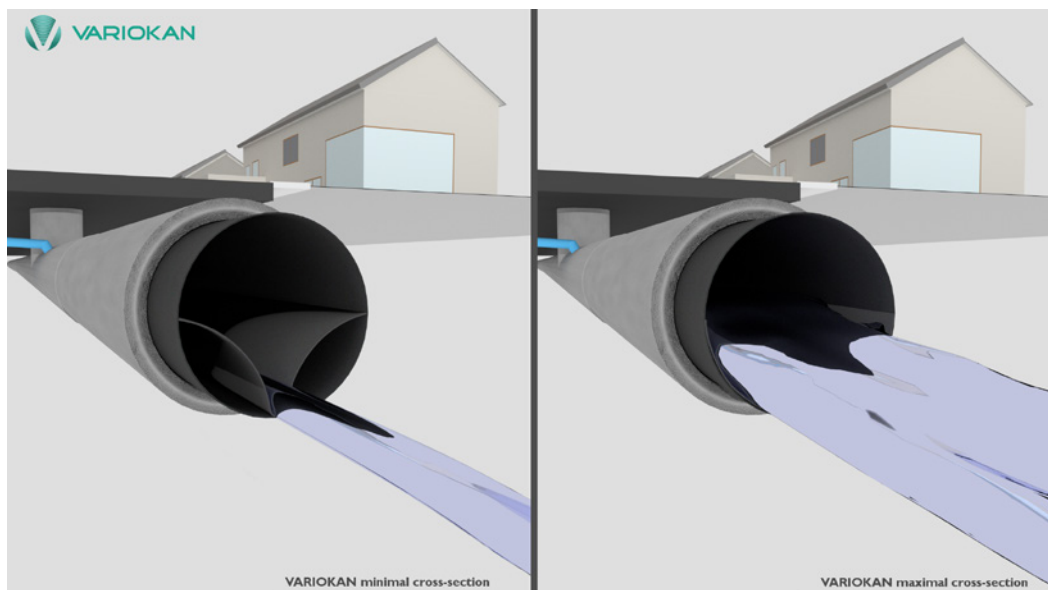


Figure 1: operating principle of VARIOKAN

ings inside the sewer pipe (preferably extruded). The inner compartments are made of ethylene propylene diene monomer rubber (EPDM). Second product variation, where the outer cover is made of a thermoplastic elastomer (TPE) and the inner compartments are made of ethylene propylene diene monomer rubber (EPDM). And a third variation, where the entire liner is made of one material: ethylene propylene diene monomer rubber (EPDM).

A niche product for cities, rural areas and areas subject to seasonal variations

More and more, the increasing population growth in urban areas is leading to sewers being overburdened and therefore disturbing many residents. The sewers can now be planned and built in a

larger capacity without any problems. Thanks to VARIOKAN, the optimum flow cross-section is always guaranteed. Thus, deposits are prevented in the event of low wastewater; at the same time, the objectives of flood protection in heavy rain are met. This means that during a period of drought, the sewer cross-section is small enough to prevent deposits, yet large enough to absorb heavy rainfall. A promising solution that increases efficiency. The population decline in rural areas is increasingly causing the often run-down sewer systems to dry out. VARIOKAN enables to carry out two things at once in existing sewer networks. Broken sewers can be rehabilitated while simultaneously providing hydraulic optimisation. VARIOKAN continuously adapts to decreasing wastewater volumes by reducing the existing sewer cross-section

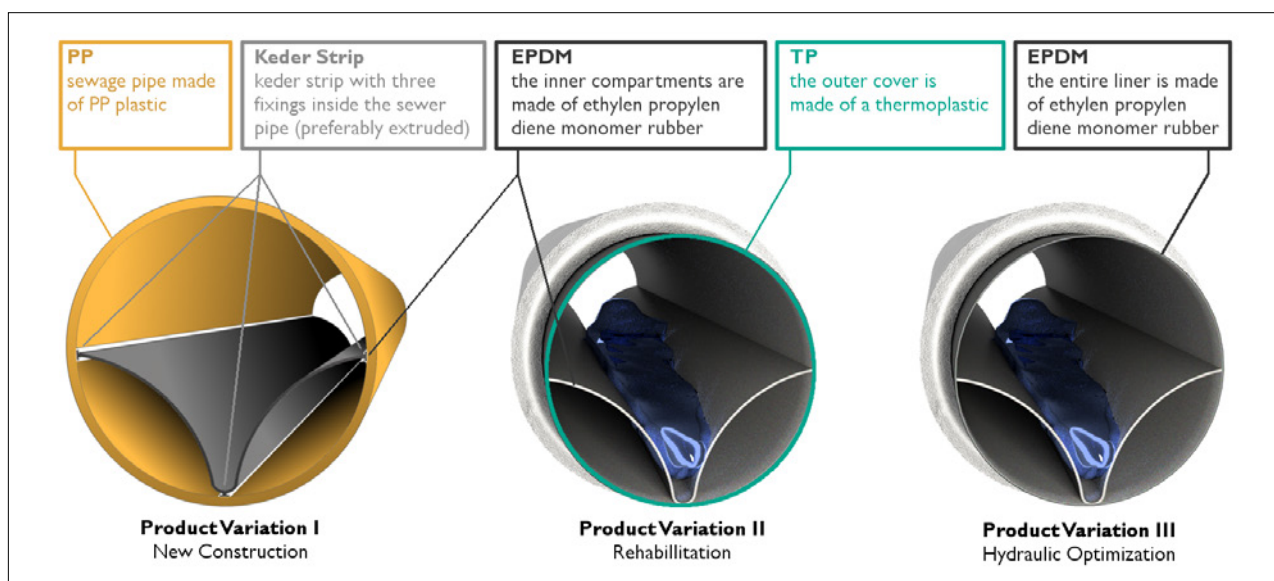


Figure 2: the variable sewer system in three versions

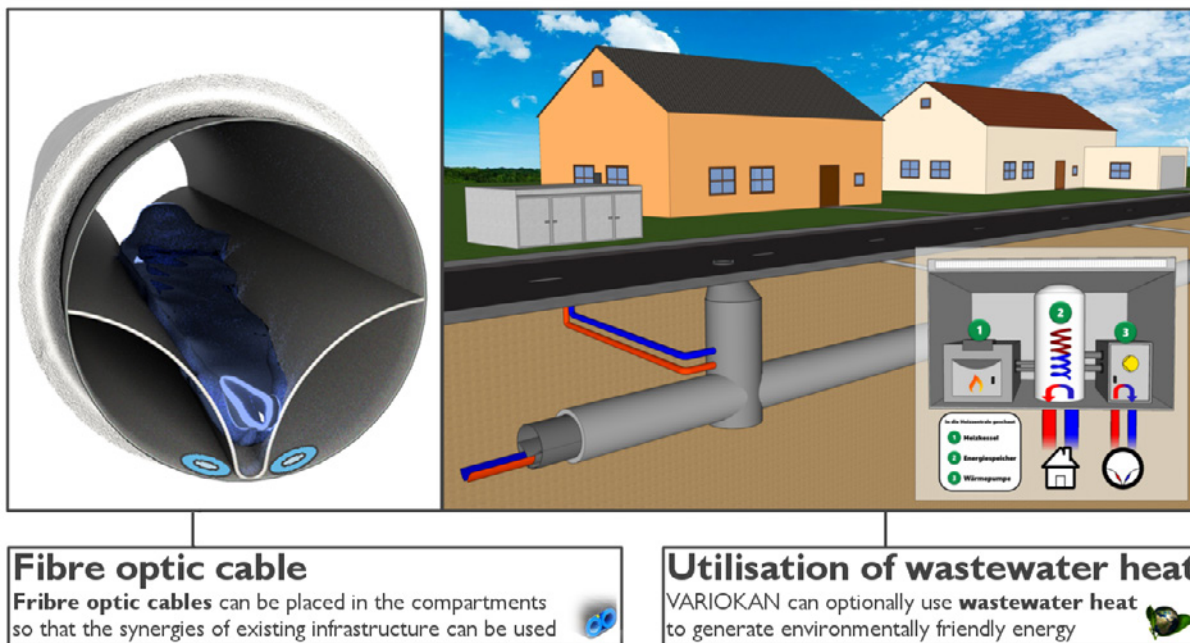


Figure 3: VARIOKAN enables environmentally friendly synergy effects

as required with a flexible dry-weather gutter. Thus, smaller sewers don't need to be built. It's a lucrative solution that saves municipalities a lot of money.

Fluctuations in wastewater particularly affect popular holiday destinations. This makes determining the optimal dimensions of sewers difficult. VARIOKAN facilitates the operation and future planning of sewer networks in season allocations. In areas with fluctuating wastewater volumes, VARIOKAN can adjust the cross-section according to the season. This means that it provides the maximum cross-section during the high season and the minimum cross-section during the low season. It's a clever solution to seasonal population growth or decline.

Variety of economic and environmental benefits

In conclusion, VARIOKAN provides tangible economic and environmental benefits: a reduction of both maintenance costs and environmental damages and an increased quality of life. Moreover, the two founders have the vision that VARIOKAN offers enhancements in the future. „Fibre optic cables can be placed in the compartments, so that the synergies of existing infrastructure can be used. Like this, VARIOKAN can for example use wastewater heat to generate environmentally friendly energy,“ says Pierre Büttner (Figure 3).

The concept of the two founders is so persuasive that they took first place in a statewide university start-up competition called “Hessen-Ideen” in 2016. This was not the first award. Already in 2014, then master's student Pierre Büttner won the competition “The sewer system of the future” of environmental services company Veolia. Last but not least, the founder duo successfully applied for the EXIST start-up grant last summer, a funding program of the German Federal Ministry for Economic Affairs and Energy and the European Union Social Fund. Since October

2017, they receive it for one year. With the money they want to finance, among others, a test facility (planned for summer 2018), in which they will expose VARIOKAN systematically to operation with different water volumes in a 25-meter-long pipe. This is important to gain further knowledge for example about the material thicknesses. In the meantime, the financing of the test facility is completely secured by additional funding from a private investor. However, the financing for the following phase is still open: it is about the implementation of pilot projects (capital expenditure approx. € 400,000). For this, the start-up is still looking for investors.

Research and development are necessary, not least in order to talk to potential manufacturers about the product features. Initially, the business concept provides that the series production of rubber hoses will be assigned to companies with expertise in the production of EPDM products, in particular rubber hoses made by extrusion. VARIOKAN will focus entirely on the sales segment.

“We want to make cities and communities flood-safe. To ensure that people don't have to be concerned that their cellars will fill up with water that destroys everything, is our mission. For this, we offer cities and communities an affordable and ecological complement to the existing infrastructure,“ says Ivana Hrisova. In this sense, the future has already begun.

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Sewage sludge for the long haul

The specialist in pump technology from Bottrop, Germany is launching a customized system solution, which combines the advantages of two conveying technologies in order to transport extensively dewatered sludge over long distances in a particularly energy-efficient manner. The sewage sludge is compressed into plugs, which are then ceaselessly boosted

down pipelines up to 1,000 m long using compressed air. This alternative to conventional processes has already been field-tested at a number of European plants and will quickly pay off for wastewater companies.

Because of new technology, a long pipeline is no longer a disadvantage. And this is currently more important than ever

when it comes to disposing of dewatered sewage sludge. A total of 1.8 million metric tons is generated every year in Germany and then processed – either through thermal processing, recycling or agriculture. Under the new German Sewage Sludge Act (AbfklärV), which came into effect in 2017, it is increasingly necessary to transport sewage sludge over long distances, e.g. to a phosphate recovery plant. Therefore, there are a number of considerations that make the new system an interesting option for some of the country's 10,000 or so municipal sewage treatment plants. The system not only meets the new requirements with distances of up to a kilometer, but is also remarkably economical, because the total investment costs, follow-up expenses and operating costs are all comparatively low.

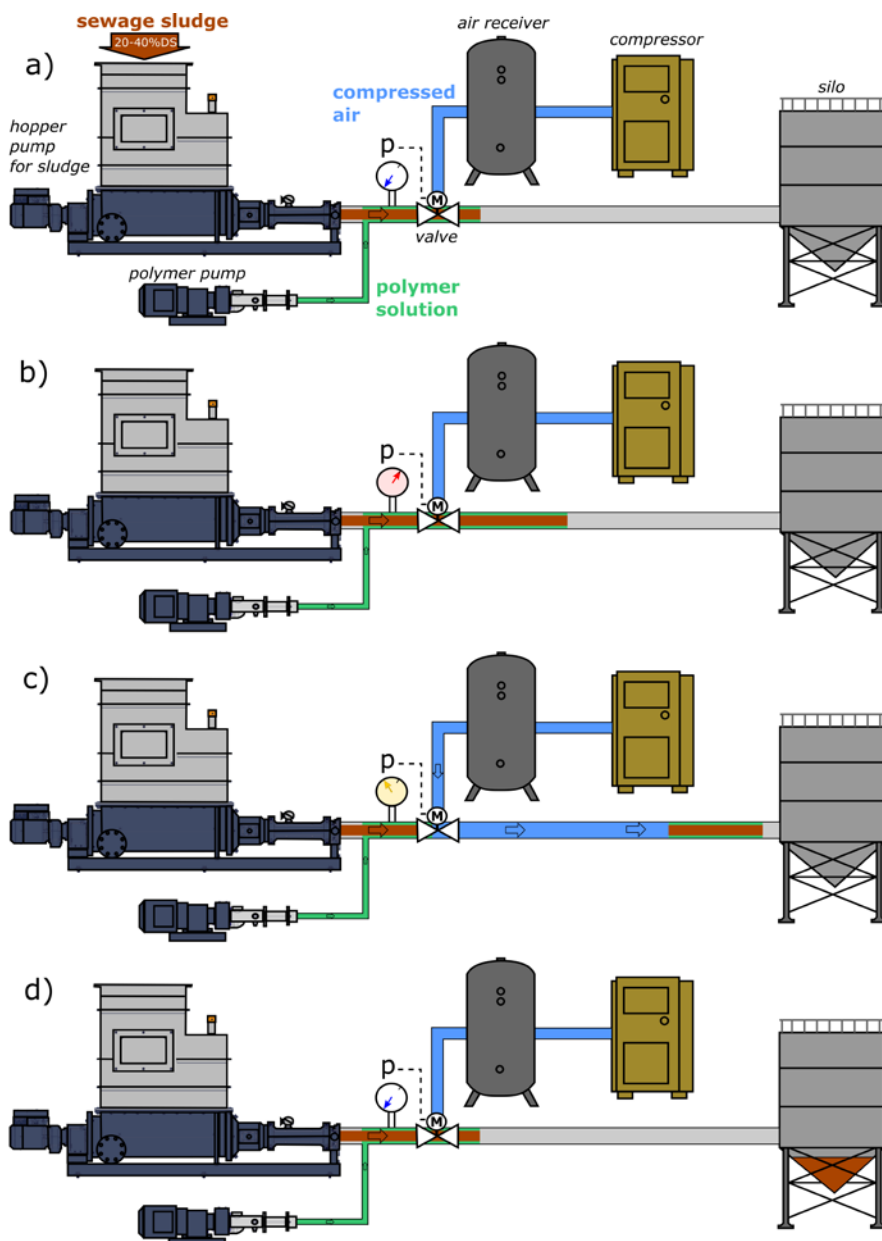


Figure 1: Schematic illustration of the system's conveying process for sewage sludge, using polymer injection and dense phase pneumatic conveying. a) Compression of sludge plug, until b) an optimized compression level is achieved in the pipeline. c) Open the compressed air valve in order to propel the sludge plug into the silo using compressed air. d) Pressure drop in the conveying pipeline

Sludge under pressure

For this system solution, the developer used a combination of pump conveying via a progressive cavity pump and dense phase pneumatic conveying. The new process requires only a cost-effective piping system made from plastic material, which plays a role not only when the system is bought new, but also whenever running expenses such as maintenance and operating costs need to be reduced. Another attractive feature is the low operating costs, which result from low energy consumption, long pump maintenance cycles of around two years and cheaper spare parts compared to other pumping processes. The time requirements for maintenance are minimal, at just a few hours, and can typically be performed by a single person and without additional hoist/crane equipment, due to the lower weight of components. Thanks to the 'maintain in place' pump design, the disassembly of the pipeline is not required. The lower pressure level additionally ensures an

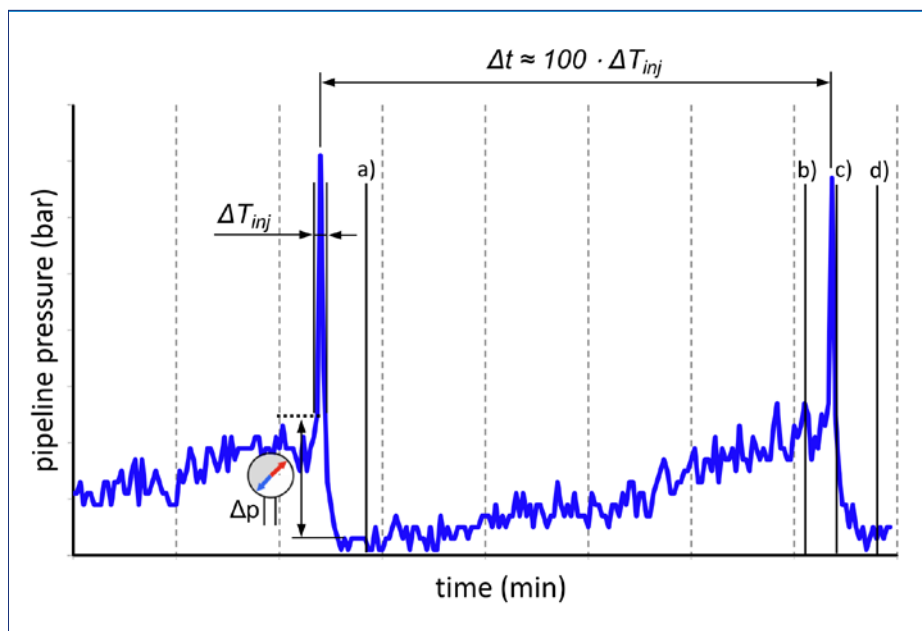


Figure 2: Schematic pressure curve at the injection point of the sludge pipeline. When a predefined pressure level is reached, compressed air is injected for a few seconds, ΔT_{inj} , after which the pressure in the sludge pipeline drops by Δp . The progressive cavity pump is then used over a period of several minutes, Δt , to pump a new sludge plug into the pipeline, until another compressed air injection takes place. The marked times a)... d) correspond to the conditions illustrated in Figure 1

increased service life for the components and a reduced pump footprint. Plus, the automated system solution along with process monitoring, can be integrated into existing automation and control systems via conventional bus interfaces. All functional components, sensors and actuators are supplied as a complete package and integrated into the control software.

The company already has its first client on the international market, with the new system being integrated into the network of one of Europe's largest water companies in the fall of 2018. The new system will now be available to wastewater disposal companies as an energy-efficient, high-performance alternative to conventional systems. As a customized conveying solution, it is engineered to fulfill the requirements of the plant and parameterized on-site to optimize its energy consumption.

The challenge

Conveying dewatered sludge over long distances represents a major challenge for municipal wastewater treatment facilities: the high viscosity and abrasiveness of the medium means that a significant pressure loss needs to be overcome in the conveying pipeline. In some cases, sequential pumping solutions such as belt conveyors or screw conveyors with multiple drive units are used. Because of their multiple drive units, these often exhibit high energy consumption and maintenance requirements. In addition, they are frequently designed to be open to the environment, which can result in unpleasant odors and rehydration by rainwater, and are inefficient for vertical or complex conveyor sections. Alternatively, closed piping can be used in conjunction with multi-stage progressive cavity pumps or in some cases piston pumps, which are particularly suitable for highly viscous media and high pressures. However, because of the large counter-pressure, they require comparatively high investment costs for

pressure-resistant piping (in some cases more than PN100). Piston pumps in particular also have significant maintenance requirements and costs, long downtime during maintenance, and relatively high drive power and energy consumption.

The new pumping solution

The new system solution has no such disadvantages. In this system, a sludge plug is first compressed and compacted in the pressure line via a hopper pump, [see **Figure 1.a)** and **1.b)**], and is then conveyed onwards by means of pulsed, compressed air injection [see **Figure 1.c)**]. The air injection is pressure-controlled via an algorithm optimized for the application (see **Figure 2**). The pneumatically transported sludge plug is also enclosed in a polymer solution. This reduces friction in the pipeline, thus improving the energy efficiency of the system as a whole.

The combination of pump conveying and dense phase pneumatic conveying permanently reduces the pressure in the entire conveying pipeline to a very low pressure level (see **Figure 2**). It results directly from the energy required to initially set the compressed sludge plug in motion. Once the static friction force has been overcome, the sludge plug is accelerated by the expanding compressed air flowing behind it, which again reduces the pressure level in the pipeline (see **Figure 2**). Adjusting system parameters such as polymer flow and air flow on-site makes it possible to set a plant-specific, energy-optimized operating point.

The lower pipeline pressure allows considerably thinner-walled and cheaper piping to be used (PN10 to PN16), which results in significant reduction in investment costs, particularly over long conveying distances. In addition, smaller single-stage hopper pumps can be used with an optimized and patented maintenance technology, which reduces maintenance requirements to a minimum (rotor/stator replacement

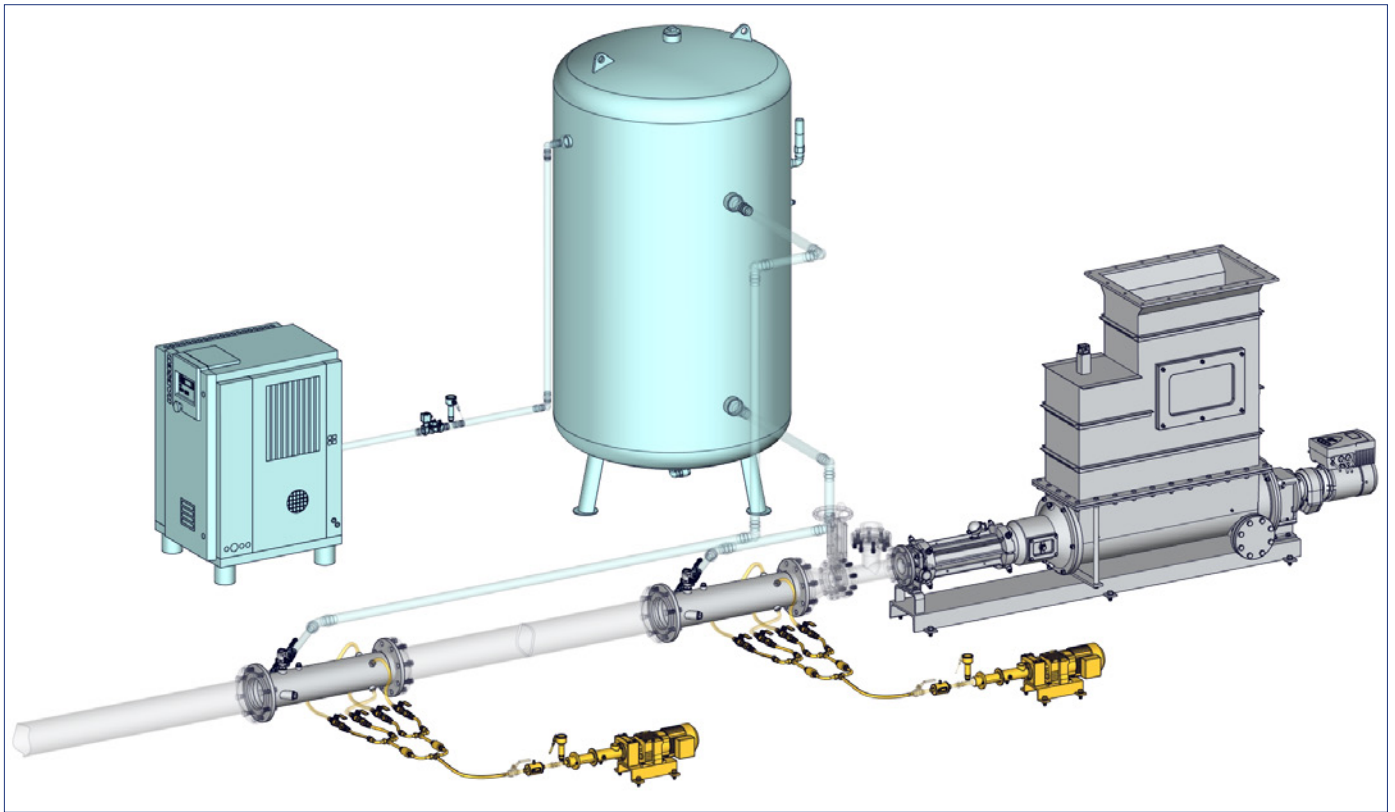


Figure 3: 3-D model of the new system with two injection points for polymer solution and compressed air

in under an hour) and has comparably low energy consumption.

