MULTI-ReUse: Modular combination of technologies for water reuse

More and more regions experience rising water demand while having limited water resources. That is the reason why water reuse is getting more and more important worldwide. The European Commission addressed this issue by proposing measures for water reuse within their recycling economy strategy (EU 2018).

Even though the water supply is guaranteed in most regions in Germany even during extreme dry periods, there already have been shortages for water providers and industrial companies in the past. Long-term forecasts indicate an intensification of that problem in certain regions, e.g. where many industrial companies are located, as it is the case in the region of Nordenham in Lower-Saxony in Germany.

The waterboard of Oldenburg (Oldenburgisch-Ostfriesischer Wasserverband, short OOWV) is currently dealing with this problem by treating water from the effluent of the waste water treatment plant in Nordenham for reuse for industrial purposes. In collaboration with the MULTI-ReUse project, a modular treatment system is tested under real conditions there.

The produced service water isn't just suitable for the industry but also can be used for agricultural purposes, urban water management or groundwater recharge (see Figure 1). To keep the treatment costs as low as possible, an adaption of the process technologies is needed to keep the minimum requirements for the respective sector.

Usage requirements and markets

The requirements for this kind of water treatment depend on the purpose of the service water. However, they often are non-binding and organized differently in the different countries. In the following MULTI-ReUse factsheets you will find good reasons for water reuse as well as information about the existing legal requirements:

- Water reuse – a topic for German municipalities, industry and agriculture?
- Requirements for water reuse in industry
- Requirements for water reuse in agriculture
- Requirements for the reuse of water in urban water management
- Requirements for water reuse in the context of groundwater recharge

Innovative process technology

For a more challenging use of service water, such as the use of demineralized water for industrial purposes for example, the combination of the innovative membrane processes ultrafiltration and reverse osmosis already proved to be successful on an international

level. Main impediments for a further proliferation of these technologies are the relatively high costs and the not sufficiently user-orientated quality of the service water. A main factor of the operating costs is the biofouling, the formation of biologically active cover layers on the membranes. Those cause pressure loss and enhance the amount of chemicals required. This can be reduced however by a fitting pre-treatment and optimization as well as the fine-tuning of operation parameters and membrane properties. This is where the MULTI-ReUse project comes into play.

The project works on using the synergy potentials of both procedures on the one hand while offer different qualities of service water by using a modular treatment on the other hand. The core processes ultrafiltration and reverse osmosis are complemented and combined differently by adapted pre- and post-treatment procedures, such as flocculation, powdered carbon dosage, activated carbon filtration and UV-disinfection. Another set of factsheets inform about the produced service water qualities, the potential applications and suitable process combinations as well as detailed information about the main processes ultrafiltration, reverse osmosis and activated carbon filtration:

- Process chains for the treatment of sewage plant effluents to meet different service water qualities
- Ultrafiltration in wastewater treatment for water reuse
- Reverse osmosis in wastewater treatment for water reuse
- Activated carbon filtration in wastewater treatment for water reuse

Innovative quality control

Water reuse processes require the precautionary handling of risks that originate from pathogenic germs and chemical combinations. Parameters about hygiene status and microbiological growth potential are essential for an assessment of the water- and process stability. They are indicators for errors or problems within the treatment process on the one hand and for the efficiency of the processes regarding the microbiological water quality on the other hand. Additionally, questions