The total system

The central element of the new system solution is the integrated control system, which regulates all functions of the total system. The filling level in the supply hopper of the sludge pump is recorded using a laser distance sensor or via load cells, and the conveying capacity of the sludge pump is adjusted depending on the fill level. The polymer flow is adapted relative to the current sludge flow, in order to minimize polymer solution consumption. Furthermore, the system is equipped with temperature, overpressure and frequency inverter monitors, which implement three safety functions to ensure smooth and safe operation of the total system. Depending on the circumstances of the conveying path, it may be necessary to inject compressed air and polymer solu-

tion into the piping at multiple points (see **Figure 3** for two injection points). The valves for injecting air can also be controlled manually via a control device with a display, which is included in the delivery. This is particularly relevant for cleaning the pipelines, e.g. before extended stoppages of the system or to clear blockages in the conveying pipeline. The system parameters can be set in two different manners. On the one hand, (remote) control can be performed via fieldbus from a control center, or on the other hand the system parameters can be modified locally via a control device. Furthermore, the flow of compressed air and polymer solution is measured and displayed on the local display of the control panel alongside other important system information, e.g. the system status and pump operating parameters.

Author:

Stephan Mottyll

About the author

- ▶ Stephan Mottyll is a development engineer, MSc Mechanical Engineering, at SEEPEX GmbH in Bottrop, and as Project Manager he advanced the product development process for the Smart Air Injection (SAI) system. The company has its headquarters in the Ruhr region of Germany and is a leading worldwide specialist in the field of pump technology, including progressive cavity pumps, macerators and control systems. The pumps are used wherever low to highly viscous, aggressive or abrasive media needs to be conveyed.

New impulse in wastewater aeration

Continental Industrie, a manufacturer of air handling equipment from Dormagen, recently launched its first turbo compressor series. The manufacturer of multistage blowers and exhausters, which has been operating worldwide for more than 25 years, is thus setting an impulse for pressurized aeration in municipal facilities that rely on energy-efficient technologies.

The technology used for diffused aeration in wastewater treatment plants and sewage treatment plants in Germany has a long tradition: Positive displacement blowers, rotary lobe compressors and turbo compressors have been used there for decades to provide the necessary pressure aeration in biological clarification systems and in the sand trap area. Different countries - different habits: In the American market, contrary to European practice, multi-stage blowers are favored for waste water treatment.

Continental Industrie has always been active in the field of wastewater aeration and has so far carried out oxygen enrichment of sewage water - for example in flotation tanks - using multistage centrifugal blowers. In several wastewater treatment systems, the pulsation and oil-free operation of this blower technology is highly appreciated because it operates below a sound pressure level of 85 dB (A). In Dubai in particular, Continental Industrie has installed nine blowers in the wastewater treatment plant of the famous Palm Island artificial island group. Numerous wastewater aeration

projects have been carried out throughout Europe with the environmental corporation SUEZ.

Under the model names TCH15, TCH25 and TCH35, Continental recently introduced a range of three integrally geared single-stage turbo compressors manufactured at its French headquarters in Lyon. The manufacturer has brought all its aerodynamic experience into the development process and ensured that all major components are manufactured in Central Europe.

The new turbo-compressors from Continental Industrie provide an efficiency of over 80 % from 10,000 Nm³/h upwards. While they require an average of 200 - 1,100 kW of power for this purpose, centrifugal blowers generally require at least 10 % more. This is of particular relevance when several such units are operating in parallel. Generally speaking, the supply of large quantities of air at low pressure requires more than 60% of the energy consumed in a sewage treatment plant. This point should be of great interest to plant managers.

The energy efficiency of turbo blowers is beneficial for waste water aeration: at the operating point it is greater than 82% efficiency, and at 50% reduced flow it is still 79%. In comparison, the efficiency of multistage blowers is just 65% at reduced flow. In general, the efficiency curve of centrifugal blowers decreases faster during turndown than for turbo compressors.



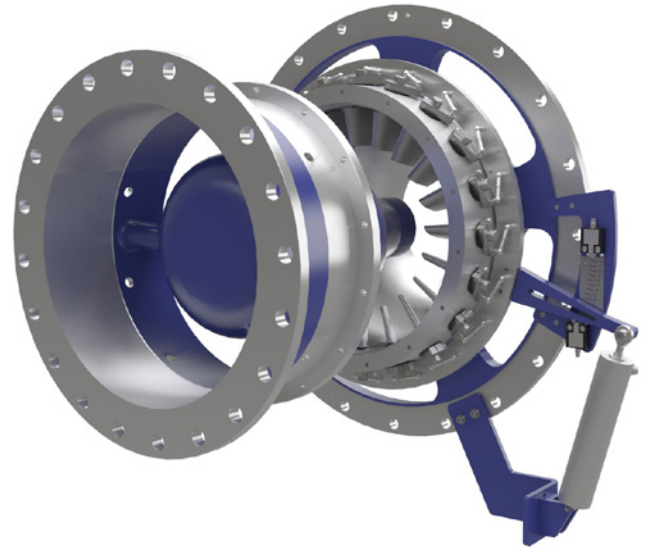
Wastewater treatment plant

Continental's turbo compressors operate in the wastewater sector at around 20,000 rpm and feature the required material and temperature durability. Sewage treatment plant operators and waste water treatment companies are familiar with this principle of operation throughout the country. The more they appreciate the advantages of integrated components such as forced oil lubrication, oil coolers, duplex oil filters and the various options of a flexible control system. In the waste water sector, the regulation range of an aeration system is of great importance - fluctuations from low water consumption to a significant increase in volume (sometimes caused by heavy rainfall) have to be taken into account as a rule.

The new turbo compressors were designed for ease of maintenance: regular intervals can be carried out conveniently from the front without having to remove the impeller via the oil-lubricated shaft. The gearbox in particular does not need to be dismantled or disassembled. Special maintenance openings are available for easy access to the gearbox, which can be used comfortably.

In particular, Continental Industrie intends to design the new turbo compressors specifically to meet the requirements of plant managers. Since some components such as the impellers are already manufactured in-house, flexible adaptations such as the design of the base frames for a specific type of motor do not present a major problem.

Continental Industrie will be exhibiting at IFAT in Munich from May 14-18: Hall A3/ Booth 129.



Source: Continental Industrie GmbH

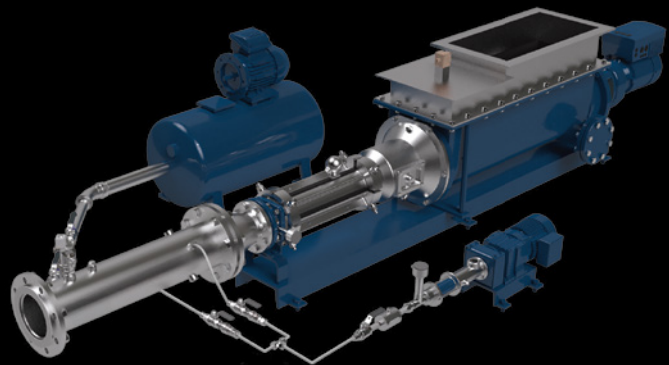
The inlet guide vanes for pressure regulation and compensation of atmospheric ambient conditions

Further information:

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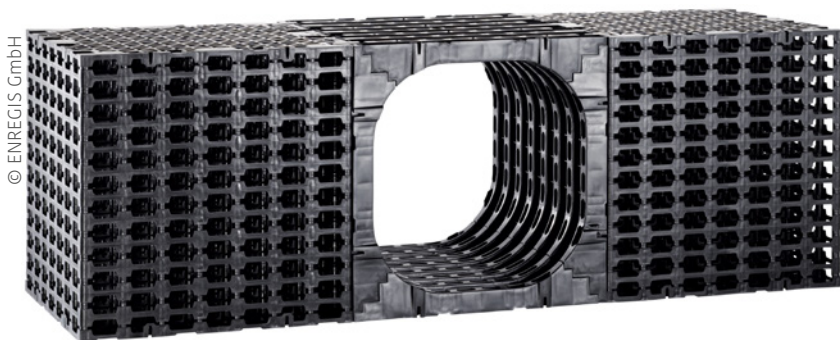
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Rainwater retention system combines inspection, filter and irrigation channel



DIBt-approved ENREGIS/X-Box®/ENREGIS/Controlbox® heavy-duty rainwater retention/drainage system

A high-quality rainwater management concept designed by ENREGIS GmbH has been selected for a major commercial centre in Röttenbach in Bavaria, Germany. The new site spans an area of 60,000 m² and the applied system assists in the retention of pollutant loads.

Sealing areas previously used as agricultural land, much like in this project, prevents the natural process of rainwater infiltration in the locality. In the event of heavy rainfall, the existing but frequently overburdened sewage systems cannot accommodate the additional volumes of water. A remedy for this is provided by decentralised rainwater and rainwater infiltration systems, although rainwater infiltration should be given priority for environmental reasons.

Local rainwater infiltration, which is possible according to regulations published by the German Association for Water, Wastewater and Waste (ATV/DVWK), was not feasible as a result of soil properties and the groundwater levels, which were already very high at -0.90 m. The existing drainage infrastructure did not allow unregulated, restricted connection to the sewage tunnels.

As is the case with many similar projects, the solution in the Röttenbach project was to be found in a combined, decentralised rainwater retention system with an upstream treatment stage and restricted rainwater runoff into the existing sewage system. The planning and creation of the rainwater retention system was particularly challenging by the positioning of the system: completely submerged in the groundwater reservoir and in an area capable of bearing HGV traffic.

Builder-owner HTI Gienger coordinated with the engineering company responsible for executing the detailed planning, Maierhofer of Munich, and decided to integrate an innovative reten-

tion system from ENREGIS GmbH, Sundern, Germany.

Large-volume hollow plastic containers from the ENREGIS/X-Box and ENREGIS/Controlbox Systems range were used as a basis for the retention measures. Along with a uniquely high static bearing capacity in both a vertical and horizontal working direction (burst pressure > 600/200 kN/m²), the system includes an inspection, filter, and irrigation channel which is larger than average, measuring more than 500 mm. The height-flexible system, which is variable in degrees of 5 cm and approved by the German Institute for Construction Engineering, DIBt, in Berlin (see DIBt approval no. Z-42.1-509 for area of application), can be incorporated near

to the surface and overbuilt with roadways (load class SLW 60). The interior inspection and filter canal assists in the further qualified retention of pollutant loads which can be introduced via the upstream filter systems, or into the storage body in the event of accidents.

The sedimentation lines which are integrated into the retention body considerably reduce maintenance costs for the entire system and make a sustainable contribution to the drastic



ENREGIS' installation team implementing the retention system on the site in Röttenbach, Germany

reduction of operating and maintenance costs in the project. Special attention was given to the installation and in particular to ensuring that the entire system was given hermetically-sealed welding. As a result of the retention body's position, completely submerged in the groundwater reservoir, it had to be guaranteed that the system was fully impermeable.

ENREGIS also maintains its own installation team which is certified for these implementing tasks. This team expertly installs the complex systems on site and on behalf of the underground engineering contractors and also expertly welds the entire system with a high-tensile, 2.0 mm thick polypropylene (HDPE) film approved by the DIBt so that it is pressure-sealed.

Any subsequent access to the system which may become necessary for maintenance or irrigation procedures is ensured in this project as a result of the DN 600 inspection shafts which are also integrated into the ENREGIS system, and via the large-

volume sedimentation, irrigation, and inspection channels (> 500 mm).

Partner information:

www.ib-mayerhofer.com

www.strabag.de

www.hti-handel.de

www.enregis.de

Contact:

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59846 Sundern, Germany

Phone: +49 29 33 98 36 8-0

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Data/Facts

- ▶ Connecting surfaces: Roof, traffic, and path surfaces
- Storage volume of heavy-duty drainage system: 102 m³

Dimensions of drainage base body/construction field

Construction height: 0.90 m

Length: 12.60 m

Width: 9.00 m

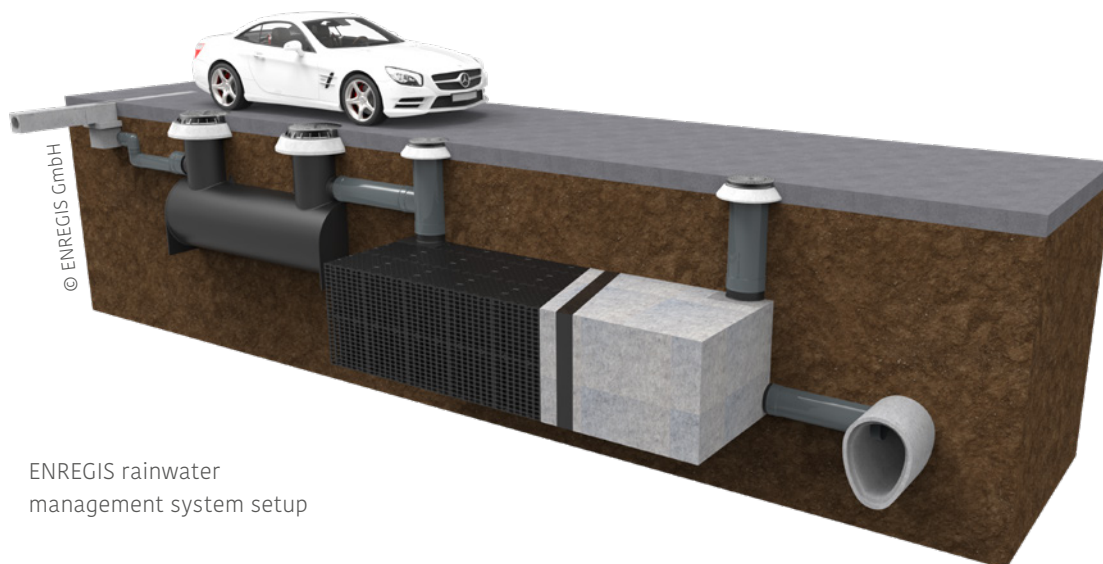
Installation depth: 1.85 m

Connections: Inflow/Outflow per 2 x DN 400, obstruction-free transition

Ventilation: DN 200, guaranteed via flow-control-shaft

Special features:

- Use of the system, structurally optimised beneath road and logistics surfaces.
- Installation of system so that it is protected against buoyancy, completely submerged in the groundwater reservoir
- Reduced covering/installation depth 0.95 m
- Interior sedimentation systems integrated into the system, length per system 12.6 m with a total filter surface of more than 15.1 m²
- Optimised for maintenance – significant reduction in maintenance costs
- Certified impermeability/leak testing



ENREGIS rainwater management system setup

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Sustainable tourism in Albania

Measures for energy, water and waste

Werner Siemers

Sustainable tourism, wastewater treatment, solid waste, renewable energy, feasibility study

The coasts of Albania are well suited for future tourist development. In fact, Albania is a growing tourist destination with advantages for natural and ecological sound tourism. However, expansion of tourism impacts on the local situation with respect to supply and disposal of water, waste and energy. It is observed, that necessary infrastructures are not adequately provided for the expansion of tourism activities. Especially the wastewater generation and non-existing treatment facilities pose a threat to the environmental situation of the Mediterranean Sea. The aim of this recent project approach is to improve the situation towards higher ecological standards and to meet overall sustainability criteria. Using the example of the planned project “Eco Village Tourism Himare” it will be shown, which technical and organisational possibilities exist for establishing a sustainable supply infrastructure. These include e.g. in the solid waste sector collection and recycling stations, biowaste separation, residual waste disposal and separation of recyclables. The wastewater sector is concerned with the prevention of wastewater, the use of greywater and the energy-saving operation of the treatment plants. Residues can be identified from both sectors, that are suitable for use in biogas plants and thus also provide energy in addition to environmental benefits. In the framework of the final feasibility study, the potential and implementation options are elaborated on the basis of a concrete example. This provides a planning scheme for the ecological development of a given resp. planned holiday resort. On the other hand, the result of the study can serve as a blueprint for further implementations.

Introduction

The project includes the drafting of a feasibility study for an ecologically sustainable tourism industry in Albania, taking one location as a real example. The section of the village Qeparo near Himare, which is adjacent to the beachfront, is selected for the conduct of this study on sustainable tourism development (**Figure 1**). The existing situation is described for the village Qeparo starting with basic information on the location, the climate and the tourism industry. After that, more detailed data collection on facts and figures regarding waste, wastewater and energy follows. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) in Germany finances this study as part of its “Environmental Technologies Export Initiative” programme. Project partners are CUTEC (now CUTEC Clausthal Research Center for Environmental Technologies), Goduni International and the Albanian counterparts.

Data collection and analysis

Energy demand and environmental infrastructure are the main areas of interest for this study. Both sectors

are analysed with the reference towards the local context. Energy demand in the area is defined as energy for the buildings and the inhabitants. A reference resp. model building is defined with two storeys



Figure 1: Village Qeparo in Albania

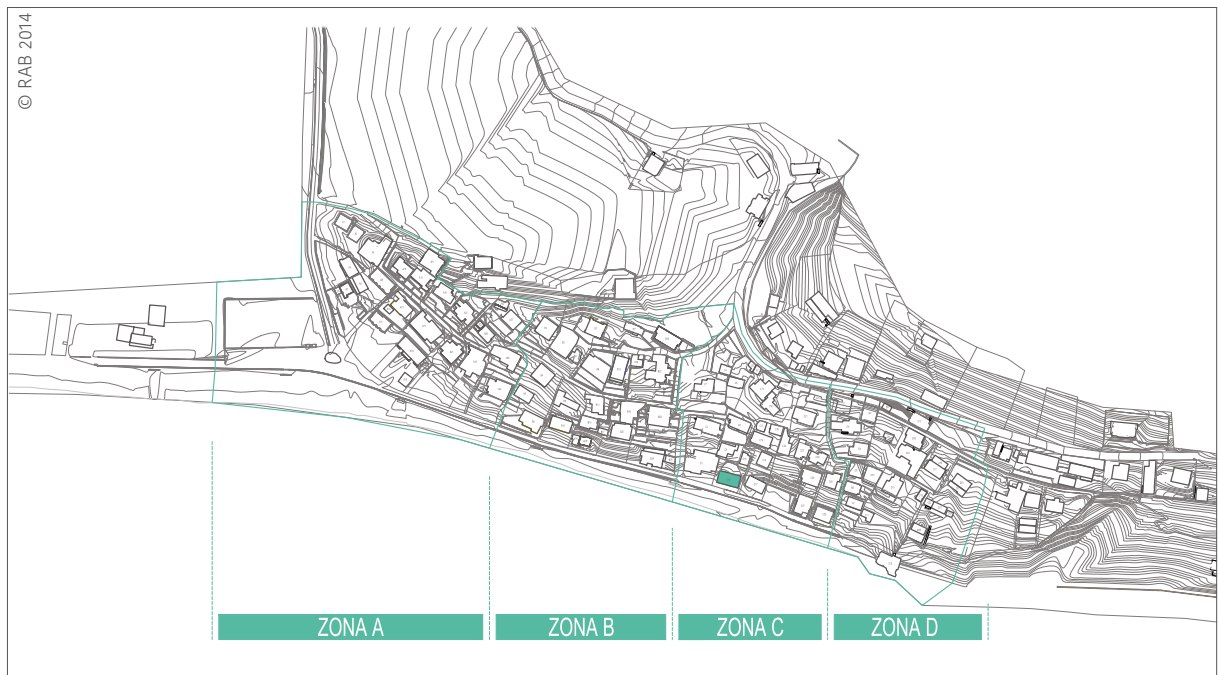


Figure 2: Plan for development of the village

and altogether 6 rooms for a bed & breakfast tourism. The total number of buildings is set to 80 for the eco-village concept (see **Figure 2**) as a pilot area. According to the tourist statistics, an occupancy model is developed, which considers a high season in summer, a transition period and a winter season. Together with the basic energy demand for heating and cooling in the different periods an expected energy demand for the tourism activities is calculated. The results show for the model building a demand for heating of 4,000 kWh and a demand for cooling of 7,000 kWh (compare **Table 1**). Besides heating and cooling energy is required for hot water, for lighting and for all other services in the house (cooking, washing etc.). It is assumed that nearly all

demand is serviced by electricity. Using standard conversion efficiencies, the demand for net electricity reaches 18,800 kWh per year per building.

Tourists produce more waste per head compared to the local resident population. Due to the seasonal fluctuation in tourist arrivals and length of stay, waste generation fluctuates as well. For the pilot area it is estimated, that the total waste volume accounts to some 232 tons per year (compare **Table 2**). Out of this, nearly 55% is produced during the two months of the high season. For further analysis the portion of the waste, which is of biological origin, is also estimated with some 87.8 t per year.

Fresh water is needed for a wide spectrum of applications. Most of the fresh water ends up as wastewater. Based

Table 1: Total energy demand in base case, per building unit

Season	Heating net, kWh	Cooling net, kWh	Hot water net, kWh	Lighting, kWh	Cooking, misc., kWh
Winter	3,266	0	640	750	1,000
Transition	761	1,378	2,313	750	1,250
Summer	0	5,709	3,234	300	600
Total per unit, per year	4,028	7,087	6,187	1,800	2,850
Conversion efficiency	0.9	2.5	0.9	1.0	1.0
Net per unit per year	4,475	2,835	6,874	1,800	2,850
Total, kWh	18,834				

Table 2: Waste generation in the study area

	Occupation, p*days	Period, months	Waste generation, kg/p*day	Waste total, kg	Waste generation, kg/month
Winter	306	5	0.9	276	55
Transition	830	5	1.2	996	199
Summer	774	2	2.1	1,625	812
Total per unit				2,896	
Total pilot area				231,712	

on similar estimations on specific consumption and occupancy it is calculated, that the total wastewater volume in one year sums up to 35,000 m³ for the whole pilot area (compare **Table 3**). Presently, wastewater is collected in individual septic tanks. However, environmental problems are being reported and are widely known.

The definition of sustainable tourism offers a wide range of different aspects. In the context of this study the sectors energy, waste and water are considered as essential and are analysed in detail for the pilot area. An introduction into the state-of-the art is given before detailed considerations are discussed. Experiences from worldwide activities are presented and recommendations given, in which areas activities can reduce energy consumption, minimise waste generation and save water resources.

Next step is the discussion of technologies with a possible impact on the situation at Qeparo. The buildings can be better insulated (wall, window, roof) to save heating and cooling energy. Effects are measurable, but the financial payback on energy savings alone seems to be weak. The present energy supply with cooling devices in summer and limited heating appliances for the winter period may be changed towards more modernised concepts like reverse cycle units or centralised cooling and heating units. Also

combined heat and power plants (CHP) offer an alternative eventually including a chilling-unit (tri-generation). In this case, fuels must be supplied, either of fossil or renewable origin. Direct renewable resources can be utilised for hot water production using solar thermal collectors or for electricity production via photovoltaic. Wind also offers opportunities at least in some regions of Albania. Least, separately collected organic waste and / or wastewater may be turned into biogas using anaerobic fermentation. The produced biogas could be utilised directly for heating or converted into electricity employing a CHP.

In waste management, separation of the waste streams brings opportunities for recycling and energy production. At least, biowaste (for fermentation or compost), recyclables (paper, glass, metal, plastics) and remaining waste should be separated. The situation on wastewater is more complex. At first, utilisation of fresh water should be efficient and wastage minimised. A treatment of wastewater is essential for the eco-village. This can be organised individually at building level with improved septic tank operations or more centrally employing micro-treatment plants. The utilisation of grey water is considered as a good alternative and may improve the quality of the wastewater for consecutive energy production.

Table 3: Wastewater generation in the study area

	Occupation, p*days	Period, months	Water demand, L/p*day	Wastewater, m ³	Wastewater, m ³ /month
Winter	306	5	150	46	9
Transition	830	5	200	166	24
Summer	774	2	300	232	108
Total per unit				444	
Total pilot area				35,524	

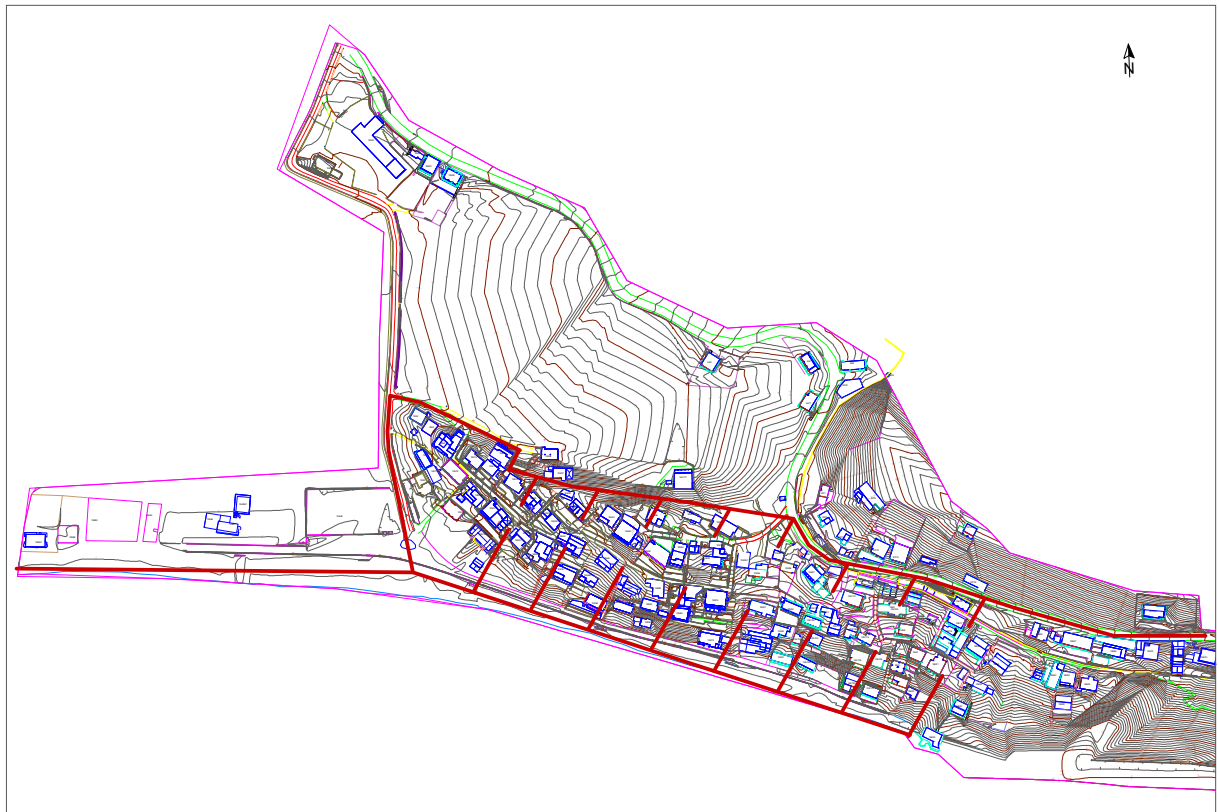


Figure 3: Proposed piping infrastructure (in red lines)

Discussion of possible measures

Out of the theoretical solutions described above, a number of possible measures is identified and discussed in detail. For each of the options the design parameters are presented and investment costs plus operational costs are calculated. Additionally, the savings are given in energy units and monetary values. The recommendations sum up the discussion and prioritise a set of measures in energy, waste and water. These mentioned projects should be realised first in order to reach an acceptable level of sustainability. Other measures can follow after successful implementation of the first set of activities. The recommendations in total are:

- improvement of building envelope,
- good housekeeping measures on energy,
- solar thermal energy supply,
- reverse cooling / heating units,
- grey water system installation,
- waste separation at source,
- PV on public places and at one central location,
- collection of biowaste,
- centralised wastewater collection and biogas production.

For the wastewater sector, more details are given here. Massive saving of fresh water is possible with the installation of a grey water system. Unfortunately, the

fresh water costs in Albania are very low on international comparison. This would not lead to a payback for the installation of a grey water system. Another important aspect, however, is the reduction of wastewater volume going into a possible biogas plant. The usual communal wastewater has a low concentration of organic matter, because a high amount of wastewater is generated by personal hygiene, washing and cleaning alone. Installing a grey water system would increase the organic matter of the final wastewater and makes it more attractive for a biogas production. It is not a prerequisite for biogas, but it would make the biogas option more valuable. The grey water system would be a good innovation for saving drinking water and enabling an efficient biogas production from wastewater. However, due to technical constraints not all houses can be equipped with a grey water system.

Waste separation at source is also a prerequisite for the biogas system. It reduces remaining waste volumes and brings valuable materials into the recycling path. It should be in function in all buildings. The waste collection system for biowaste is needed for the supply of the biogas plant with organic material. It should be executed fully.

On the larger level of the municipality, wastewater treatment should be organised with an underground sewer system and a central wastewater treatment

plant. In order to benefit from economies of scale, a central treatment plant should serve several thousand inhabitants. Then, an advanced and extended sewer system must be erected, which needs large investments and planning / construction time. This alternative is out of scope of this study, but it has to be considered for the final solution.

In any case, a pipe infrastructure must be installed to serve the initial pilot area. The renovated promenade at Qeparo already contains a wastewater pipe. A natural place for a centralised wastewater treatment would be the area north-west of the main village. The central pipe is already near to that place. On that site either a modular treatment plant can be installed, which serves as interim solution until a central treatment plant is erected and the village be connected to that central plant. Or the site is used to install a small biogas operation. Besides the wastewater, input into biogas would be the collected biowaste. The biogas operation can be started on small scale serving only the pilot area. If the operation is smooth and successful, more wastewater and more biowaste can be acquired from the adjacent villages and increase throughput and outcome for the biogas plant. **Figure 3** shows the layout of a piping system for the pilot area. Two main collection points are defined to cater for the terrain as one half of the area shows a slope towards the beach, whereas the other half orients into a small valley after an elevated part of the village. The two main collection pipes are then combined and lead the wastewater towards the chosen site for biogas production resp. treatment. A small CHP (biogas engine) or an ORC-plant (organic Rankine cycle) is an option for producing electricity. The decision to invest into a CHP should be taken after the successful operation of the biogas plant. In absence of a CHP, the biogas may be used in direct form for heating and cooking.

Conclusion

An appropriate planning process enables the incorporation of sustainability criteria into the final devel-

opment of a given tourist area expansion. The presented case¹ is an example for a medium sized expansion of a site into an eco-village with a bed & breakfast atmosphere as an alternative to mass tourism. Ecological standards would be higher compared to the nearer and neighbouring regions. The beach as well as the hinterland can attract a more environmentally concerned clientele. The overall investment costs including allowance for planning and engineering are estimated with 1.7 Mio. € for all measures excluding the building envelope improvement, which needs 2.56 Mio. € alone for the total 80 buildings in the eco-village. It is expected that the visitors may contribute through an extra eco-charge to the additional investments and improve the financial payback.

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Ultrafiltration technology in major projects

There is a growing awareness of the importance of professional drinking water treatment and eco-friendly methods of wastewater reuse and recycling – not just in arid regions, but worldwide. Against this backdrop, ultrafiltration (UF) has taken on an increasingly important role over the past 15 to 20 years in a broad range of water treatment applications.

As treatment plants get bigger, so too do the challenges involved in building and running them. As a result, the quality and reliability of their components has become a key factor, and comprehensive technical support from component suppliers has become a crucial part of successful plant engineering projects. inge® has achieved huge success in recent years by identifying and fulfilling those needs.

Multiple examples of large scale projects around the globe confirm that inge GmbH's membrane technology has adopted a leading role in the UF market. The following reference projects are just a selection of the company's recent achievements.

Accra, Ghana (Africa)

Huge quantities of drinking water are required for the metropolitan area of the Ghanaian capital Accra. To meet these needs, a cutting-edge sea water desalination plant was officially opened about two years ago in Nungua Township, some 12 kilometers from Accra.

The plant uses reverse osmosis (RO) to produce 60,000 cubic meters of drinking water a day for around 500,000 people. Following a rigorous selection process, the plant contractor chose inge® to equip the plant with 10 UF lines as a pretreatment stage for RO.

As well as specifying top-quality UF technology, consulting expertise, and engineering services at the planning stage, the client also expressly requested an expanded package of services for this project. In response, inge® offered not only its high-performance ultrafiltration racks with their patented Multibore® membrane fibers, but also the central header pipes, valve units, local instrumentation and assembly of the UF lines. This full package bid proved to be enough to secure the contract.

Despite the fact that the quality of the feedwater turned out to be significantly lower than the figures stated in the tender, the UF system has been successfully supplying 135,000 cubic meters a day (35.7 MGD) of pre-filtered water to the RO stage ever since, helping to turn sea water into clean drinking water for the local population.

Putatan in the Philippines

The private water company Maynilad operates in the western part of the Manila metropolitan area in the Philippines, supplying drinking water to over nine million people. Maynilad runs a total of three water treatment plants, one of which – situated

in the Putatan barangay in the city of Muntinlupa – uses inge® ultrafiltration technology.

The water is drawn from the Laguna Lake, which lies to the south-east of Manila and borders Muntinlupa. The lake water undergoes a rigorous filtration process before being used to supply 490,000 people with a total of 150 million liters of clean drinking water a day, 50 million liters (13 MGD) of which is filtered by inge® ultrafiltration technology.

Purifying the water poses some significant challenges, however. As well as seasonal variations in water quality, the lake becomes also soiled by industries that include a nearby slaughterhouse and extensive fish farming right next to where the water is extracted. Despite the often extremely poor quality of the lake water, the inge® ultrafiltration models have been running without a hitch for the past two years, delivering consistently clean water that meets the required quality standards.

But it wasn't just the high yields and consistent quality of the purified water that prompted the operator to choose this system. Both the plant constructor and the end customer were reassured by inge®'s experience and expertise in treating surface water as well as by the flexible operation of its innovative T-Rack® 3.0 concept. They were also impressed by the comprehensive technical support inge® provided throughout the installation and commissioning stages. The whole package was rounded off with extensive training for treatment plant employees by the inge® team. This ultimately led to highly satisfied customers and an important reference project for the South East Asia region.

The follow-on project, which is due to be completed in 2018, is also based around inge® modules, providing yet another indication of how satisfied people are with this In-to-Out technology.

Jamnagar in India

This mega project in the Indian city of Jamnagar was a genuine milestone in inge®'s corporate history. It involved the biggest sea water desalination plant that inge® had ever equipped with its membrane technology. Built by the contractor IDE Technologies, the plant supplies process water to one of the world's largest refinery complexes in Jamnagar, which is situated in the Indian state of Gujarat. inge® supplied the UF modules used as a pretreatment stage for reverse osmosis (RO) in the sea water desalination process.

Over 4,000 T-Rack® 3.0 modules went online in April 2017. Since then, they have been supplying 456 million liters (120 MGD) of pre-cleaned water a day to the RO units. The inge® UF pretreatment stage significantly improves the quality of the sea water that is treated using conventional pre-cleaning methods. The UF modules play a major role in protecting the highly sensitive reverse osmosis membranes.



There is a growing awareness of the importance of professional drinking water treatment and eco-friendly methods of wastewater reuse and recycling

inge® initially installed a pilot system on-site to prove that its modules could comfortably fulfill the customers demanding standards for the UF system. Even during the monsoon season, when the water was particularly challenging, the UF module still met the targets for process stability, filtrate quality and yield. What's more, the T-Rack® 3.0 concept satisfied all the customer's requirements regarding a compact and space-saving design. During the execution of the project, inge® provided top-notch technical support for the entire UF system in collaboration with the plant contractor.

Jazan in Saudi Arabia

Another key project undertaken by inge® involved a plant in the port city of Jazan in the Kingdom of Saudi Arabia, situated on the coast of the Red Sea. The UF membrane experts were selected by the petroleum company Saudi Aramco to provide UF modules as a pretreatment stage for a sea water desalination plant. The inge® modules are designed to deliver 105,000 cubic meters of filtered water a day (27.8 MGD) to the reverse osmosis stage.

The end client, Saudi Aramco, insisted on a top-quality UF system and laid down a series of rigorous requirements for the technical equipment and documentation. All the suppliers involved in the project were subject to the most demanding standards. This policy included the UF lines, which had to comply with strict earthquake-resistant design specifications. The plant contractor was familiar with and enthusiastic about inge® products and technical support based on their experience with previous projects in Saudi Arabia. Together, the contractor and the inge® team managed to fulfill all the customer's stipulations and win the contract.

A further sea water desalination plant has already been commissioned in Jazan. Once again, it will deploy inge® UF technology as a pretreatment stage for RO. The new plant will be used to convert sea water into drinking water for Jazan Economic City, a recently established city 60 kilometers north-east of Jazan. This planned

city, which will eventually be home to 500,000 people, will be based around the manufacturing industry and the energy sector. The UF system will have an output of 168 MLD (44.4 MGD). The drinking water treatment plant is expected to be up and running by the end of 2018.

TUAS III – Singapore

Another mega-project that offers a striking example of inge® technology in the Southeast Asia region is TUAS III in Singapore. The island city-state has no fresh water reserves of its own and is therefore entirely reliant on alternative sources of drinking water. As well as rainwater collection, these sources include cleaned and recycled water, imported water and seawater desalination.

This latter option already makes up one quarter of Singapore's water supplies and is steadily gaining in importance. Since 2005, the country has had the technology in place to secure enough water for its more than 5.5 million citizens, and by 2060 it hopes to cover 30 percent of its water requirements with sea water desalination.

The new sea water desalination plant TUAS III is currently under construction and is scheduled to come online by the end of 2017. inge GmbH is supplying the UF system to pretreat 289,000 cubic meters a day (76.6 MGD) of pre-filtered water for the subsequent reverse osmosis stage.

This is the first sea water desalination plant in Singapore that will be run directly by the national water agency PUB. The end customer has therefore insisted on the highest standards of quality for all the system components. As well as supplying the UF technology, inge® also provides extensive technical support to ensure all the customer's requirements are met.

Further information:

www.inge.basf.com

Desalination in the Middle East: when energy efficiency becomes key

Exploring the technologies behind the new Barka IWP desalination plant in Oman, the largest in the country and one of the top 10 worldwide using reverse osmosis membranes.

Efficient management of water resources is one of the biggest challenges that nations around world face nowadays. In fact, in 2016, the World Economic Forum rated water crisis as one of the three main dangers that could affect people and economies across the globe. This is even more relevant for water-stressed regions, including the Middle East, one of the most arid places in the world. Under these circumstances, one of the most significant challenges affecting future development and well-being is the intrinsic relationship between water and energy, where one is necessary to produce the other, and vice versa. This water-energy nexus is one of the most compelling societal challenges to resolve to ensure sustainable development.

Given Oman's desert location and scarcity of naturally available potable water, the Government of Oman, with these challenges in mind, has procured numerous water desalination ventures as independent water projects (IWP), including the inauguration of a new desalination plant, the largest in the country and one of the top 10 largest seawater reverse osmosis desalination plants worldwide. With the aim of alleviating water scarcity in the area and positively contributing

to the security of water supply in the country, the new Barka IWP plant is schedule to have a capacity to deliver 281 million liters of safe drinking water to the north of the country and is due to begin operation in April 2018.

Dow Water & Process Solutions, a global leader in sustainable water separation and purification technologies and a global business unit of DowDuPont Specialty Products Division, was selected by Suez, a reverse osmosis desalination plant design, construction and operations leader, to provide the more than 22,000 reverse osmosis elements with the aim of maximizing the energy-efficiency of the new desalination plant. In fact, energy is the costliest element of seawater desalination, consisting of up to 50% of the total cost of the treatment. According to the Pacific Institute consultancy, the energy required in seawater desalination can range from about three to six kilowatt hours (kWh) of energy to produce one cubic meter of potable water, making it one of the most energy-intensive, and therefore one of the most cost-intensive, water treatment processes available.

For this reason, the company decided to install a selection of the DOW FILMTEC™ reverse osmosis elements, including nearly 9,000 DOW FILMTEC™ SEAMAXX™ membranes, which consume up to 10% less energy than conventional desalination elements. Developed by Dow Water & Process Solutions



Source: Dow

Inside the plant

in 2014, the high permeability of the SEAMAXX™ elements enables higher total production without increasing operating pressure, therefore, reducing the specific energy consumption (kWh/m³) needed to produce freshwater and becoming one of the most efficient solutions to minimize the total water processing costs for the project. In addition, the technology has also been proved to have less fouling at high operating flux and has typically demonstrated success in producing 99.7% water purity.

The new Barka IWP plant is an example of how smart water treatments can help companies, municipalities and countries to become more sustainable both in environmental and economic terms. More and more, industry and governments are recognizing that water treatment technologies can be solution to manage the water-energy nexus and ensure future water supply across the world.



Checking a reverse osmosis membrane

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Uncompromised UF Technology for Waste Water Treatment

inge® ultrafiltration technology is the preferred choice of customers worldwide for a wide variety of applications, including waste water treatment. Based on our Multibore® membranes - the world's most robust UF fibers - our systems purify water by reliably removing bacteria, viruses, particles and suspended solids. Our goal is clear: to preserve our planet's precious water resources by setting the highest standards in waste water reuse.

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Smart water treatments for a smarter society

The issue of water use has become increasingly important to many countries in Europe. In this article, Dow Water & Process Solutions explores how a multi-technology installation in Sardinia could help Italy to become a more sustainable country.

In an increasingly water-scarce Italy, it is important to approach water challenges with more efficient and creative ways. In this sense, it is important to manage the relationship between water and energy to achieve a productive, healthy community. This relationship, called the water-energy nexus, analyzes symbiotic connection of scarce but mutually needy resources - it takes energy, lots of it, to produce clean water and vice versa. This crucial relationship will only become more complex as the world's population continues to increase - by 2050, the United Nations (UN) estimates that world population will reach 9.5 billion. This increase will mean a sharp surge in water, energy and food demand and, in fact, UN estimates also predict that by 2030 the world will require 30% more water and 45% more energy.

In addition, the nexus becomes especially relevant in a country like Italy, where each Italian's water footprint, the water consumed directly and indirectly, reaches almost 6,400 liters of water a day, nearly 60% more than the global average. There are steps to take both in terms of awareness and in terms of action in the face of efficient water management, especially considering that, while the European average index is of 0.14, where zero means no water stress and one extreme water stress, the Italian index is over 0.27, one of the highest in the continent.

However, water is necessary for many sectors in the country's economy. For instance, according to WWF, the water footprint for production in Italy arises to about 70 billion m³ of water per year. Similarly, agriculture is the thirstiest economic sector in Italy with a water footprint of 85% of the total water uses in the country. For this reason, developing sustainable water treatments becomes key to ensure water availability for the industrial sector as well for the Italian citizens in the future. Both industries and municipalities are aware of this situation and many of them are already installing smart water treatments to become more sustainable. Sardinia, the second largest island in the Mediterranean Sea, is currently suffering from a water shortage, primarily because of increasing water demand and poor management practices, which affects the agriculture and industry sector as well as the water drinking supply. The level of available water supply is far below the 1000 m³ laid down by the global environmental research group, Worldwatch Institute, being comparable to the level of water supply in countries such as Saudi Arabia or Libya.

In this scenario, Protecno, the Italian provider of solutions, systems and plants for the treatment of primary water, started the construction of a brackish water purification plant in Sardinia. The aim of the installation was to reduce the use of chemicals compared to similar water treatment facilities as well as offering a

small footprint enabling, in case of need, an easier transportation from one location to another. The water treatment company, with almost 40 years of experience in the industry, elected to continue its ongoing partnership with Dow Water & Process Solutions, a global leader in sustainable water separation and purification technologies and a global business unit of DowDuPont Specialty Products Division, as the only company able to supply the full range of water treatment technologies in the market; from solutions such as reverse osmosis and ultrafiltration, to other applications such as ion exchange resins and electrodeionization. This unique technology integration enables a better vision of the whole project, as the installation is designed and assembled by the same team from the beginning until the end. In addition, this advantage can help to streamline the processes making the system installation faster and more efficient.

This is not the first time that both companies partner to develop joint projects that face the challenges posed by the water-energy nexus. Previous works include the installation of 42 DOW FILMTEC™ SEAMAXX™ membranes at Protecno's Lampedusa plant, which helped to reduce energy consumption in its desalination processes by up to 15%. Protecno installed the chemically advanced membranes to increase efficiency by reducing energy expenditure while continuing to produce the same quantity of clean water as the previous system. The feedwater for this system was drawn directly from the Mediterranean Sea for processing and served to provide drinking water for the island. Thanks to this new system, over a five-years period Protecno is expected to save more than \$230,000 dollars (approximately €175,000).

This time, the state of the art system, which started its operations in June 2015, consists of a multi-technology installation built in four trains. It includes a pre-treatment system using DOW™ ultrafiltration modules followed by FILMTEC™ reverse osmosis membrane technology and DOW™ electrodeionization modules. Each of the trains contains one ultrafiltration and electrodeionization container and two reverse osmosis containers. The whole system has a total capacity of 200 m³ per hour, meeting the strict quality requirements needed to produce the final boiler feedwater, including a conductivity of less than 0.1 µS/cm and less than 20 parts per billion of silicon dioxide.

Minimal chemical use

One of the key objectives of the project was to minimize the use of chemicals to increase the sustainability of the system. For this reason, Dow Water & Process Solutions proposed DOW™ EDI-310 electrodeionization modules instead of an ion exchange resin mixed bed treatment, which would usually be employed in this type of purification processes. Electrodeionization is a water treatment technology that utilizes electricity, ion exchange membranes and resin to deionize water and separate dissolved ions (impurities)



Source: Dow Water & Process Solutions

The selected modules are made using a patented spiral wound design containing membrane and ion exchange resins sealed in a high-strength fiberglass reinforced plastic (FRP) pressure vessel

from water. It differs from other water purification technologies in that it is done without the use of chemical treatments and is usually a polishing treatment to reverse osmosis.

The selected DOW™ EDI-310 modules are made using a patented spiral wound design containing membrane and ion exchange resins sealed in a high-strength fiberglass reinforced plastic (FRP) pressure vessel. The modules optimize performance, maintain continuous product quality and can produce up to 18 megohm-cm product water for high purity industrial water applications. The spiral wound Dow EDI modules allow system integrators to build systems that have both lower capital and operating costs when compared to plate and frame EDI devices.

In addition, given that the well water source for the plant in Sardinia was located close to the sea, the feedwater was high in Total Dissolved Solids (TDS) with around 11,000 mg/L. For this reason, before the final electrodeionization stage, a DOW FILMTEC™ reverse osmosis system with two passes was installed allowing a total recovery of about 70% with an extra low energy consumption. The first part of the system included Seawater Reverse Osmosis (SWRO) membranes, which are designed to reduce capital and operating cost of desalination systems. Meanwhile, the second pass featured Brackish Water Reverse Osmosis (BWRO) membranes to process water with higher salt concentrations and under higher operation pressures than membranes used to filter tap water. This structure adapts perfectly to an island like Sardinia, which is surrounded by seawater.

Installation to reduce the water footprint

Sardinia, as many other islands, has a limited geography where the space is a valuable asset for any company or project developed in this land. For this reason, the other main aim of the installation developed by the Dow Water & Process Solutions experts was to create an installation with a limited footprint. In addition, Protecno required a mobile and flexible system that could be transported

to other plants in a fast and easy process, should it be necessary, to increase adaptability of the system.

The experts decided to develop a system based on containers that, at the same time, were installed in trains. Each of the four trains was equipped with one ultrafiltration and electrodeionization container and two reverse osmosis containers, offering two main advantages. On the one hand, the system minimizes the footprint of the installation and, on the other hand, it allows all the technologies to be mounted in portable containers that can be moved according to the company's necessities. This offers a breakthrough solution for companies with various plants around the world or those opening new facilities, which may have to move technologies between locations. The combination of pre-treatments used for the brackish water plant in Sardinia led as well to a smaller water footprint.

Installations like the one in Sardinia are at the spearhead of the technology trends both in Europe and Italy. Companies are realizing about the importance of installing smart water treatments that can help them minimizing their environmental footprint while allowing them to increase their economic savings at the bottom line. To become more sustainable, it is key to reduce the amount of energy consumed without decreasing the quantity or quality of water processed.

In this sense, water treatment technologies are a viable solution to problems posed by water scarcity, and significantly help in addressing the issues generated by challenges such as the water-energy nexus. Identifying new ways to reuse water within industries and municipalities, and elsewhere, is the starting point to ensuring a safe future for Italy, for Europe, and for the world.

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Practical test in large industrial water treatment plant

Reverse osmosis membrane elements from LANXESS have successfully completed a year-long practical test in Germany's largest industrial water treatment plant. The new element grades with ASD feed spacers impressed Zellstoff Stendal GmbH based in Arneburg with their performance and consistently high level of rejection. Optimized for applications in brackish water, these Lewabrane-branded elements are characterized by very low energy consumption (LE = low energy) and high fouling resistance (FR = fouling-resistant).

"The outstanding results of our ASD products in benchmark tests with other manufacturers at one of the largest pulp manufacturers in Europe once again underline the extraordinary quality of our products," says Alexander Scheffler, responsible for LANXESS's global membrane business.

One year ago, Zellstoff Stendal launched a project to test LANXESS's newly developed Lewabrane ASD range of membrane elements. This involved installing conventional reverse osmosis (RO) elements with a standard feed spacer and FR elements with LANXESS's new ASD spacer in parallel in a single pressure vessel. The LANXESS spacers have a special "netting" that reduces biological growth and particle fouling by minimizing dead zones. The netting has an alternating strand design (ASD) of thin and thick filaments, which is what gives the spacer its name.

Frank Gorges, plant technician for water treatment at Zellstoff Stendal GmbH in Arneburg, was excited about the result: "We were very impressed by the performance of the ASD membrane elements from LANXESS. We test a lot of products in our plant and hardly any of them have been able to provide such consistently high results throughout an entire year."

During the period of the project, the LANXESS RO elements demonstrated excellent performance and impressed with a consistently high level of rejection. This has a positive effect

on the service life of the mixed bed and the amount of chemicals required for regenerating the ion exchangers.

After one year, the elements were removed and taken to the applications laboratory LANXESS operates in Bitterfeld for an "autopsy". Compared to a standard element, there was hardly any increased pressure drop along the element when using the ASD grades. This indicates less blockage from fouling or biological growth.

In addition to the fouling-resistant Lewabrane B400 FR ASD grade tested by Zellstoff Stendal, LANXESS also offers Lewabrane B400 LE ASD, another premium product where the innovative feed spacers have improved productivity by four percent. For users, this means potential energy savings of approximately the same percentage.

Computational fluid dynamic (CFD) simulations had previously indicated that RO elements with ASD feed spacers would indeed be capable of achieving higher performance levels than standard grades. Furthermore, the tendency toward fouling in the element is reduced. "As we calculated, using the new elements reduces energy requirements while at the same time increasing service lives," says Dr. Jens Lipnizki, head of Technical Marketing Membranes in the Liquid Purification Technologies (LPT) business unit at LANXESS.

Water treatment technologies for pulp manufacturing

Zellstoff Stendal, part of the American-Canadian Mercer International Group, is the largest and most cutting-edge manufacturer of NBSK (Northern Bleached Softwood Kraft) market pulp in Central Europe. With their outstanding properties – especially their high tensile strength and high degree of whiteness – these pulps are used, for example, for high-quality printing and copying paper, wallpaper bases, household paper such as paper tissues and kitchen roll, filter paper and a range of other specialist papers like silicone base paper. Wood elements such as bark and lignin that are not used for pulp production are incinerated in boiler plants. A combined heat and power process in this case generates heat energy that is used as process steam and electricity. Located in the north of Saxony-Anhalt, the plant generates enough power to cover its own needs and also feeds a large part of the renewable energy generated into the public electricity grid. More than 50,000 cubic meters of water are needed every day for pulp manufacturing in Arneburg, and this is treated using reverse osmosis and ion exchange resins. The Lewatit MonoPlus S 100 and Lewatit MonoPlus M 600 grades are used in the multistep process, while Lewatit MonoPlus SP 112 H and Lewatit MonoPlus MP 500 are used in the mixed bed.

Further information:
<http://lpt.lanxess.com>

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Carbon electrodes for low energy desalination

MIDES (for Microbial Desalination) is a 4-year project funded by the European Union Horizon 2020 program to develop an advanced reverse osmosis desalination technology with reduced energy consumption. SGL Group, as a MIDES partner, provides carbon and graphite components for the microbial desalination cell.

Reliable supplies of fresh water for drinking, industrial use and irrigation is a monumental challenge in many regions around the world, and desalination is one approach to increase fresh-water resources. However, current desalination technologies require enormous amounts of thermal or electrical energy. Even with reverse osmosis, which is the most established technology with the lowest energy consumption, more than 3 kWh are required to produce 1 m³ of fresh water.

MIDES is developing a low-energy solution through the implementation of a pre-treatment step using microbial desalination cells (MDC) as part of a reverse osmosis system (**Figure 1**). The MDC concept was first published in 2009, but to date has only been investigated at lab scale. The MIDES consortium, led by the Spanish water management company FCC Aqualia, aims to demonstrate the feasibility of this technology for large-scale desalination with an energy consumption at or below 0.5 kWh/m³ by 2020.

How does this work? Simply put, wastewater will be used as an energy source to fuel the desalination process.

Microbial desalination

The basic principle of a microbial desalination cell is an electrodialysis process which is powered by the metabolism of so-called electroactive bacteria supported on a carbon anode (**Figure 2**). Similar to well-known microbial fuel cells (MFC), this specific type of bacteria metabolizes organic matter and converts it to electricity. Unlike MFCs, which consist of two chambers, MDCs comprise three chambers, separated by two ion exchange membranes. In the anodic chamber, wastewater is fed to the bioanode, organic matter is oxidized by the electroactive bacteria in the biofilm, and electrons are transferred to the anode material. In the cathodic chamber, a mediator redox system with high positive standard potential is used to establish a high cell potential. The middle chamber is fed with high-saline water. Driven by the electric potential gradient between anode and cathode, ions (Na⁺ and Cl⁻) migrate through the respective membranes and concentrate in the cathodic and anodic chamber, respectively. Based on that principle, the MDC can decrease the salinity in the middle chamber from 35 g/L to around 5 g/L.

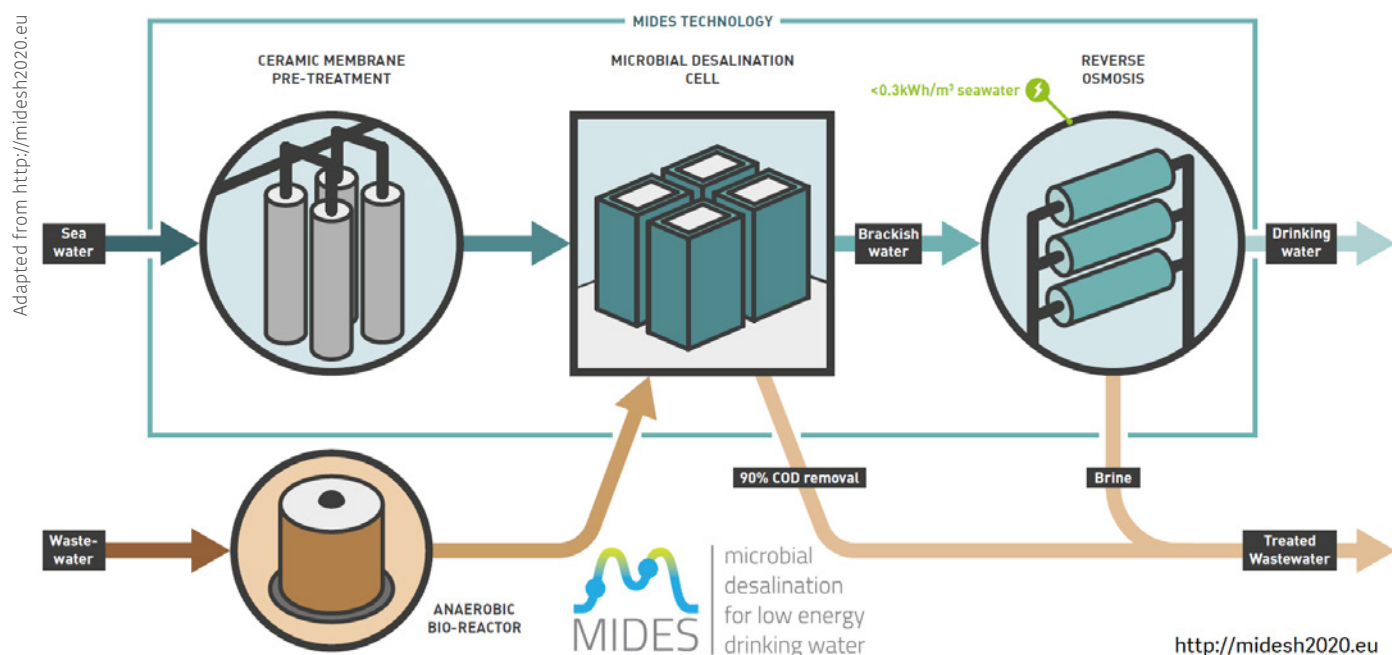


Figure 1: The MIDES approach combines wastewater treatment and desalination in a complex system with the microbial desalination cell at the heart of the process

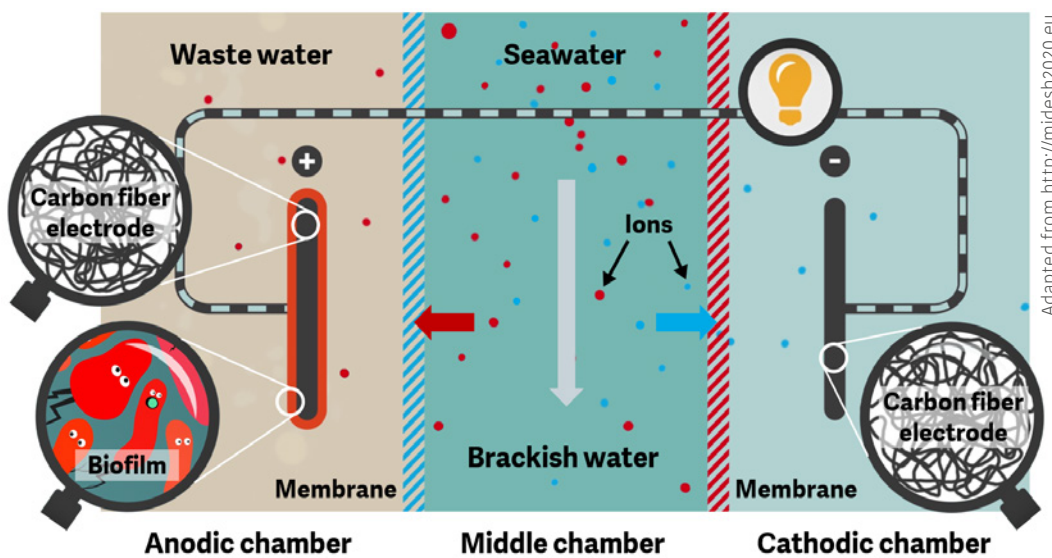


Figure 2: Schematic representation of a microbial desalination cell.

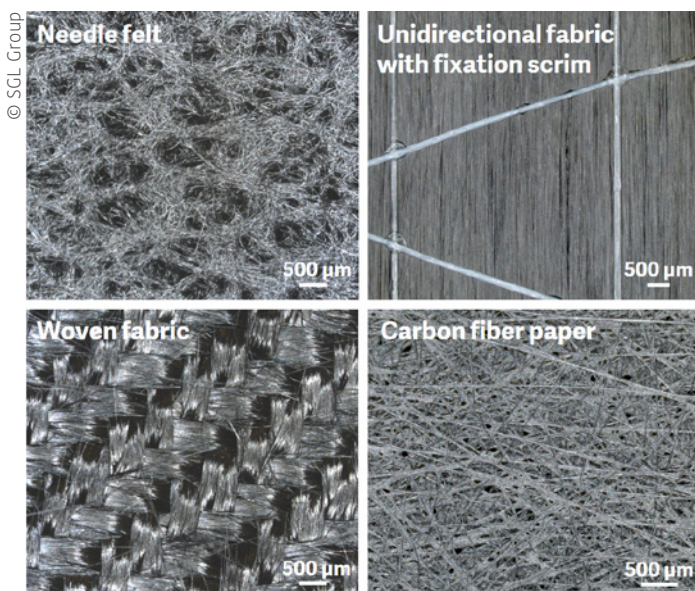


Figure 3: Optical microscopy images of various carbon fiber textiles used as electrode for MDCs.

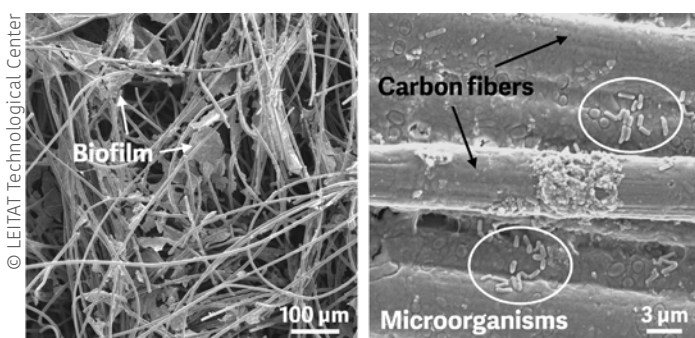


Figure 4: SEM images showing the biofilm on and in between the carbon fiber anode. At higher magnification, the individual microorganisms are visible.

Subsequently, the resulting brackish water can be completely desalinated by reverse osmosis with a significantly lower energy consumption of less than 0.5 kWh/m³.

Carbon fiber based electrodes

Carbon fibers are known mainly for their impressive mechanical properties and applications in lightweight construction. In addition, carbon materials offer promising characteristics in water treatment. For example, an anode material with a porous structure is needed to obtain a large active biofilm area in the MDC and, consequently, an efficient desalination process. Carbon fiber textiles are the perfect material to meet this requirement while also exhibiting the following favorable characteristics:

- Nontoxic and biocompatible
- Long-term resistance to corrosive media, e.g. high salinity solutions
- Good electrical conductivity which enables large current densities
- Low weight and high flexibility
- Adjustable surface morphology of individual carbon fibers allows for an increase of the active surface of the anode and improved contact to the biofilm
- Possibility to tailor the surface chemistry, e.g. introducing oxygen or nitrogen functional groups, to improve and accelerate the formation of the anodic biofilm
- Economic fabrication at large scale

SGL Group's portfolio offers various carbon fiber based textiles suitable for the application in microbial electrochemical technologies. Within the MIDES project, carbon fiber needle felts, unidirectional fabrics and woven fabrics have been identified as the most suitable base for high performance anode materials (Figure 3). By scanning electron microscopy (SEM), the biofilm, which forms around and in between the carbon fibers, could be investigated (Figure 4). At higher magnification, even individual microorganisms could be observed.

In addition to the anode, carbon fiber textiles are also the base

material of choice for the cathode. Two configurations are being investigated:

- A 'liquid cathode' configuration (symmetric MDC), which uses water-dissolved species as redox couples, and is based on similar carbon electrodes as the anode.
- An 'air-cathode' configuration (breathing MDC), which is based on the oxygen-reduction reaction (ORR) and consists of gas diffusion electrodes based on carbon fiber paper (**Figure 3**).

Finally, graphite plates manufactured from expanded graphite can be employed as current collectors to establish electrical contact to the porous electrodes.

Outlook

The objectives of the MIDES project include three pilot plants with a desalination capacity of 1-3 m³ per day. The first pre-pilot system is currently in operation at the reverse osmosis desalination plant in Denia, Spain, situated at the Costa Blanca. Furthermore, sites in Tunisia (seawater) and Chile (brackish water in a mining site) will follow to demonstrate the feasibility of low energy microbial desalination on large scale.

Acknowledgement

The MIDES project is a consortium of 10 companies and research organizations from 8 countries funded by the European Union within the Horizon 2020 NMP24-2015 program (grant agreement No. 685793). Research on electrode materials was performed in collaboration with LEITAT Technological Center, Barcelona.

Further information:

<http://midesh2020.eu/>

<http://www.sglgroup.com/cms/international/innovation/future-carbon-technologies>

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Economic and operating improvement by Investigation of an RO water treatment plant

The reverse osmosis facility at the Slovnaft oil refinery in Slovakia is one of the largest surface water treatment plants in Eastern Europe. SLOVNAFT, A.S. in Bratislava is the leading supplier of refinery products in Slovakia. The refinery produces a broad range of petrochemical raw materials. The company is a member of the Hungarian MOL Group.

The refinery water treatment facility produces fully demineralized water that is available as boiler feed water for water-steam circuits and other technical purposes. The raw water for the refinery is sourced from the Danube River. It contains between 320 and 400 mg/l dissolved solids with seasonally fluctuating organic fractions. The river water can report electrical conductivity of up to 580 mS/cm. During treatment, it first undergoes chemical pretreatment (coagulation and ultra-filtration), before entry to the reverse osmosis (RO) system, which is divided into five separate lines, each equipped with 126 membrane elements. The three-stage reverse osmosis demineralization facility can produce up to 135 cubic meters

of permeate per hour, per line. The RO system has a permeate recovery of up to 85 percent. The maximum permeate conductivity as specified by the operator is 15 mS/cm, max. Post RO treatment, the permeate is sent to downstream mixed bed ion exchange resins for removal of any remaining ionic compounds.

At the beginning of the project, a projection of the RO plant was done with the LewaPlus design software to predict the performance of the plant. A high rejection (HR) membrane element type was selected since a conductivity of less than 10 mS/cm could be expected. Further and as additional benefit, this resulted in less of an ionic burden on the mixed bed ion exchange resins, lowering regeneration frequency.

Start Up and Operational Concerns

In December 2014, a total of 630 Lewabrane RO B400 HR high rejection membrane elements went into operation in the refinery complex's water treatment plant. The calculated

Source: LANXESS AG



LANXESS is producing the Lewabrane reverse osmosis elements at its German plant in Bitterfeld



Source: SLOVNAFT, a.s.

SLOVNAFT, a.s. in Bratislava is the leading supplier of refinery products in Slovakia and it produces a broad range of petrochemical raw materials. In the water treatment plant of the refinery complex, LANXESS' Lewabrane membrane elements running stably and reliably since 2015

operational parameters were confirmed, and projected water quality was on the order of $5 \mu\text{S}/\text{cm}$.

Another concern of refinery management was the reduction of cleaning chemicals around the RO system. The previous installed RO elements required a cleaning treatment every 4 - 6 weeks, usually prompted by an increase in feed pressure (and consequently, higher power consumption). To reduce this cleaning frequency required an investigation, and deeper understanding of the site-specific causes of the flux decline, and increase in pressure drop along the vessel.

A common cause for a higher applied feed pressure can be fouling, caused by organic settling, membrane scaling (caused by the precipitation of sparingly soluble salts), or biological growth. Generally, most of the bacteria and organics which cause fouling or biogrowth should be removed by the ultra-filtration (UF); however, it may happen that fiber breakage within some of the UF modules can lead to an increase of these foulants in the system. Further, membrane scaling is also a common cause of increasing feed pressures. The Lewa-Plus projection showed the possibility of Barium Sulfate and Calcium Carbonate scaling. The chemical addition prior to the RO system applies Antiscalant; however, there is always the possibility of underfeeding.

Investigation

It is generally known that fouling will appear in the front end of an RO system, and that scaling usually appears at the tail end of the system (since the salt concentration at the tail end is more the four times higher compared to the feed inlet). To investigate the problem of fouling and/ or scaling, the operational parameters of the RO system were checked, and

the data normalized against a specific reference condition. Normalization programs are available from several RO suppliers. They are usually Excel spreadsheets which calculate the performance of an RO plant to a selected standard conditions. This data normalization helps the plant operator to judge whether the observed plant performance changes are due to a variation in the feed water conditions, like temperature or salt concentration, or whether the changes are due to fouling or scaling.

The Slovnaft refinery plant data analysis and normalization showed an increase in pressure drop in Stage one, and an overall flux decline of the plant. This investigation suggested that the primary reason for the loss of performance was from lead-end fouling. To confirm this observation, a pressure vessel of Stage one was opened, and the lead and the last elements were removed for further investigation.

One fast and efficient method to evaluate the incidence of fouling is the measurement of the weight of an RO element. While a drip dry, new 8 inch diameter element has an average weight of around 16 kg, an increase in weight of more than one kg is a strong indication for fouling or scaling. In this case, the lead element was heavier than the last element, and a brown gelatinous film was observed on the feed side of the lead element. This was the first strong evidence for organic fouling and biogrowth in Stage one.

Changes in Chemical Treatment

As a result of the normalization analysis and visual RO element inspection, Kurita was asked to propose an improved chemical treatment application to address the known fouling and biogrowth in the feed water to the RO system.

The existing Slovnaft refinery raw water treatment includes the dosing of organic coagulant, and dechlorination by dosing of a stabilized sodium bisulphite agent. The additional treatment steps proposed by Kurita included the following:

- dosing of antiscalant to prevent scale formation on RO membranes
- dosing of two different non-oxidizing biocides for prevention of biofouling
- periodic cleaning and disinfection of RO membranes.

A Kurita's software program was used to select a suitable antiscalant product which has shown excellent results not only in calcium carbonate and calcium sulfate scaling prevention, but also highly effective for barium salts precipitation.

The biocide injection was applied as a complex chemical treatment program. In addition to chlorination, the process includes 2 non-oxidizing biocides (with different active components) which are dosed intermittently into the feed water. After discussion with specialists of the Main Technology Dept. of Slovnaft, it was decided that the biocides were to be dosed alternately over a 3 month period.

It is now known that the RO membranes are fouled with both soft and hard deposits on the membrane surface. These deposits (or foulants) decrease the permeate flow and salt rejection, and increase the differential pressure and energy consumption. This situation, if untreated, often results in the necessity of membrane replacement, but can be remedied by improvements in cleaning protocols.

In this case, a specially developed CIP (Cleaning In Place) program for the RO membranes was applied for the removal of both inorganic and organic fouling materials. A 2-step CIP program was applied using the following conditions:

- alkaline CIP, using a special chemical composition and procedure. A combination of 3 products is used – surfactant, dispersant, plus pH adjustment. The main purpose is to remove the colloidal matters, iron and organic substances, bacteria, algae, etc...
- acidic CIP, the main purpose is to remove scale deposits from membrane surface. Based on collaborative work with

Lanxess, a product with a special combination of active ingredients was developed and has been successfully applied. As the result of the customized CIP procedure, and application of the new, complex chemical treatment process described above, the cleaning interval of the Lanxess RO membranes was prolonged to 2,5 – 3 months on average, within a year.

Conclusion

An RO system is judged by its efficiency and reliability. The new installed elements showed a rejection (permeate quality) above the expectations. At start up, the applied feed pressure was within the predicted range, but a slight increase in pressure drop could be observed after some weeks. To understand these subtle changes in operating performance, an investigation of the RO system was necessary. In this case, normalization of the operating data, and RO element autopsy were employed to determine the causes of lower operational performance. This approach confirmed that biogrowth and organic fouling was reducing the efficiency and reliability of the RO system.

An improved and customized chemical treatment and CIP cleaning protocol was applied at the plant. The initial results are quite encouraging with respect to cleaning frequency. Less frequent cleaning cycles, and less regenerant chemicals consumption for the downstream ion exchange mixed-bed are the reward for the application of these new protocols. In the final analysis, these improvements should result in an economic and ecologic benefit for the refinery.

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Effective treatment of stainless-steel pickling

The more profitable a project, the greater the investment. But it's not just high savings potentials which motivate businesses to invest in wastewater treatment. The responsibility to protect the environment is also playing a key role for an increasing number of industrial companies. That's why thermofin's main aim was to create a wastewater treatment system which enables sustainable recirculation and pays off quickly. A requirement which H2O GmbH from Steinen in Baden-Württemberg has fulfilled with its VACUDEST XS 360 vacuum distillation system.

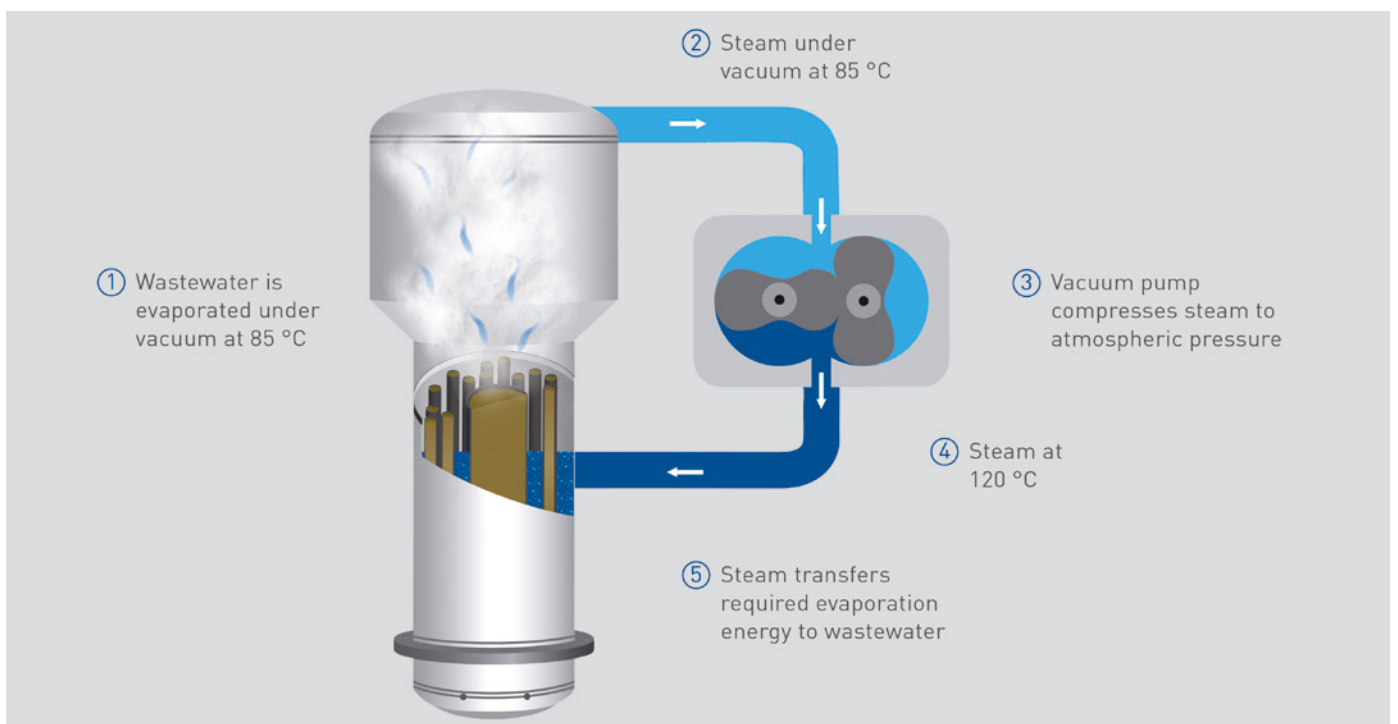
The first contact between heat-exchanger manufacturer thermofin, based in the Saxon town of Reichenbach, and H2O GmbH, was made at the Pulversymposium in Dresden. Even at this early stage, it became clear that, with disposal costs of up to 400 Euros per cubic metre of wastewater, a lot of money could be saved through wastewater treatment.

Thermofin specialises in manufacturing industrial heat exchangers, which are produced as per customer requirements in lengths of up to eight metres. The reputable company's customers include the Electoral Palace in Dresden, the Saudi Electricity Company in Riyadh, the Hamberger gastronomy wholesaler in Munich and the SnowDome indoor skiing facility in Bispingen (Lüneburg Heath). Thermofin's heat-exchanger manufacturing processes result in stainless-

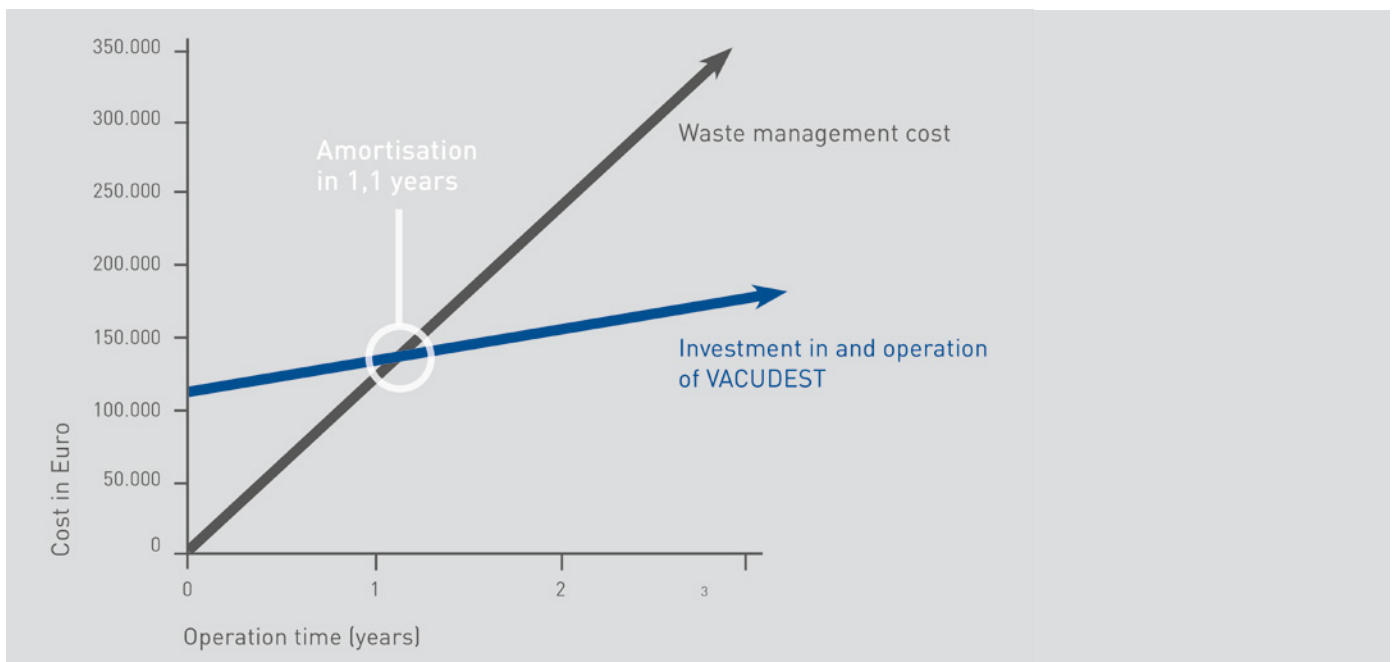


The VACUDEST XS saves over 100,000 Euros a year at thermofin

steel pickling solutions, as well as rinse water from powder-coating pre-treatments. Around 300 cubic metres of wastewater are produced each year.



95% energy recycling ensures cost effectiveness



The graph shows how fast the investment in VACUDEST XS 360 will pay off for thermofin: just 1.1 years



Tight spaces are not a problem for H2O GmbH's engineers: The tanks were quickly placed on top of one another to save space in the production facility

Calculation of amortisation time and saving

This wastewater from the stainless-steel pickling solution and the rinse water from the paint pre-treatment has previously been collected by a local disposal company and charged at a rate of up to 400 Euros per cubic metre, resulting in additional production costs of over 100,000 Euros a year. The laboratory trial conducted at H2O's application centre for wastewater-free production found that wastewater quantities can be reduced by up to 98 percent. This 98% saving in disposal costs means the investment's profitability quickly becomes apparent.

Inspection of an operating customer system

After production manager Thomas Speck expressed interest in seeing an H2O system in use at a customer facility, a visit was made to the production plant of Kaeser Kompressoren in Gera in April. He was thrilled with the clear structure, component layout and positive feedback from production managers: "Clean treatment like this would also work well at thermofin!". He was particularly impressed by Kaeser's ratings of the system's profitability and reliability, and the results in terms of treatment and distillate quality. The system yields the exact results promised in the laboratory trial – which is very crucial when it comes to reusing the distillate.

The plan for treating and reusing the process water at the production plant was efficiently formulated, allowing both companies to meet for contract negotiations as early as May.

The wastewater treatment for the thermofin project went off without a hitch.

The components and system were efficiently installed in August, thanks to H2O's excellent planning. The tight space

	VACUDEST XS 360	disposal of waste
Resulting wastewater	300 m ³ /year	300 m ³ /year
Energy costs	3.780 Euro/year	---
Operational expense	1.560 Euro/year	1.560 Euro/year
Interest rate for capital raising	3.360 Euro/year	---
Fresh water	---	600 Euro/year
Maintenance by H2O (optional)	5.100 Euro/year	---
Spare and wear parts	910 Euro/year	---
Consumables	600 Euro/year	---
Disposal of evaporation residue/waste-water	3.600 Euro/year	120.600 Euro/year
Total	18.910 Euro/year	122.760 Euro/year
Saving potential in 10 years with your VACUDEST	1.038.500 Euro	

3.3 x 4.0 metres. As space was tight on the side, a vertical layout was opted for, resulting in both tanks for neutralisation and distillate being placed on top of one another. The space provided was maximised. The production managers' great interest in completing the project as quickly as possible also helped. Production manager Thomas Speck was always open to H2O's queries and able to assist. thermofin has been saving on disposal costs for production wastewater since early September. The initial results have been very promising, and even managing director Bernd Löffler is pleased: "Thanks to VACUDEST, we are saving so much wastewater every day that the investment will soon pay itself off. We are delighted that the product could be carried out so quickly and smoothly, and that we can also help protect the environment."

Author:

Thomas Nadler
 Area Sales Manager Bavaria & Austria
 H2O GmbH Steinen, Germany

behind the powder coating area of the production plant posed a setup challenge; the VACUDEST XS 360, including tanks and residual oil separators, had to be installed in an area of just

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Low maintenance plant operation, maximum throughputs, minimum energy costs

The rotating membrane filtration plant VRM® manufactured by the mechanical engineering company Huber SE in Berching (Germany) has successfully been applied in municipal and industrial MBR applications for more than 15 years.

After a comprehensive redesign in close coordination with MICRODYN-NADIR the first HUBER Membrane Filtration VRM®50 went into service on WWTP Hutthurm in Bavaria. After half a year of problem-free operation during the start-up phase we have taken stock and can now present the first interim results.

Stable plant operation

Together with the three membrane filtration units type VRM® 30 put into service in May 2008, the Hutthurm MBR plant uses now four filtration units with more than 19,000 m² total membrane surface, of which 9,200 m² are provided by the new membrane filtration VRM® 50. The first seven month of the trial operation went off without any problems. During the summer months, when it rained, up to 4,000 m³ wastewater per day were handled without problems. Most of the time,

one or two of the filtration units were even in stand-by mode. Plant operation in winter was more of a challenge. Especially during the wet and cold January 2018, the plant had to cope with huge amounts of cold rain and melt water that caused the temperature in the aeration stage to drop to 6-8 °C sometimes. This was not only a great challenge for the microorganisms, also the filtration process itself became more demanding.

On WWTP Hutthurm, it was above all thanks to the proactive operational actions of the experienced staff on site that membrane permeability could be kept constantly above 200 l/(m² h bar) during these weeks.

Mainly for new installations, operator's experience with this new process technology, which is so important for MBR processes, is however often missing.

This is exactly where the fully automated permeability monitoring HUBER uses now as standard is an especially beneficial solution.

The plant operating staff is automatically notified in time, i.e. before the plant leaves the "green operating range". This

enables them to counteract early enough and take suitable measures if membrane permeability is falling rapidly or any parameter is falling below a certain limit. Such measures to take could for example be membrane cleaning, chemical backwashing or process adjustments. HUBER Permeability monitoring is not intended to and cannot replace competent operating staff on site, it is to support the staff under difficult operating conditions and during start-up phases, thus contributing a valuable share to safe and stable system operation.





Source: Huber

Low energy consumption

If such a solution offers not only high process stability but additionally high energy efficiency, it is becoming really interesting for plant operators. This is exactly the case at Hutthurm, even with the low throughput rates in winter. The reason for this extremely low energy demand is the very low product-specific amount of scouring air of only 40-60 l/m² h. These low amount are possible due to sequential membrane cleaning as the membranes are rotating and the air is blown in at only half the depth required otherwise.

During the coming months, the energy optimisation phase will be extended to the entire MBR process. The aim is to make plant operation even more energy-efficient and reduce the specific energy consumption to below the threshold of 100 Wh/m³.

Automated backwashing

Variably adjustable backwash intervals and run times are generally the precondition for a stable and sustainable plant operation, not only on WWTP Hutthurm. These options, combined with continuous HUBER permeability monitoring, ensure maximum operating reliability in the long run.

Also chemical purification of the membrane modules is now performed conveniently and virtually maintenance-free via the backwashing program – a timesaving and safe solution without the need to empty the filtration chamber.

The new HUBER Membrane Filtration VRM® 50 has been equipped with a completely redesigned scouring air system. Maintainability and high energy efficiency were the main goals during development. The practice test has now shown that the new air distributors are not only very energy efficient, but also completely maintenance-free.

Résumé

Minimum energy consumption, backwashable and self-healing membrane, safe and convenient to operate – to mention only the most important customer benefits.

Josef Krenn, the site manager of the Hutthurm plant, is also very satisfied: “Constantly high permeability, trouble-free operation, little effort and work required – what more could you ask for?”

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Coagulation and flocculation in the Helsinki drinking water treatment plant

The raw water for Finland's capital Helsinki is pumped from Lake Päijänne, located approximately 120 km away, via a tunnel to two water treatment plants, where it is treated and purified. This secures sufficient drinking water of excellent quality for around one million people. HSY, Helsinki's Environmental Services Authority, is the communal treatment plant operator; it is responsible for securing the entire water supply. In the drinking water treatment plant in Vanhakaupunki 18 HYPERCLASSIC® Evolution7 mixers and three CYBERPITCH® mixers made by INVENT have been in operation since July 2017.

The current plant was reconstructed in order to increase its capacity and to realize a more energyefficient configuration. As early as during the design phase of the reconstruction INVENT's distribution partner Puwimex Oy was able to lay-out and recommend suitable INVENT mixers for plant operator HSY to optimize coagulation and flocculation. In addition and with the help of high-resolution, realistic flow simulation processing steps were modeled and optimized.

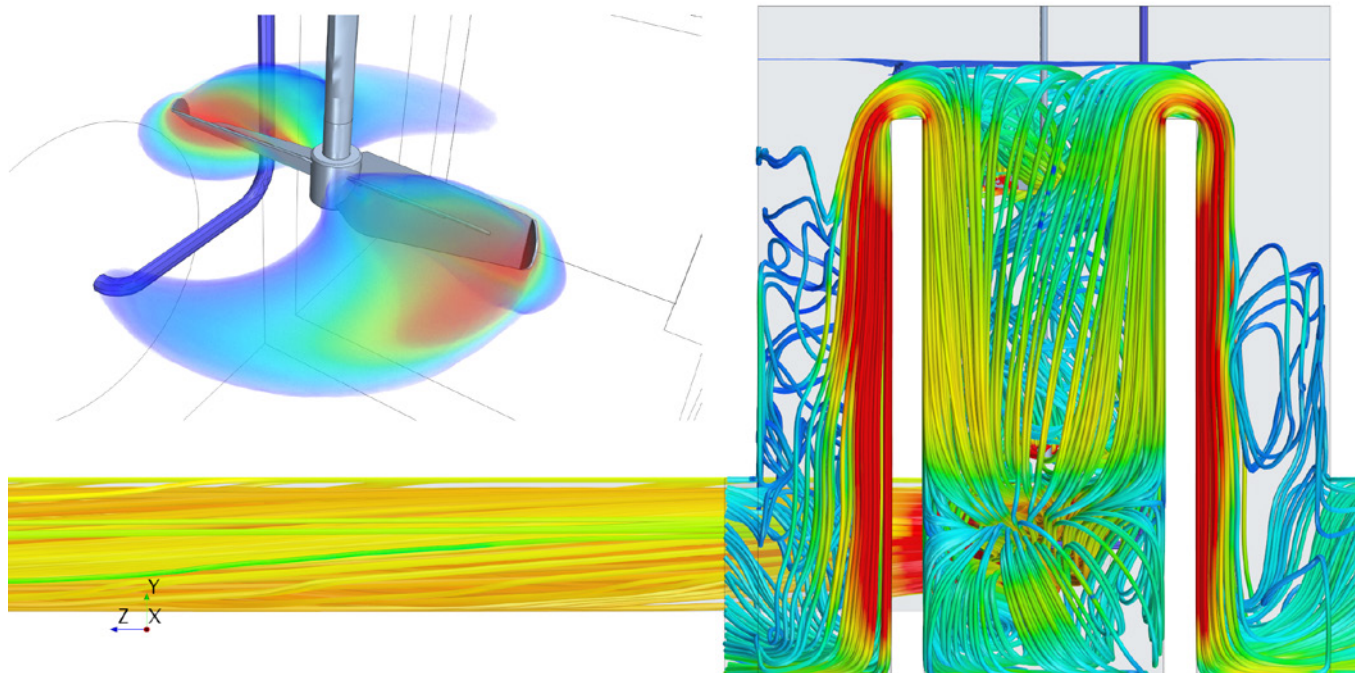
One challenge during the layout was the significant improvement of the mixing result in the supply tank of the drinking water plant. The goal is to achieve a spontaneous equalizing of the charge on the particles' surface so that colloiddally present particles can grow into flakes. This is where CYBERPITCH® mixers come into operation, as they mix with high velocity and energy. The mixer consists of a refined angled-blade mixer, which accelerates the water not only in an axial but also in a radial direction. The CYBERPITCH® mixers also evenly stir in the flocculation agent.

The HYPERCLASSIC® Evolution7 mixers are employed in the flocculation tanks in order to remove unwanted ingredients in the drinking water, such as particles causing turbidity or solute organic matter; this is achieved through agglomeration of suspended or colloidal particles. Subsequently the water passes through a sedimentation, flotation and filtration phase.

The design of both mixers very much meets the requirements of drinking water treatment. The power units are dry installed above the water's surface and therefore do not come into contact with



INVENT HYPERCLASSIC® mixers in the flocculation tank in the Vanhakaupunki drinking water treatment plant, Helsinki, Finland

THINK Fluid Dynamix

High flow velocities and turbulences in the distribution tank with an INVENT CYBERPITCH® mixer

water. The mixers are equipped with food-grade oil in power units and oil trays in accordance with the customer's specific requirements to prevent impurities in drinking water.

With the help of the HYPERCLASSIC® mixers all prerequisites for the optimal formation of flakes can be fulfilled and undesirable impurities can be separated. By rotating close to the bottom of the tank the HYPERCLASSIC® Evolution7 hyperboloid mixer's eight integrated and specifically optimized transport ribs generate a radially external bottom flow. This flow is particularly turbulent close to the bottom of the tank and efficiently stirs up sediments, so that sedimentation of particles in the flocculation tank does not occur. Additionally, incidences of short circuit flows are securely eliminated. Due to the fact that the flow on the water's surface is directed towards the drive shaft all particles are evenly mixed throughout the tank, so that almost all of the particles come into contact with the flocculation agent, agglomerate and form flakes. Due to the mixer's large diameter, its optimal geometry and its low rotational speed the HYPERCLASSIC® mixer's shear forces are

minimized. This enhances the agglomeration of the flakes and avoids loading the flakes. The bigger and more stable these flakes are, the more easily they can be separated in the subsequent purification steps. Impurities are almost entirely removed from the drinking water. These facts contribute to the significant improvement of the plant's purification capacity.

The reconstruction and retrofitting of the plant in the summer of 2017 with INVENT mixers enabled the operator HSY not only to meet a higher demand, but also to deliver the best and a more energy-efficiently produced drinking water to approximately one million people in and around Helsinki. Kippis!

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Cleaning and disinfection of the fresh water system on board the windjammer SEA CLOUD

Chemical cleaning and subsequent disinfection of pipes and storage containers on ships and offshore sites are essential in maintaining hygienic conditions. Piping and water storage container may develop biofilms and scaling within a short time and thereby compromising the quality of the fresh water supply on board. Example: Every three months the freshwater system on board the SEA CLOUD is checked, cleaned and disinfected by trained personnel and once a year while staying at ports the whole system including pipes and container is cleaned by the professional multi-step flushing procedure.

May it be washing your hands or cleaning dishes and surfaces - sanitation is a part of everyday routines in virtually all areas of modern life. However, there are still areas that do not get the attention they deserve, despite the potential harmful consequences. On passenger and container ships, insufficient sanitation of the fresh water supply and low quality port water can be serious sources of infection [1]. It is therefore of paramount importance to ensure regular check-ups, cleaning and disinfection routines for fresh water tanks and the distribution system on board.

Contamination and poor maintenance lead to biofilm, sludge and scaling

If left unchecked internal surfaces of pipes and water tanks will relatively quickly be covered with microbial growth (biofilm) and, as a result of water hardness, scaling. If scaling is not removed in a timely manner, it is likely to enhance biofilm development further because it provides both nutrition and optimal attachment conditions for microbes. Biofilms may contain a variety of microbial life including bacteria, fungi, viruses and amoeba all of which may pose a health threat. Sludge may accumulate if fresh water tanks are contaminated with seawater or bilge water¹, which in most cases is a result of faulty design, e.g. when inspection covers of fresh water tanks are below bilge water level¹. Cross-contamination with bilge or seawater also increases the risk of microbial contamination, in particular when sewage is involved Water-borne infections on ships are commonly caused by enterotoxigenic *E. coli* or norovirus [1,2]. Depending on inspection stringency in some ports either the

¹ bilge water refers to water that accumulates in the bottom of the ship and may contain sewage, seawater and other components from the ship's water system



Source: korinexan

The SEA CLOUD II: Modern cruise liner with historic charm

water itself or storage or distribution systems may already be of poor hygienic quality and will consequently also contaminate on-board systems. The World Health Organisation (WHO) identified the transfer from shore to ship as a third possible contamination route for fresh water if vessels, tanks or pipes for transfer are insufficiently maintained or protected from environmental input [3].

Water source and treatment affects quality and composition

Fresh water is usually boarded in different ports and often varies greatly in quality and composition. The quality in terms of how it is treated (e.g. filtering, disinfection, deionization) depends on local or national regulations, whereas the composition and parameters such as hardness, pH and content of organic compounds also greatly depends on soil properties and the actual source of the water. By seeping through different layers of rock, water takes on minerals including calcium and magnesium both of which are responsible for the degree of hardness. Especially in areas rich in limestone, gypsum or dolomite the water contains higher amounts of calcium and magnesium making it hard. Water that is won in areas rich in basalt, sandstone or granite and surface water from lakes, streams and rivers are generally soft. Especially high temperatures promote the formation of calcium carbonate in water, which leads to the familiar yet irritating scaling in water kettles or coffee makers but also in pipes and water heaters on ships.

Installing a softening plant or an ion exchanger to remove the minerals is generally regarded as the method of choice and has proven useful. The efficacy of limescale protection devices on the other hand remains to be fully demonstrated specifically for those using electric or magnetic fields. The mechanism proposed is to stabilize calcium and magnesium and thereby preventing scaling without removing the minerals from the water. An exception are devices working with nanocrystals or seed crystals for which an effect on limescale build up has been shown. However, even fresh water storage and distribution systems using this technology require regular cleaning since scaling cannot be prevented completely.

The pH of the water depends on various factors most of which the ship owner has only limited influence on. The interior material of new pipes (concrete, cement mortar, fibre cement, spun concrete) as part of the distribution system on shore, often exhibits a high alkalinity and thus raises the pH of the water during transfer. This can cause a significantly reduced efficiency of certain disinfectants, in particular the commonly used chlorine and hypochlorite.

Cleaning and disinfection – but right

Efficient and professional cleaning and disinfection of pipes and other parts of the fresh water system are essential requirements for hygienic operation. Unfortunately, the idea seems to persist that disinfection (of the water or the pipes) alone is sufficient to ensure proper sanitation. However, there is mounting evidence showing that a professional cleaning



Equipment for cleaning on board

prior to disinfection is required and should not be omitted for the sake of time saving to remove biofilm and solid particles such as scaling from internal surfaces. This holds true for newly installed as well as continuously or only intermittently used fresh water systems.

Internal surfaces of pipes are cleaned to create a normal flow rate, which in comparison to installing new pipes is less cost intensive and takes less time. Using the right method – for instance, multi-step flushing combining specialized and complementing products - this can be achieved within a day or even a few hours.

Given the aforementioned range of and often alkaline pH, it is more advisable to use chlorine dioxide as a disinfectant rather than chlorine or hypochlorite (also known as bleach). Unlike hypochlorite, chlorine dioxide is still efficient at high pH-values, while at the same time it does not leave the typical taste and odour of chlorine, thus making the consumption of fresh water more agreeable.

In addition, the CARELA group designed a dosing system for water conditioning (CAREbox, patent pending) that allows long distance monitoring based on machine-to-machine (M2M) technology and can therefore be used worldwide. The system can also be used to disinfect hygienically unacceptable water immediately after transferring it from port onto the ship. If required the korinexan® service team is able to provide support from the distance without travel expenditure.



Source: korinexan

Fresh water tank during professional cleaning

Routine check-ups and cleaning of pipes and tanks prevent costly restoration or re-installation

As a crucial component of fresh water hygiene in maritime and inland navigation, the fresh water distribution system should be checked and cleaned at regular intervals – at least once a year, or better two to four times a year. This will help prevent health risks for consumers caused by hygienic problems and avoid high follow-up costs.

Ship owners should, whenever possible, during installation or maintenance works visually check the interior of pipes to make sure they are aware of the pipes' condition at all times. This will allow them to react in a timely manner should it be required. It will always be more economic to clean when scaling and biofilm are still relatively scarce and recent as compared to having to remove firm impurities or fouling that is already causing hygienic problems or may even require installing new pipes.

Years of experience in the field have shown that consequently performed regular hygienic cleaning and subsequent disinfection (multi-step flushing) of fresh water storage tanks and distributing pipes can help reducing or even avoiding continuous disinfection of the fresh water. This promotes the wellbeing and hygienic experience of passengers and crew members by raising the actual and perceived fresh water quality.

Notable shipyard and shipping companies have long since acknowledged these requirements. They rely on the CARELA group based in Germany that specializes in the development

and production of professional cleaning agents and disinfectants for waterworks and the water industry. Its subsidiary korinexan®, with its division ships & marine & offshore, supports shipyard operators and ship owners with a professional cleaning service to meet their hygienic demands for fresh water storage and distribution systems.

Cleaning and service assignments in the seaports of Singapore, Hamburg, Kiel, Rostock, Rotterdam, Copenhagen, Genoa, Shanghai and Dubai are regularly and routinely completed for major shipping companies. In addition, the fresh water systems of inland navigation ships cruising and crossing the Rhine, Danube, Neckar, and Lake Constance and Lake Geneva, to name just a few, are regularly cleaned to high hygienic standards with korinexan® multi-step flushing.

Aboard the windjammer SEA CLOUD II

The SEA CLOUD sailing ships offer high-end cruises for a selective number of passengers who expect high standards and quality in all aspects on board the ship. To adequately fulfill these expectations with regard to the quality of fresh water, the system is routinely cleaned and disinfected every three months. The korinexan® multi-step flushing was specifically designed to comply with the time-limited demands of ships and offshore sites. There is a two-layered approach to efficient and successful sanitation: crew members of the SEA CLOUD were trained and instructed by korinexan® to independently and within a short time inspect, clean and disinfect emptied fresh water storage tanks while the ship is on cruise. Once a year during unloading or maintenance work a korinexan® team of qualified personnel uses professional multi-step flushing to conduct a comprehensive cleaning of the whole fresh water system including all piping from the beginning to the final outlet in the passengers' cabins. Subsequent sampling through independent national or local authorities confirm a consecutively high fresh water quality. Passengers unaccustomed to this quality of fresh water, e.g. from the US, are genuinely impressed and do not seem to miss the taste of chlorine that is so common in some regions.

“Highly recommended”, says Capt. Adam Pazdzioch of SEA CLOUD Cruises in Hamburg.

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Methane emissions from wastewater treatment plants

Assessment and review of quantification methods

Pascal Kosse, Oliver Knoop, Manfred Lübken, Torsten C. Schmidt, Marc Wichern

Wastewater treatment, methane emissions, Henry's law constant, K_{AW} values, salt-induced stripping

The treatment of municipal wastewater results in the production of greenhouse gas emissions such as methane (CH_4). At wastewater treatment plant (WWTP) level it was shown that the dominant emission sources are the anaerobic digesters and anaerobic sludge storage tanks, while also the sewer system via the WWTP's influent contributes substantially to methane loads. The identification of such emission hotspots demands accurate quantification methods, which are still rare. The present paper discusses the derivation of a new method that is based on static headspace analysis. For this purpose, the recently developed salt-induced stripping method is introduced to determine an air-water partitioning coefficient (K_{AW}) for methane in synthetic sewage, which is a compulsory requirement for headspace analysis.

1. Introduction

Human activities trigger the Earth's climate by continuously releasing greenhouse gases into the atmosphere. Among all anthropogenic greenhouse gases, methane is the second most prevalent one with a comparative impact that is 28 times that of carbon dioxide over a period of 100 years ($GWP_{100} = 28$) [1]. Back in 2005, global anthropogenic methane emissions were at 323 Mt and are expected to increase by 28% to 414 Mt in 2030 assuming no further mitigation measures [2]. From these global anthropogenic emissions, it is estimated that 4 – 5% can be attributed to wastewater treatment [3, 4]. At wastewater treatment plants (WWTPs) methane is essentially emitted from the sludge treatment units where anaerobic conditions prevail. These comprise the primary sludge thickener, secondary sludge thickener, unavoidable leakages from the digester, digested sludge thickener and digested sludge stackable bins [5, 6]. These units contribute with a share of 72% of methane emissions of the WWTPs, while the remaining emissions come from aerobic reactors where methane is not totally removed by the biological system [7]. According to Gärtner et al. [5], the ratio of methane being emitted from these wastewater treatment units and digested sludge treatment units is slightly different with about 1:9. As reported previously, it is always important to consider both, direct gaseous emissions as well as the dissolved fraction [8], which also includes methane loads originating from the sewer system that are emitted at the plant later on.

1.1 Methane emissions from the sewer system

Methane emissions from the sewer system originating from methanogenesis that runs simultaneously to sulfate-reduction in sewer biofilms. The sewer system provides ideal environmental conditions for methanogenesis resulting in a considerable amount of methane. The microbiological processes involved take place in a stratified sewer biofilm where anaerobic, heterotrophic microorganisms coexist with sulfate-reducing bacteria (SRB) and methanogenic archaea (MA). It is hypothesized that the fermentative heterotrophs and the sulfate-reducing bacteria are predominant in the outer zone, nearer the wastewater, while the methanogenic archaea inhabit the inner zone, nearer the sewer pipe. As the wastewater is rich in organic matter, fermentative heterotrophs breakdown these components yielding organic by-products such as volatile fatty acids (VFAs), amino acids and sugars along with carbon dioxide. The fermentation by-products, such as acetate, propionate, butyrate, lactate and hydrogen, can be consumed in the presence of sulfate (SO_4^{2-}) by the anaerobic sulfate-reducing bacteria. At this, sulfate is used as the terminal electron acceptor. In the absence of sulfate, or in case acetate has been produced directly by fermentation or indirectly by acetogenesis, methanogenic bacteria consume hydrogen and acetate to produce methane. The latter one can potentially reach the wastewater treatment plant in dissolved form. Under turbulent flows, it is stripped out from primary treatment units and potentially also during aeration from the activated sludge tank [9]. Former studies have revealed that the contribution of the

Table 1: Direct methane emissions reported in full-scale studies

Description	CH ₄ [g · PE ⁻¹ · a ⁻¹]	CO _{2,eq.} [g · PE ⁻¹ · a ⁻¹]	kg _{methane} · kg _{influent COD} ⁻¹ [%]	Reference
WWTP Coleshill, UK Nitrification unit	*31	859	0.07	[9]
WWTP in North Rhine Westphalia (Germany)	250	7000	N/A	[21]
WWTP Durham (UK), wastewater treatment & aerobic sewage sludge stabilization	39	1092	N/A	[6]
WWTP Kralingseveer, Netherlands	306	8568	1.13	[6]
WWTP Kralingseveer, Netherlands	390	10920	1.1	[16]
Methane emissions (measurement) Swedish WWTP with digestion	*110	3066	0.25	[23]
WWTP Jinan, China	11	316	0.08	[19]
WWTP Viikinmäki, Finland	159	4460	N/A	[24]
WWTP Bochum-Ölbachtal, Germany	196	5479	N/A	[22]

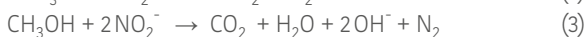
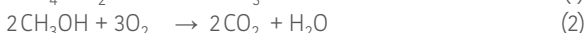
*Calculated by assuming a COD inflow load of 120 g · PE⁻¹ · d⁻¹

sewer system regarding methane emissions cannot be neglected [10], but still those emissions are dismissed in the IPCC guidelines [11]. Factors influencing the amount of methane produced in the sewer system comprise the organic matter and thus the COD level, the pressure inside the sewer, and the area to volume ratio (A/V) inside the pipeline [10]. A high pressure stimulates the activity of hydrogen and thus the level of methanogenesis [12], while it also increases the saturation level of methane within the pipe and thus more methane is produced [10, 13]. A larger A/V ratio increases contact with the biofilm and hence more methane is yielded [14]. Ultimately, the higher the hydraulic retention time (HRT), the longer is the wastewater exposed to the sewer biofilm, which increases the methane production [15].

1.2 Dissolved methane during wastewater treatment

A further production pathway for dissolved methane is linked to the digester unit. The anaerobic digestion of surplus sludge yields biogas, which contains up to 67% CH₄ and 33% CO₂ [6, 16]. However, not all of the produced methane quantities can be retrieved in the biogas. Some of the methane remains dissolved in the liquid phase of the digested sludge and becomes discharged together with the digested sludge from the digestion unit [17]. Based on a modified salt-induced stripping method, Schaum et al. [17, 18] have found average dissolved methane concentrations in mesophilic digested sludge of 29 g · m⁻³, which corresponds to an estimated yearly specific load of approximately 14–21 g CH₄ per population equivalent (PE). After sludge digestion, methane is either stripped, for instance during dewatering of the digested sludge, or it will remain dissolved in the reject water and as such it will end up in the aeration tanks of the WWTP, as does the methane dissolved in the influent wastewater stream [6]. In the aeration tanks it can be potentially stripped again due to turbulences caused by aeration [6, 19], or it can be biologically oxidized by the microbial community in the activated sludge [6, 20], as shown by equation (1) – (3). Interestingly, methanol is produced as a by-

product, which is added as a carbon source during denitrification.



The digested sludge that leaves the wastewater treatment plant for incineration may be further biodegraded under anaerobic conditions, hence methane can be released to the atmosphere by surface diffusion [19].

Nonetheless, in the context of urban wastewater management, methane emissions appear to be somehow underestimated as only a few publications have been dedicated to this research topic so far. Its formation and emission in sewer systems has not received as much attention as H₂S formation [10], while at WWTP level it has received far less attention compared to nitrous oxide (N₂O) [6]. On the latter level, the energetic aspect is more in the focus, since electricity and heat can be generated by using biogas where methane is an important component [18]. However, methane emissions can have a much higher share on the total GHG emissions compared to nitrous oxide emissions at WWTP level as shown previously by Becker et al. [21]. Regarding a total GHG emission range for a medium-sized WWTP of 7–12 kg CO_{2,eq.} · PE⁻¹ · a⁻¹, CH₄ had a share of 5–9 kg CO_{2,eq.} · PE⁻¹ · a⁻¹, while N₂O only 2–3 kg CO_{2,eq.} · PE⁻¹ · a⁻¹. A similar observation was made in the study by Thöle et al. [22]: 79% CH₄, 20% N₂O and 1% NH₃. The few measurement data published could not yet trigger demands by the United Nations Framework on Climate Change (UNFCCC) to include methane emissions in national inventory reports for greenhouse gases as it has been defined that wastewater treatment is solely performed aerobically. This should be seen very critical in this context as underlined by the few measurement data published that prove substantial amounts of methane (**Table 1**). As is also known for nitrous oxide, it can be summarized that methane emissions are highly variable ranging from 11 g · PE⁻¹ · a⁻¹ up to 390 g · PE⁻¹ · a⁻¹ depending on the boundary conditions.

1.3 Quantification techniques for methane

To date, measurement techniques for methane include similar devices as for nitrous oxide. For the gaseous phase optical telemetry procedures following the Fourier Transform Infrared (FT-IR) principle have been successfully applied [5, 24]. On-line microsensors for the liquid phase, such as for nitrous oxide, are, to the authors' knowledge, currently not available.

Methane belongs to the chemical group of Volatile Organic Compounds (VOCs) indicating that it can easily vaporize. This property can be utilized for the derivation of quantification techniques such as the headspace approach. The headspace method is a well-established analytical technique for the qualitative and quantitative analysis of VOCs in samples that efficiently partition between the headspace gas volume and the liquid phase. The transfer between the headspace and the liquid phase is one of the key processes in headspace analysis. It is therefore necessary to understand the distribution between these two phases. Henry's law constants describe a constant equilibrium ratio between the abundances of chemical compounds in the gas phase and in the liquid phase for a dilute solution. There are many variants of Henry's law constants, where the exact variant of the Henry's law constant is often specified by two superscripts. The dimensionless one (H^{cc}) is defined as the ratio of the aqueous-phase concentration c_a of a species and its gas-phase concentration c_g . In other words, the number of molecules or mass in air versus the number of molecules or mass dissolved in water. With regard to the research question, the dimensionless Henry's law constant can be converted into different units and definitions. For instance, H^{cp} [$\text{mol} \cdot \text{m}^{-3} \cdot \text{Pa}^{-1}$] is a form of the Henry's law constant that is often used in chemical engineering. The superscript 'c' refers to the concentration of a species in the aqueous phase, while 'p' is the partial pressure of that species in the gas phase under equilibrium conditions. In environmental chemistry, the dimensionless form H^{cc} is better known as the air-water partitioning coefficient K_{AW} [-]. **Table 2** presents the entire spectrum of experi-

mentally determined Henry's law constants for methane as compiled in Sander et al. [25].

The dimensionless air-water partitioning coefficient is frequently used in the field of urban water management, e.g. for biogas calculations, or in the framework of the Anaerobic Digestion Model No. 1 (ADM1). Per definition, K_{AW} values are defined for pure water. However, gas solubilities are strongly affected by salt concentrations. An increased salinity causes the gas solubility to decrease. Schaum et al. [17, 18] have included salt effects in their study to develop a modified salt-induced stripping method for the determination of liquid methane concentrations in digested sewage sludge. Other than that, no publication, to the best of the authors' knowledge, has seriously considered or discussed such a dependency and hence this issue raises a research gap and demands a critical discussion of potential salt effects.

There are two ways of including potential salt effects. One that uses Sechenov constants and one that experimentally determines methane solubilities under most realistic circumstances. In the previously mentioned publications by Schaum et al. [17, 18] an approach based on the Sechenov equation was used that corrects the Henry's law constant in terms of the salt molality [32]. It is recommendable to do so, because molality is invariant to temperature and to the addition of dry salt to the solution [33]. The disadvantage of the Sechenov approach is that it applies only to solutions of a single salt. Wastewater contains various salts that can influence the GHG solubility differently.

1.4 Salt-induced stripping method

Nowadays, a variety of different methods for K_{AW} determination exists that have been frequently used in experiments. However, not every approach has been specifically used for methane, nor has any approach been applied for the wastewater matrix. This is hardly surprising as the wastewater is subject to strong diurnal and seasonal fluctuations. As a substitute, synthetic sewage could be used, e.g. compiled according to ISO 11733:2004. This one yields a mean dissolved organic carbon (DOC) concentration of about $100 \text{ g} \cdot \text{m}^{-3}$, which is a good representative for municipal wastewater. The recently introduced salt-induced stripping method [8, 34], originally developed for nitrous oxide quantification in the liquid phase, might work as a simple method that offers various benefits for K_{AW} determination. The method takes advantage on the fact that salinity triggers the aqueous solubility of gases in a way that they have to strip out from the liquid phase. Hence, they can be analyzed by gas chromatography. Since the solubility of nitrous oxide is relatively high for water, the development of such a salt-induced stripping method requires a suitable inorganic salt that is capable of stripping nitrous oxide

Table 2: Experimentally determined Henry's law constants for water as solvent at 298.15K [25]

H^{cp}	K_{AW} [-]	Reference
1.2×10^{-5}	0.030	[26]
1.3×10^{-5}	0.032	[27]
1.2×10^{-5} (at 310.15 K)	0.030 (at 310.15 K)	[28]
1.4×10^{-5}	0.035	[29]
1.4×10^{-5}	0.035	[30]
1.3×10^{-5}	0.032	[31]

completely out. Recently, sodium bromide (NaBr) was found to be most effective for this purpose. The experimental set-up for this approach is shown in **Figure 1**. For methane, this method should work in either way, since its aqueous solubility is far lower compared to nitrous oxide ($1.25 \text{ g N}_2\text{O} \cdot \text{L}^{-1}$ and $0.025 \text{ g CH}_4 \cdot \text{L}^{-1}$ at 20°C and 1.013 bar). This can be explained on the molecular level. When methane becomes dissolved in water two processes need to occur. At first, the intermolecular forces between the methane molecules need to be broken up, which are Van der Waals dispersion forces. Secondly, the intermolecular forces between the water molecules need to be broken up, too, so that methane molecules can fit between the water molecules. The primary intermolecular forces in water are hydrogen bonds. Breaking these attractions ($23.34 \text{ kJ} \cdot \text{mol}^{-1}$) requires much more energy compared to the Van der Waals dispersion forces ($10.9 \text{ kJ} \cdot \text{mol}^{-1}$) [35, 36]. As a simplification, the dissolution of methane in water does not release a profitable amount of energy when new bonds between methane and water are formed. Methane is therefore only very sparingly soluble in water. The little amounts of methane that still become dissolved should therefore be easily stripped out using the proposed approach with NaBr.

1.5 Mitigation measures

There are a couple of known measures to minimize methane emissions at wastewater treatment plants. One solution is to cover thickening sludge tanks and sludge disposal tanks to avoid gas leakages [6]. The methane emissions can thus be captured by hoods and later be used as a fuel for electricity production as proposed by Daelman et al. [6]. In that way the total GHG emissions of the plant are lowered in terms of CO_2 equivalents as the methane is burnt to carbon dioxide. Another solution addresses the methane loads that derive from the sewer system, which have been estimated to account for 1% of the influent COD load [6]. These methane loads will be mainly oxidized in the activated sludge tanks. This known process can be exploited, e.g. by developing an aerobic methane oxidation coupled to denitrification process (AME-D) as recently proposed by Zhu et al. [37].

2. Conclusion and outlook

The mitigation of greenhouse gas emissions will undoubtedly occupy our attention for quite some time. In the framework of urban wastewater management, methane emissions will play an increasingly central role. As a result of the review, the knowledge about methane emissions at WWTP is still limited. Adequate quantification techniques, full-scale measurement campaigns and dynamic modeling attempts are, more or less, unexplored. Nonetheless, it is clear at this stage that methane emissions result, in contrast to nitrous oxide emissions, from the sewer system and, more or less, from every treatment step at a wastewater treat-

ment plant. Besides, methane emissions have a higher share in terms of absolute greenhouse gas emissions than nitrous oxide, while the emission rates of methane can vary enormously as also known for nitrous oxide. All these aspects emphasize again the need and importance for future research activities.

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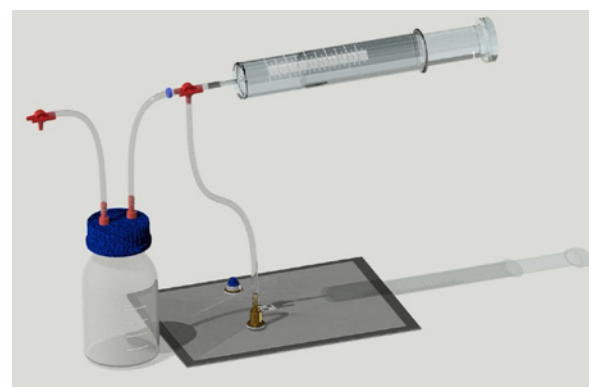


Figure 1: Experimental set-up of the salt-induced stripping approach [8, 34]

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Leibniz Institute for Baltic Sea Research

Global warming lets grow the dead zones in the Black Sea

What geoscientists from three universities found out about environmental history told by sludge

Geoscientists from the Warnemünde Leibniz Institute for Baltic Sea Research, the universities of Oldenburg and Hanover as well as the Rutgers University (USA) succeeded now in reconstructing the depositional environment of the last interglacial (Eemian, 128,000 years ago) in the Black Sea with unprecedented details. This enabled for the first time a direct comparison between the current oxygen-depleted conditions in the deep water with those during the Eemian when the water temperatures in summer were 3° higher. It shows that the dead zones of the Black Sea will most probably expand by a future global warming leading to a significant shrinking of the productive zone in the surface water.

Oxygen deficiency together with the occurrence of toxic hydrogen sulphide below water depths of 100 – 150 m are the most prominent features of the Black Sea, the world’s largest brackish basin. Today, up to 90 % of the Black Sea water body is a harsh and hostile oxygen-free environment where no higher life can survive. It is critical to understand how these dead zones will develop in response to the ongoing global warming and sea level rise. The detailed analyses of sediments from the last interglacial (Eemian) in the Black Sea, recently published in the international journal “Palaeogeography, Palaeoclimatology, Palaeoecology” offer insights into a potential future.

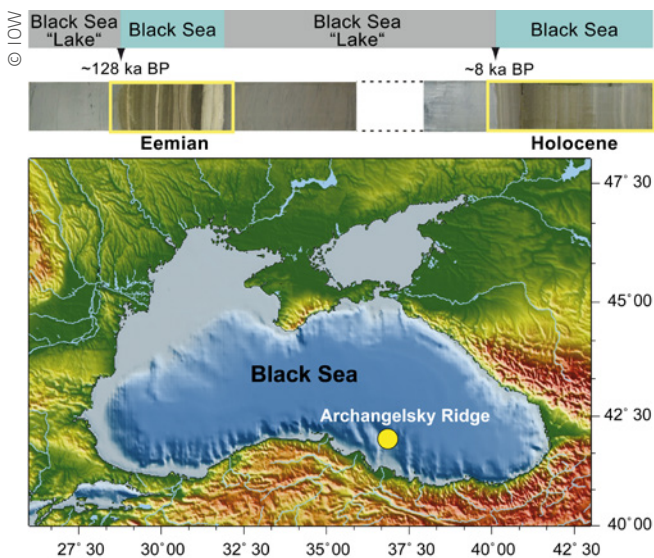
Oxygen depletion in the bottom waters of the Black Sea causes a decelerated decomposition of the organic matter sinking to the seafloor. These organic-rich muds form the so-called sapropels that are quite common among both recent and Eemian deposits. By means of detailed analyses of redox-sensitive chemical ele-

ments in these sapropels, the team succeeded in reconstructing a differentiated picture of the deep-water conditions during the Holocene and Eemian periods in the Black Sea. As environmental witnesses (so-called proxies) the geoscientists used, for example, the trace elements molybdenum and rhenium, which react differently and specifically on oxygen deficiency and the presence of sulphide. In total, the analysis of more than 10 of such proxies enabled the reconstruction of a complex picture.

IOW geologist Antje Wegwerth summarises the results, “During the Eemian period the deep water of the Black Sea showed a significantly higher concentration of sulphide and, thus, was more toxic than today. The hostile conditions expanded over thousands of years and finally reached the so called photic zone, the highly productive surface water layer exposed to light.”

In such a resolution and quality, no Eemian sediments have been investigated so far, because these deep lying deposits are normally accessible only by expensive deep-sea drillings. However, during a cruise on R/V METEOR sediments from both Holocene and Eemian periods could be retrieved by conventional gravity coring from a prominent bathymetric ridge structure. Thus, the direct comparison of both interglacials became possible.

Postglacial warming during the Eemian and the Holocene caused significant changes in the Black Sea. The large polar ice sheets disappeared, the global sea level rose, and once flooding the shallow Bosphorus sill, the salty and dense water masses of the Mediterranean Sea intruded the formerly Black Sea “Lake”. This led to a strong stratification with saline deep waters below the brackish surface waters. At the same time, elevated sea surface temperatures resulted in an increased productivity and flux of organic matter, ultimately exhausting oxygen in the basin during its decomposition. The interaction of these processes finally leads to the generation of enormous “dead zones” in the Black Sea.




Dark sediments represent “dead zones” during warm periods like Eemian and Holocene. The warmer Eemian might serve as a benchmark for a potential future climate

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Technische Universität Berlin

Study program “Water engineering” at TU Campus El Gouna

TU Berlin founded a central institute at the Red Sea in El Gouna, Egypt. Initiated by the Egyptian entrepreneur Samih Swairis and the former TU Berlin president Prof. Dr. Kurt Kutzler, the basis for a public-private-partnership was placed. The first Master programs in Energy Engineering, Urban development and Water engineering with a practical-oriented training started in 2012. For an insight on the study program “Water engineering”, read more.

The water supply in Egypt depends almost exclusively on the Nile River. Water Engineering Department at TU Berlin tries to concentrate on a sustainable development in this arid region. Measures for water reuse and the improvement of a sustainable use and exploration of groundwater resources are taught in a practice-oriented way to move the focus on a resource efficient development. The study program in the second semester takes place in Germany so that students get to know German culture and working method. In the fourth semester students work on their master thesis. A cooperation with Egyptian or German companies is possible.

About the study program

In dry climate regions like the MENA-region, the gap between water availability, both in terms of quality and quantity, and water demand increased during the last decades. The study program is organized in four main areas of expertise: Water and Wastewater Treatment, Water Science, Hydro-Engineering Infrastructure and Interdisciplinary Studies.

Lectures, seminars and self-studies are completed by integrated courses, laboratory work, practices on test stands, modeling exercises, field trips, internships, integrated projects,

and excursions. Well-equipped chemical laboratories, cutting-edge analytical equipment, innovative water/wastewater pilot treatment plants, and excellent field equipment used for applied research are integrated in the study program.

The program aims to:

- Determine the complex challenges facing the water sector in regions with a dry and semi-dry climate
- Provide students with broad, technology-orientated knowledge in water related engineering and natural sciences
- Develop appropriate academic and scientific problem-solving strategies
- Teach students how to work in international project teams on multidisciplinary topics in order to deal with water in a sustainable, integrated manner
- Teach hydraulics, hydrogeology, modeling of water-related and environmental systems for sustainable exploration of water resources, especially groundwater
- Teach conventional and advanced treatment of water and wastewater, wastewater discharge systems, decentralized sanitation solutions, water tanks and networks, sludge treatment/disposal and water reuse
- Convey fundamentals of international water legislation, economics and socioeconomic aspects of water



Figure 1: TU Campus El Gouna: Staff and visitors at open day 2017-2018

© All Figures: TU Berlin/Water Engineering Department



Figure 2: Test plant in El Gouna

Transition to research

Furthermore, the Water department is concentrating on research in arid regions. The team consists of a group of scientists with various backgrounds related to water. They work in hydrology, hydraulics, potable water and wastewater treatment.

Water and Wastewater Treatment

Water-based problems are becoming increasingly common and are rated amongst immediate and serious environmental threats facing humans. The use of water has increased tremendously since 1950. There are modern and traditional approaches being employed to enhance water treatment efficiency. Waste water reuse is one of the approaches and served as essential way to complement the conventional sources of water. All techniques being studied in text book cannot be understood without implementing them on the field. TU Berlin Campus Gouna emphasizes on implementation of new and innovative projects in the campus for the students to have a better understanding of the emerging techniques. Few examples of such projects are:

- **“Waterbase” test plant:** This joint venture of TU Berlin Campus El Gouna and ecoglobe GmbH is a decentralized wastewater treatment system for hotels, single residential houses, clusters of houses and suburbs. The highly customizable technology makes use of natural treatment processes that have proven their effectiveness and reliability in thousands of applications worldwide. Waterbase was especially designed for safe reuse of the treated water for irrigation, and cooling. The system allows for replacing up to 100% of irrigation water and cooling water demand by Waterbase’s high-quality reclaimed water – enabling new options for upgrading real-estate projects. Waterbase is operated using a central remote monitoring and control unit that provides a live link to German engineers at any time to ensure optimal process performance.

“Waterbase” from ecoglobe GmbH is a type of unplanted vertical flow constructed wetland. This study is focused on investigating the effect of depth on the performance of the vertical flow constructed wetland. For this purpose, a set of tests are done on a pilot plant situated in TU Berlin Campus El Gouna.



Figure 3: Diagrammatic representation of plant implementation

There are two layers with the same material but different depths (15 cm and 30 cm). The system was managed and monitored over a period of 5 months of data collection.

The conditions were changed throughout the testing period in order to get a better understanding of the performance. All the necessary physical and chemical parameters were measured for the influent and the effluents from both the layers. Another salient feature of this study is the changing impact of pre-treatment with varying water retention time in the step. After the analysis, it was found that the Layer 4 had a better removal efficiency for COD, BOD 5 and Total nitrogen. The performance of the layer kept on improving even in the last phase when the flow rate of the wastewater was double the value of when the plant was started.

In the end the effluent qualities from different phases is compared to the effluent limits for reuse in agriculture and irrigation. For this purpose, as the plant is situated in El Gouna, Egypt, Egyptian standards for wastewater reuse were taken as an example.

- **Biofilm Hybrid Processes for Wastewater Treatment in North African Climate:** Usually, there is conventional bio film carrier material for biofilm growth. But it was found that the bottle cap is made of the same material as that of conventional biofilm carrier material. A test pilot plant was designed and constructed at the municipal wastewater treatment plant El Gouna to check the feasibility of the alternative material.

Hydrogeology Science

The water supply in El Gouna is 100% dependent on desalinization of sea water. A problem is the disposal of the remaining brines of desalinization which are conducted to the close lagoons, drained on the surface or injected in deep wells close to the desalinization plants. Since the existence of such cities in Egypt is dependent on sea water desalinization, the aim of scientists’ study at Campus El Gouna is to investigate the influence of the brine disposal on the groundwater quality in addition to seawater intrusion and mixing processes of groundwater and seawater.



Figure 4: Implementation of biofilm carrier material in the wastewater treatment plant

By means of the Br/Cl-ratio and $2D,18O$ (that are not affected by the desalination processes), the primary groundwater/seawater mixing rates are determined ranging from 5% to >80%

PlastX

Reading recommendation: effects of microplastics on the environment and society

The topic of microplastics has received a lot of attention in recent years, because the tiny particles, which are barely visible to the naked eye, can now be detected all over the world: in the rivers of Europe as well as in the lakes of Mongolia or at the end of their journey – in the seas and oceans of the earth. Aquatic organisms are considered to be endangered because they ingest the tiny plastic particles with their food. But the real extent of the potential risks is far from being researched. The newly published book “Freshwater Microplastics” is dedicated to these risks. Within this publication, the ISOE scientists Johanna Kramm and Carolin Völker will discuss the effects of particles on the environment and society.

About 40 years ago, tiny plastic fragments were discovered in the sea and scientifically mentioned for the first time. With the increasing emergence of small particles in large water bodies, not only awareness of the environmental problems of plastics but also the number of publications on microplastics in the seas and oceans has increased. Only recently, the

of seawater in the different DSP. Due to the infiltration of high concentrated brines from the DSP, the groundwater salinization is partially strongly increased in the wells feeding the DSP. In addition, the groundwater in areas of brine infiltration becomes saturated with Gypsum and shows increased CO_2 -pressures above the normal background.

The second approach of the research investigates the groundwater age using the tritium-helium as indicators for recent recharge. The analysis shows that groundwater is older than 1955, and the helium analysis shows that water can have a hydrothermal contribution coming from the earth mantle. The research concentrates on the temperature gradient at the fault Zone of Abu Shaar Mountain where the groundwater temperature reaches 38 °C and shows a different gradient from the gradient close to the Red Sea.

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so-called limnic ecosystems have been taken into account: lakes, rivers and streams. Here too, microplastics have been detected. The book “Freshwaters Microplastics. Emerging Environmental Contaminants?” is the first interdisciplinary anthology devoted to microplastics in flowing waters.

One of the challenges of our “plastic age” is the question of how plastics affect people and the environment and how the effects can be scientifically assessed. Worries include the assumption that microplastics enter the food chain and could also be harmful

Understanding the Risks of Microplastics: A Social-Ecological Risk Perspective

In: M. Wagner, S. Lambert (eds.), Freshwater Microplastics, Emerging Environmental Contaminants? The Handbook of Environmental Chemistry 58, Springer, Cham 2018 DOI 10.1007/978-3-319-61615-5



Source: J.J. Dierks / pixelio.de

One of the challenges of our “plastic age” is the question of how plastics affect people and the environment and how the effects can be scientifically assessed

to human health. Whether it is justified, however, is still controversial in research. In their contribution “Understanding the Risks of Microplastics: A Social-Ecological Risk Perspective”, the authors Johanna Kramm and Carolin Völker show the challenges that science and society face by addressing this global risk topic.

Need for research: Understanding the risks, lifecycles and global distribution plastics

The researchers at ISOE – Institute for Social-Ecological Research are working on systemic risks of plastics. But what are the risks involved? What role do the media play in communicating potential risks? Kramm and Völker focus on responsibilities in production, consumption and disposal of plastics and question current solution strategies, such as voluntary commitments by industry. Can manufacturers help to minimise risks?

In this way, the researchers are addressing questions of the current scientific and public debate. They urgently recommend more in-depth research into unintended side effects. The data available on the potential environmental and health risks of plastics in the environment is contradictory. The hormonal effects of plasticizers made of plastics on organisms living in the water are considered to be largely undisputed, other effects lack reliable data.

Kramm and Völker also recommend intensifying research into the global dimension of plastic pollution and its causes. The debate

on waste disposal and recycling is just as important as global plastic goods flows or consumer and producer responsibility. Particularly with regard to countries of the Global South, where a growing middle class is increasingly demanding plastic products, they believe that a momentous consumption scenario with corresponding waste problems is emerging. It is, therefore, necessary to take a global view on the entire life cycle of plastic packaging – from production, distribution, consumption and disposal to the environment. Due to the complexity of the microplastics phenomenon, research should also focus on the question of how society can deal with uncertainty in the face of possible risks in dealing with plastics.

Human geographer Johanna Kramm and ecotoxicologist Carolin Völker lead the junior research group “PlastX – Plastics as a Systemic Risk for Social-Ecological Supply Systems” at ISOE, whose research work is funded by the Federal Ministry of Education and Research (BMBF).

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Background

- ▶ The junior research group “PlastX - Plastics as a systemic risk for social-ecological supply systems”, led by ISOE - Institute for Social-Ecological Research, is funded by the German Federal Ministry for Education and Research (BMBF) as part of the funding measure “SÖF – Social-Ecological Research”. Other participants of the joint project are the Department of Aquatic Ecotoxicology at the Goethe University Frankfurt and the Department of Physical Chemistry of Polymers at Max-Planck Institute for Polymer Research in Mainz. The interdisciplinary research group is examining the societal role of plastic and the associated environmental impacts. Within this framework, the team of social and natural scientists is attempting to find out how plastic might be used more sustainably.

IWW Water Centre

Developing a standardized maturity model for water supply 4.0

Digitalization sets one of the most relevant development fields in the water sector. A research project of IWW Water Centre is currently developing a standardized maturity model for water supply 4.0 filling the gap between existing strategies and future visions related to digitalization.

The overall goal of the R&D project is to develop a standardized maturity model for operators, organizations and asset owners with regards to digitalization of water supply. Output of the project will be an adaptable model to evaluate water infrastructures focused on drinking water supply. The approach is methodologically grounded on an existing maturity model for industrial production processes that has been applied in various companies of different sectors and types of businesses. Specific characteristics of water infrastructure have to be addressed in the standardized maturity model for water supply smart to enable operators to analyze their digital development path systematically. The model shall answer the following strategic questions:

- Where are we standing now?
- What digital development opportunities do exist?
- Where do we want to go and what is beneficial for our company in its specific context?

Important objectives of the project are: (i) the development and validation of the maturity model and (ii) the development and provision of a web-based self-assessment tool for further dissemination and easy application and setting-up to the operators.

Methodology

The maturity model for water supply 4.0 is conceptually based on the acatech Industry 4.0 Maturity Index and follows a state

of the art maturity modeling approach. The supplier's digital transformation process is represented by a sequence of six value-based maturity levels (**Figure 1**) defined as

1. computerization,
2. connectivity,
3. visibility,
4. understanding,
5. predictive capacity/ability to predict and
6. adaptability.

Accomplishing the next level, the water supplier gets one step further on the path of digital transformation towards a learning and agile organization that can quickly adapt to changing conditions.

To assess digital maturity levels, various capabilities in the main areas resources, information systems, culture and organizational structure are defined within different scopes and achievement criteria. For each capability specific requirements will be defined in the project, which are linked to the six maturity levels. As a result, the fulfillment of the capabilities of each area determines the development stage of each main area.

Secondly, the capabilities are analyzed for all main administrative and technical processes of drinking water supply. This approach allows a differentiated analysis of water supply system from source to tap on main process level related to the main targets.

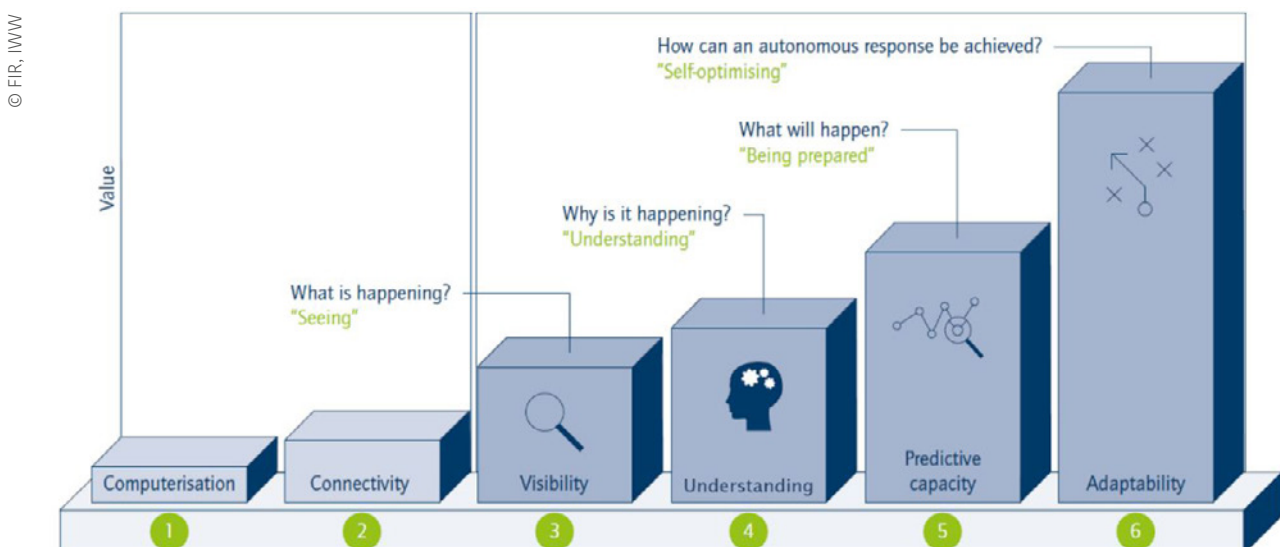


Figure 1: Six development stages in the maturity assessment for water supply 4.0

Project profile

- ▶ **Name of project:** Development of a standardized Maturity model for water supply 4.0
- Type of project:** R&D-Project including piloting and case study based validation, programming and provision of a web-based self-assessment tool
- Duration:** October 2017 until November 2018
- Key words:** maturity model, digitalization, process evaluation, smart water systems, drinking water supply 4.0
- Coordinator:** IWW Rheinisch-Westfälisches Institut für Wasserforschung gGmbH, IWW Water Centre, Mülheim an der Ruhr, Germany
- Project leader:** Andreas Hein, Head of department Water Economics & Management of IWW Water Centre
- Funder:** DVGW Deutscher Verein des Gas- und Wasserfaches e.V. - Technisch-wissenschaftlicher Verein - (German association for gas and water)
- Partners:** Forschungsinstitut für Rationalisierung (FIR) e.V., Institute for Industrial Management at RWTH Aachen University, Germany, MOcons GmbH & Co. KG, Mülheim an der Ruhr, Germany

These targets are defined related to German standards in so-called performance characteristics: quality of supply, security of supply, customer service, sustainability and economic efficiency.

Benefits and outcomes

Expected outcomes of the project solve different challenges of the drinking water sector. The most important one is filling the gap between existing strategies and future visions related to digitalization. The methodology to be developed allows firstly to evaluate the own status quo and secondly to set-up fields of action towards a more digital and smarter service of supply in the future. Furthermore, the project is characterized by an active involvement of different water suppliers (bulk and direct suppliers; small, medium and large suppliers; public and private suppliers). Involved suppliers play the role of piloted case studies to evaluate the operational capability of the maturity model including its associated web tool on the one hand. On the other hand, the validation of evaluation results in terms of different maturity levels for main processes and assets in drinking water supply will be an additional success factor.

The concept can be expanded to other public infrastructure sectors, e. g. wastewater.

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Technical University of Munich (TUM)

Dissertation “Development and Evaluation of an Assessment Method for Decentralized Stormwater Treatment Systems for Runoff from Traffic Areas”

The runoff from traffic areas is polluted by several substances (e.g., heavy metals, hydrocarbons, compounds of de-icing salts, and solids) and must often be treated prior to discharge into receiving waters. In the last few years, many decentralized stormwater treatment systems have been developed and can be tested in Germany and worldwide by standardized methods. However, no detailed method is currently available for the determination of the service lives and the influences of de-icing salts on the remobilization of pollutants that were previously fixed onto filter materials. Decentralized stormwater treatment systems, which do not pose any risk for groundwater and surface water by discharging dissolved pollutants, can only be developed and operated with the knowledge of a realistic service life and a possible remobilization of previously retained heavy metals by de-icing salts. Therefore, the focus of this thesis was set on the development and evaluation of an assessment method for decentralized stormwater treatment systems for runoff from traffic areas.

294 data sets evaluated

In a first step, a literature study was performed to collect data from international monitoring programs (294 data sets) to determine the heavy metal concentrations of the most relevant heavy metals cadmium, chromium, copper, lead, nickel, and zinc in runoff from traffic areas. For these metals, the total and dissolved concentrations (median, average, and distribution) were determined separately for eight traffic area categories. In addition, the measured runoff concentrations of the metals antimony, cobalt, manganese, palladium, platinum, rhodium, titanium, and tungsten were compiled. Moreover, the influences of site-specific and method-specific factors on the results of monitoring programs were evaluated. As one result, the runoff concentrations of zinc were the most variable compared with the other heavy metals. Furthermore, the method of calculating average values has a huge impact on the results and the pH value of runoff waters does not correlate with the dissolved part of heavy metals in the

field. In the 80s and 90s, the lead concentrations in runoff from traffic areas significantly decreased, whereas no trends were detected for copper and zinc.

Comparison of batch and column experiments

The determined distributions of the dissolved metal concentrations were used to perform appropriate experiments for the evaluation of the heavy metal removal by filter materials in lab-, pilot-, and full-scale experiments. Although the removal mechanisms of filter materials consist of filtration (e.g., after precipitation), sorption, ion exchange, or biochemical transformation, the term “filter material” was deliberately chosen because it is commonly used by manufacturers and operators. At the beginning, a comparison of batch and column experiments was performed. Capacities and kinetics were determined that describe the removal of copper, nickel, and zinc by six filter materials. For batch experiments, the influences of two different types of shakers, a variation of the initial pH value (5 and 7), and the presence of a buffer was tested. For most experiments, the use of a rotary shaker, a pH buffer simulating ionic strength, and an initial pH value of 7 instead of 5 increased the capacities. In contrast to batch experiments, the column experiments were performed with more realistic boundary conditions. For the results of the column experiments, the differences between the filter materials were more significant compared with the batch test results. The capacities determined by column experiments decreased with increasing influent concentrations and shorter contact times. As a further result, lab-scale column experiments can be used as an indicator to determine the service lives of treatment systems. Batch experiments with heavy metals can only be used under identical and well-defined conditions to select appropriate filter materials and to prove the comparability of different production batches. In contrast, the cation exchange capacities, which were determined in accordance with the Standard Methods DIN EN ISO 11260:2011-09 and DIN EN 16070:2014-06, were not suitable to determine heavy metal removal capacities and to characterize the performance of filter materials. For the determination of realistic service lives and removal efficiencies of decentralized stormwater treatment systems for traffic area runoff, pilot-scale experiments are necessary. Therefore, a novel and standard-

ized method was developed that consists of two parts. In Part 1, the filter material is rapidly preloaded in individual models with the heavy metals copper and zinc. In Part 2, the long-term performance of the system is assessed by simulating the last year of the filter material’s service life with three different rain events. All tested treatment systems had different removal efficiencies, in particular in their long-term performances. The average removal efficiencies varied between 48.2% and 99.3% for copper and between 59.7% and 99.4% for zinc. The smallest values were determined during the rain event with the highest rain intensity. The applicability of the method was confirmed by a comparison of the novel test method results with field measurements, which were performed at four sites for two filter channel systems.

Moreover, the remobilization risk of previously retained heavy metals was determined for cadmium, copper, lead, nickel, and zinc under application of de-icing salts by lab-scale column experiments. Hereby, tests were performed with eight columns for each of the six filter materials to determine the heavy metal removal. Afterwards, three different experiments were performed with sodium chloride, a mixture of sodium chloride and calcium chloride, and a mixture of sodium chloride and magnesium chloride in duplicates. The mixture of sodium chloride and calcium chloride remobilized the most heavy metals. The remobilization increased with an increasing preloading of the filter and it also depends on the filter material and the heavy metal. The two preloaded columns without subsequent salt tests were used for further studies to describe the removal mechanisms.

A monograph was also published that provides an introduction into the topic decentralized stormwater treatment of runoff from traffic areas and metal roofs. It includes an overview of the system types, their removal mechanisms, the catchment areas, the discharge criteria, the receiving compartments, the legal requirements, the approval procedures, and the test methods.

Dissertation

Huber, M., 2016. Development and Evaluation of an Assessment Method for Decentralized Stormwater Treatment Systems for Runoff from Traffic Areas. Retrieved from <https://mediatum.ub.tum.de/node?id=1292808>

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Water for the World Programme helped 800,000 people to access clean water and sanitation



Borealis and Borouge celebrate the tenth anniversary of their aid programme

Access to water and sanitation is a basic human right. However, the United Nations (UN) estimates that at least 1.8 billion people have to drink water contaminated with faeces while 2.4 billion people lack basic sanitation such as toilets or latrines. This contributes to nearly 1,000 children dying each day due to preventable diseases and is a major hurdle for the development of both people and nations.

The UN has therefore identified access to water and sanitation as one of its 17 Sustainable Development Goals. By 2030, it wants to achieve universal and equitable access to safe and affordable drinking water, ensure access to adequate and equitable sanitation and hygiene, and end open defecation.

The programme looks to advance solutions, expertise and know-how to address the global water challenge in local communities, as well as internationally.

To do this, Water for the World focuses on three areas:

- Improving access to safe water and sanitation through local projects
- Preserving water resources by advancing sustainable water management best practices
- Raising awareness in communities and across the value chain

To maximise the benefit it brings, Water for the World works in partnership with NGOs and the private sector, including the partners and customers of Borealis and Borouge. Since its launch more than 10 years ago, Water for the World and its partners have carried out numerous projects across Asia and Africa, including in India, Pakistan, Nepal, China, Ethiopia and Kenya, benefiting the lives of around 800,000 people.

Among the many examples of the programme's work, notable projects include:

- Providing safe and affordable drinking water to around 50,000 of the poorest people in Nairobi, Kenya. This is the programme's largest ever project and was carried out in partnership with Water and Sanitation for the Urban Poor (WSUP) and OFID, the OPEC Fund for International Development. A follow-up project in Mozambique is currently being prepared.
- Improving water and sanitation facilities for 124,000 patients and workers at Thach Ha District Hospital, in one of Vietnam's poorest provinces. Water for the World joined with Borouge's local agent Han Huy Trading and Singapore-based NHO Lien Aid, to carry out this work.
- Installing new water supply systems serving more than 5,000 people, after monsoon rains destroyed much of the infrastructure in mountain villages in Northern Pakistan. This project was in conjunction with Pakistan NGO HEED.

"The challenge of ensuring people have access to water and sanitation remains urgent and Water for the World will continue its work," says Borealis CEO Mark Garrett. "Borealis has an important role to play, using our high-quality polyethylene pipes to create long-lasting, resilient and low-maintenance networks."

"Project after project, we see our creative solutions come to life and make a tangible impact on the communities around us, helping people and driving progress," says Wim Roels, CEO of Borouge Pte Ltd. "The first 10 years of Water for the World have brought us great experience and pride, and we have exciting plans for the next decade," adds Ahmed O. Abdulla, CEO of Abu Dhabi Polymers Company (Borouge).

Borealis and Borouge announced their contributions to communities in need during the International Water Summit in Abu Dhabi, where companies from around the world demonstrated the projects they carried out across the world to help people in poor communities have a proper access to fresh water and sanitation. This year, the global event promoted water sustainability in arid regions, which goes in line with the strategic objectives of the Water for the World programme.



Water dispenser in use: providing safe and affordable drinking water to people in Kenya

More information:
www.waterfortheworld.net

Exposing the hidden groundwater crisis with remote sensors

Groundwater is a critical resource for most people who live in rural areas of the world. To put it in perspective, around three in every five rural households in sub-Saharan Africa rely on aquifers accessed by hand dug or drilled wells as their primary water source. The common ideal of rural water supply in developing countries is shifting away from point-source handpumps towards higher volumes of water provided in more convenient locations, namely with higher-capacity groundwater pumping systems and piped distribution networks (**Figure 1**). While Water Mission supports this ideal and is actively working with government and development partners to make it a reality, there is a potential complication to rapid expansion of rural water services.

We know surprisingly little about the sustainability of the Earth's groundwater resources, particularly in developing countries. Global monitoring systems exist for hydrological phenomena such as precipitation, stream flow, and water quality – but not for groundwater. The British Geological Survey has devoted significant effort to cataloging what is known about availability of groundwater resources in sub-Saharan Africa through their Africa Groundwater Atlas initiative.

However, as was highlighted at the 2017 Stockholm World Water Week, there is a general lack of data on groundwater withdrawal and recharge rates. This information gap is driving a growing concern that exploitation of groundwater resources paired with low or misunderstood aquifer recharge could lead

to depletion of resources that have been relied on for centuries. The risk posed to rural populations because of unformed groundwater development is often referred to as a “hidden” crisis because aquifers cannot be seen and the impacts are not understood.

Historically, there has not been a simple or cost-effective way to measure or monitor changes in aquifer volume at the global scale. Although pumping tests which are typically conducted to measure the sustainable yield of drilled wells are uncomplicated, they are labor intensive. Complex environmental and hydrogeological studies can give scientists perspective on aquifer recharge, but they are expensive and often inaccurate or inconclusive. These methods have limited scalability considering the global nature of the hidden groundwater crisis.

Need for low-cost, scalable data collection systems

Furthermore, since current methods only provide insight into the status of groundwater resources at one point in time, they require significant ongoing investment to measure changes and predict long-term trends. There is a need for low-cost, scalable data collection systems which are capable of continuously monitoring withdrawal and recharge of groundwater aquifers for decades.

In collaboration with partners at SonSet solutions and IBM jStart, Water Mission has developed a remote sensing system



Figure 1: the common ideal of rural water supply in developing countries, like here in Uganda, is shifting away from point-source handpumps towards higher volumes of water provided in more convenient locations

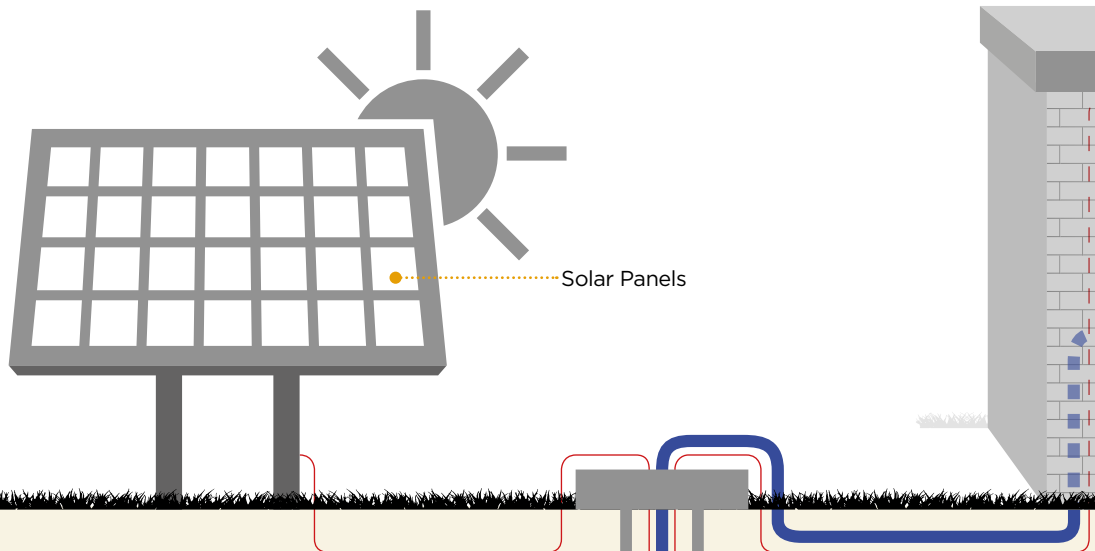
Water Mission's Sustainable Project Model

The manner in which rural safe water supply projects are implemented is critical to sustainability. Three key elements enable ongoing, reliable safe water service (this brochure is primarily focused on the first two):

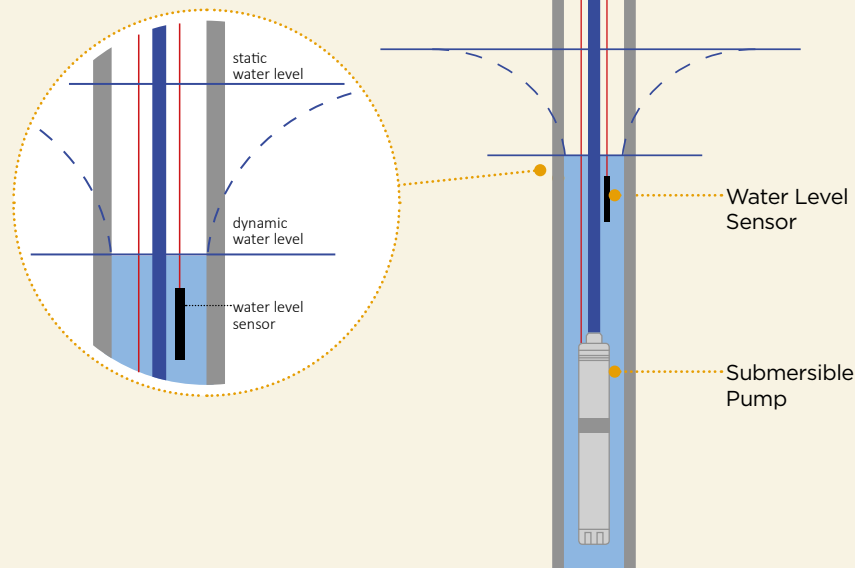
1. Technical Design – Solutions need to be designed in accordance with engineering standards while also accounting for unique cultural context and supply chain limitations.
2. Onsite Project Management – Reliable project management is required to ensure the system is constructed and processes executed in accordance with the design.
3. Community Development – The people processes and systems necessary to operate and maintain equipment and manage ongoing finances must be planned and cultivated in collaboration with local stakeholders.



With key advantages over traditional power options, solar-powered pumping is Water Mission's preferred solution for both ground and surface water sources. When desired, back-up power sources are also easily integrated. Water Mission's strategic partner for back-up power systems is Kohler/SDMO. They offer a full range of diesel solutions.

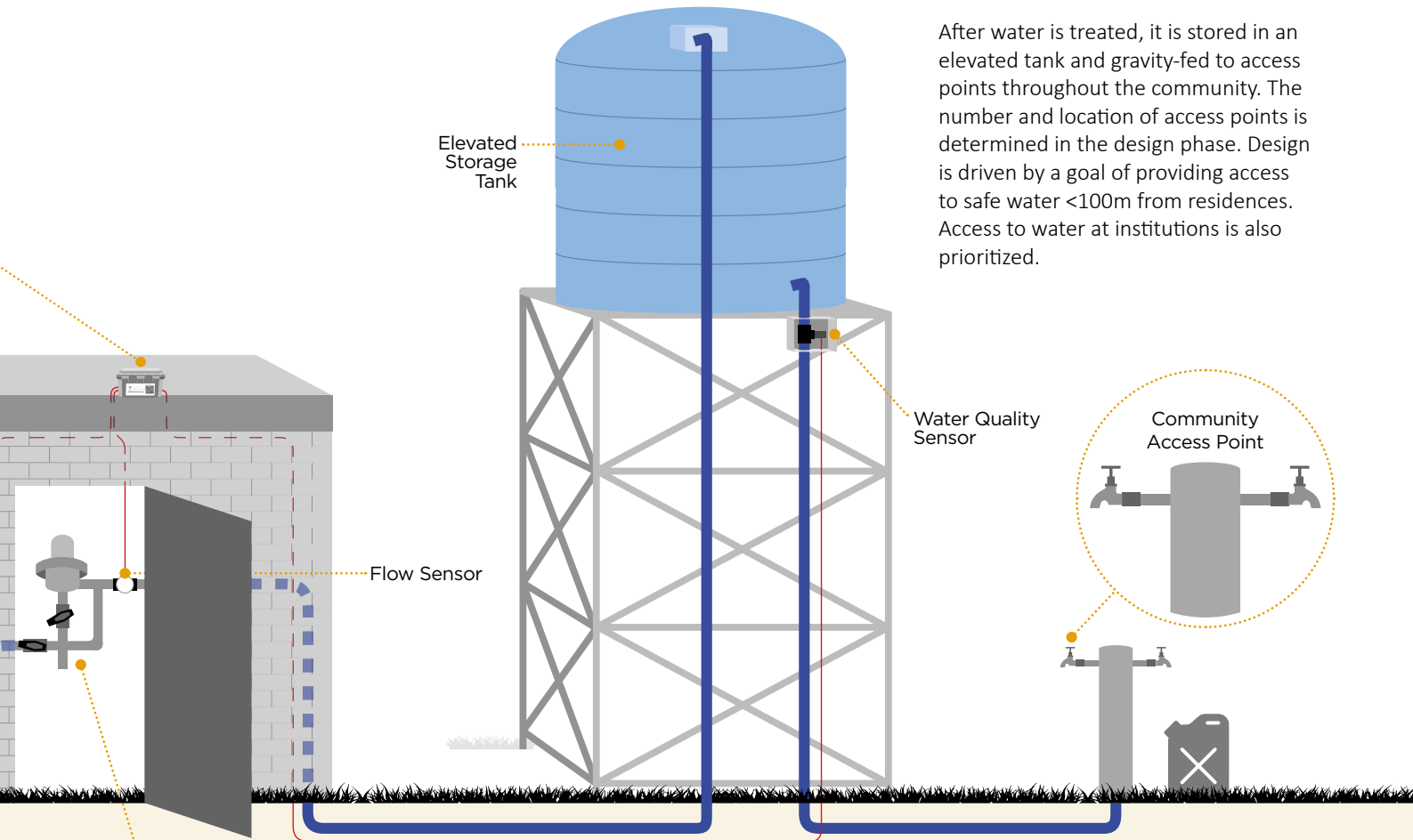
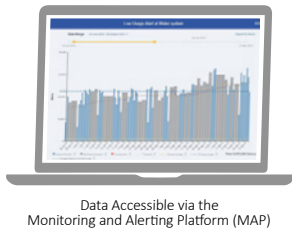


Our strategic partner for solar pumping solutions is Grundfos. Their systems are direct solar-driven and do not require batteries/charge controllers. They accept a wide range of electrical inputs and have robust protection systems (run-dry and over/under voltage). This allows for minimal maintenance and long-term reliability.



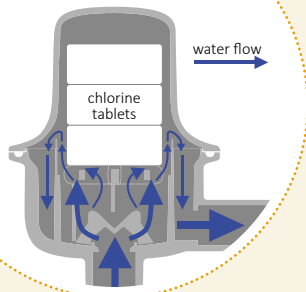
Remote sensors enable authorities to ensure that a rural water supply system continues to provide reliable safe water service. Long distances and fragile in-country infrastructure can make monitoring in remote areas a challenge. Water Mission overcomes this challenge through the use of an equipment-agnostic, satellite transmission-based remote monitoring technology known as SatWater.

- Using the SatWater Communicator, data from water systems worldwide can be transmitted via satellite to an accessible online database.
- The SatWater Communicator is designed to receive and transmit data on a daily basis, including water level, flow, pressure, and quality.



After water is treated, it is stored in an elevated tank and gravity-fed to access points throughout the community. The number and location of access points is determined in the design phase. Design is driven by a goal of providing access to safe water <100m from residences. Access to water at institutions is also prioritized.

Potable Water Chlorinator



The Potable Water Chlorinator is designed to disinfect water from clear water sources (i.e. boreholes, wells, springs, etc.) providing protection against recontamination during collection, transport, and storage. It is easy to operate and requires minimal maintenance. Design flow rate is up to 5m³/hr, and multiple chlorinators can be installed in parallel to allow for higher flow applications.

Figure 3: diagram illustrating how sensors can be utilized to monitor functional and environmental sustainability of a rural water supply system

UGANDA										
2 projects have active alerts										
Action taken	Category	Standard type	Information source	Project No.	Project Name	Days	Description	Last communication in log		
	Output	Safety	SatWater ORP	1582	KDO-10	1	Between August 18 and August 19 The SatWater ORP (installed in: Water Treatment System) has a low chlorine alert. Over the past 3 days, the average free chlorine concentration was approximately 0.1 ppm, which is below the alert level of 0.2 ppm.	There have not been any communication logged yet	Record action	Edit or unsubscribe
	Output	Technical Sustainability	SatWater Meter	1584	BO-15	1	Between August 18 and August 19 The SatWater Meter (installed in: Main Distribution Line) has a low usage alert. Over the requested 7 days, 100 gallons a day has passed through it, which is less than the alert level of 200 gallons of water per day.	Aug 17 2016: Called operator and operator was able to find someone to repair it	Record action	Edit or unsubscribe
	Output	Technical Sustainability	SatWater Communicator	1584	BO-15	1	Between August 18 and August 19, the SatWater Meter (installed in: Main Distribution Line) had a high usage alert. Over the requested 3 days, 9890 gallons a day has passed through it, which is more than the alert level of 1000 gallons of water per day.	There have not been any communication logged yet	Record action	Edit or unsubscribe
1 project had an unscheduled service outage over the past 7 days										
Action taken	Category	Standard type	Information source	Project No.	Project Name	Days	Description	Last communication in log		
	Output	Accessibility	Follow-up report	1582	KDO-10	6	High unscheduled service outage alert - There were 3 days without service (not covered by warranty) for the following reason: Technical failure (wires eaten-up by termites)	Aug 17 2016: Called operator and operator was able to find someone to repair it	Record action	Edit or unsubscribe
1 project has alerts with insufficient data to analyze										
Action taken	Category	Standard type	Information source	Project No.	Project Name	Days	Description	Last communication in log		
	Output	Technical Sustainability	Sensor	1582	KDO-10	0	Usage trend alert has been unable to analyze data for the past 5 days because of an insufficient amount of data.	Aug 19 2016: I wanted to find out what you meant to say in your additional information. Did Rob instruct the SWC/operator to do the cleaning under his supervision?	Record action	Edit or unsubscribe
1 project has cleared alerts (between August 18 and August 19)										
Action taken	Category	Standard type	Information source	Project No.	Project Name	Days before cleared	Description	Last communication in log		
	Output	Accessibility	SatWater Meter	1582	KDO-10	0	Between August 18 and August 19, the SatWater Communicator had a no data received alert. The alert was cleared on August 19.	There have not been any communication logged yet	Record action	Edit or unsubscribe
4 projects have no alerts										

Figure 2: MAP example: the SatWater communicator can receive real-time data from any type of sensor such as flow rate, pressure, or oxidation-reduction potential and transmit from anywhere in the world to a web-based data alerting and analysis dashboard

that enables effective and efficient monitoring of aquifer sustainability as well as rural water system functionality. The SatWater communicator can receive real-time data from any type of sensor such as flow rate, pressure, or oxidation-reduction potential (a proxy for chlorine residual) and transmit from anywhere in the world to a web-based data alerting and analysis dashboard called the MAP, or “Monitoring and Alerting Platform” (Figure 2).

The system brings acute technical issues and long-term performance trends to light, empowering managers to make actionable decisions and track responsiveness. Water Mission uses the system to monitor groundwater sustainability by mounting robust pressure sensors in drilled wells and measuring daily fluctuations in water level. The system triggers an alert if a significant decline in water level over time is registered. Figure 3 shows a diagram illustrating how sensors can be utilized to monitor functional and environmental sustainability of a rural water supply system.

Water Mission’s remote monitoring system has strong potential to improve management of groundwater resources and enable expansion of rural water services because it addresses key scalability issues. Since the communicator utilizes satellite instead of a mobile network to transmit data, the platform is capable of rapid deployment without needing to

negotiate multiple service agreements – SatWater communicators have been installed in ten countries to-date under a single global contract.

Furthermore, the total life-cycle cost of sensors and 10 years of data transmission is a few thousand dollars per water supply system – incremental when the far-reaching impacts of the data availability is considered. The challenge Water Mission faces along with its field partners in realizing those impacts is to share and utilize the data, integrate remote monitoring data streams into established national and global monitoring systems, and translate it into action.

Further information:

<https://watermission.org/groundwater-remote-sensors/>

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Technology, training, and local knowledge

Hygiene Trainings held in East Africa teach about water and hygiene



© Siemens Stiftung/Linah Rugabelah

A new hand-washing station was installed at the beginning of the school year at the Gatumanyaga Primary School in Ngoliba, Kenya. Around 1,200 children can now wash their hands regularly, which helps prevent disease

The fact that contaminated drinking water and a lack of hygiene can lead to deadly diseases is not widely known in many rural regions of East Africa. That is why in recent years, Siemens Stiftung and local partners have expanded and improved on training and informational work done in schools, homes, and at water kiosks. Local knowledge and cultural experience play an important role right alongside the information taken from the foundation's education working area.

Simple experiments from the Experimento program clearly illustrate the process of water purification and the dangers of bacterial contamination. Through hands-on test and learn with visible effects, functional knowledge and causal relationships are easy for participants to understand and retain.

This educational work is essential for the Siemens Stiftung water kiosks to reach their full

potential. The right technology put to use in the right place will reliably purify contaminated surface water, but it does not ensure the positive effect on health becomes permanent. In terms of finances and personnel, Siemens Stiftung invests around three times the amount for Hygiene Trainings than it does for technical equipment and infrastructure of Safe Water Enterprises.

Practical knowledge transfer improves health in rural regions

For communities

- Explanation and increased awareness
- Community gatherings
- Business training in the water sector

For schools

- Hygienic behavior as part of lessons
- Training for teachers as multipliers
- School events on water and hygiene
- Installation of hand-washing stations

For kiosk operators

- Training and consulting for kiosk management and water committees with information on social entrepreneurship, social marketing, drinking water and health, technical training, operations, and maintenance

The Hygiene Trainings held in East Africa prove technical equipment to be good, but knowledge to be even better. In light of this, Siemens Stiftung has elaborated two different manuals over the past three years, one for Community Health Volunteers and one for Hygiene promotion at Primary Schools. Both manuals are scheduled to be published on the website of Siemens Stiftung in April.

Further information:
www.siemens-stiftung.org



Facts and data



160

Health workers trained

3,500

Home visits to provide information about drinking water and water-borne illnesses



48

Primary schools participating in drinking water and hygiene program

130

Teachers took part in hygiene education training session

3

Hand-washing stations installed at schools



25

Kiosk operators received additional training in technology, business management, water, and health

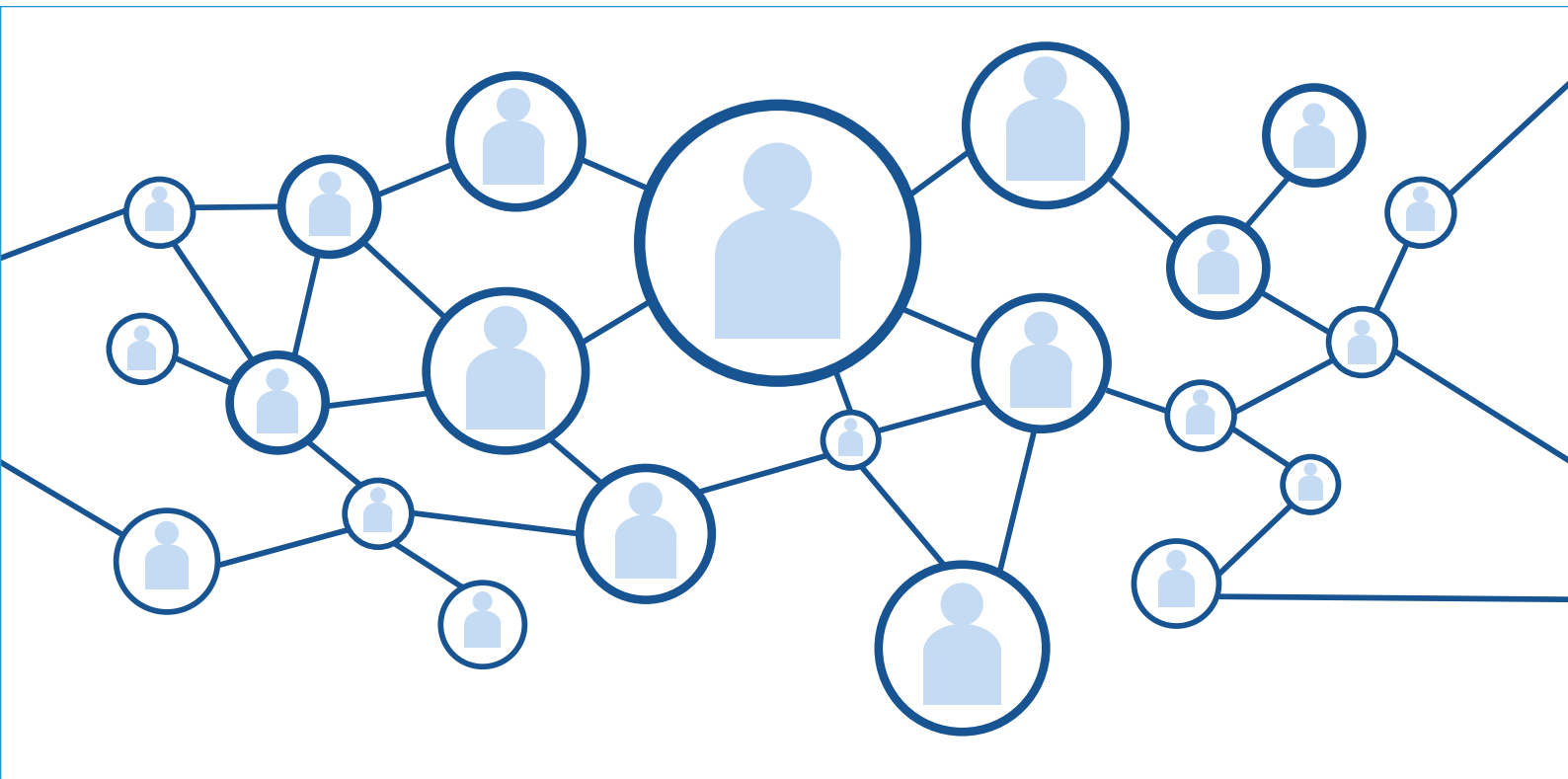
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11 th – 14 th June 2018	ACE – American Water Works Association Annual Conference & Exposition in Las Vegas, USA www.awwa.org/conferences-education/conferences/annual-conference/ace-program.aspx	28 th – 30 th June 2018	Indo Water in Surabaya, Indonesia www.indowater.com
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