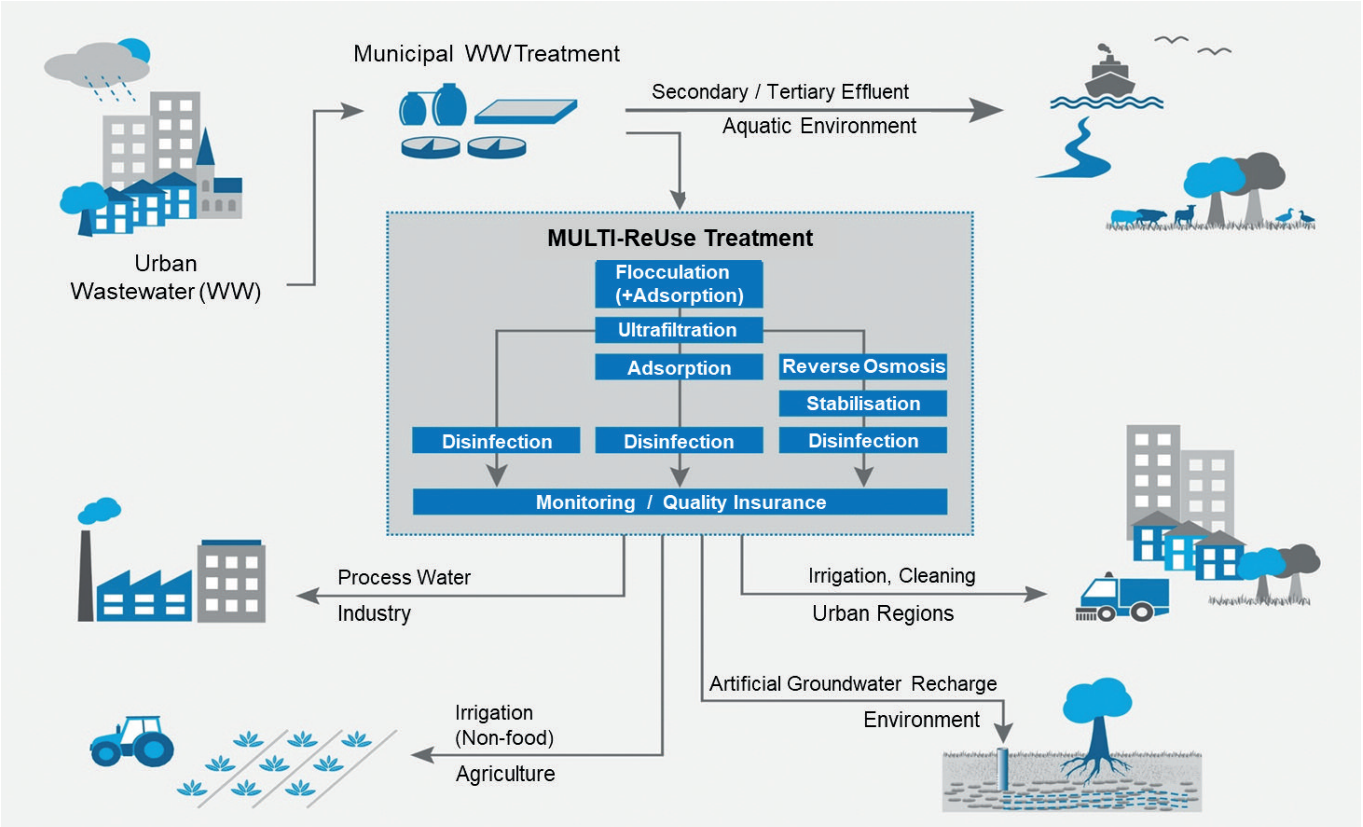

Figure 1: Water reuse with MULTI-ReUse

about the water stability during storage or distribution in a pipe network can be answered.

Therefore, two innovative monitoring procedures for the microbiological process monitoring and assessment of bacterial growth and biofilm potential were developed within MULTI-ReUse:

The flow cytometry allows a quick detection of microbiological fluctuation in the water quality and indicates the need for action for quality control. The determination of a bacteria concentration is online possible within 15 minutes. Next to the quantification of cell numbers the method also allows the differentiation between inactive and damaged bacteria.

A new method to determine the biodegradable dissolved organic carbon (BDOC) is the “Reverse Isotope Labeling” (RIL). The measured degradation of nutrients in the water, resp. DOC allows conclusions about the microbial activity in the treated water.

The two innovative monitoring procedures are described in detail in the following factsheets:

Flow cytometry for quick determination of microbiology and growth potential in the water

“Reverse Isotope Labeling”: A new method to determine the biodegradable dissolved organic carbon (BDOC)

Practical tests of the MULTI-ReUse treatment

To optimally prepare a large scale implementation of MULTI-ReUse technologies at the location of the pilot plant, three service water qualities are produced under real conditions, using innovative process chains and qualitative monitoring. The demonstration phase of several months is used to optimize the processes and to answer the following questions:

- Can the aspired service water qualities permanently be reached, even with fluctuating raw water quality?
- Are there toxicological effects in the produced service waters? Do the different treatment processes are associated with certain effects?
- What kind of pipe material is required for an application-specific service water network?

Assessment tool for water reuse options

A decision to implement a water reuse measure can only be made individually. Important here is the holistic assessment of potentially suitable process chains compared to the status quo. For this purpose an assessment tool was developed, where MULTI-ReUse technologies are compared to currently practiced service water supply strategies. Hereby technical, ecologic, economic and social criteria are being taken into account. The multi-criterial assessment tool offers decision support for the choice of location and the assessment of different water reuse alternatives. With the help of the tool a sustainability assessment of MULTI-ReUse technologies is being carried out for different situations until summer 2019.

Development of an export strategy

The within MULTI-ReUse researched and (further) developed treatment and monitoring technologies for water reuse for different fields of application can also be applied in countries with less water availability than Germany. The project therefore is researching possibilities for the export of these technologies. Important multipliers for promising target markets could be advising companies and plant designers; therefore the final project results are being prepared professionally and introduced to them at the end of the project.

Literature

EU (2018). Water reuse. European Commission. http://ec.europa.eu/environment/water/reuse.htm (28.5.2018)

Authors

Anja Rohn, Anil Gaba, Dr. Andreas Nahrstedt
IWW Water Centre, Section Water Technologies
Mülheim an der Ruhr

Contact: a.rohn@iww-online.de

Short description of the MULTI-ReUse project

Treated wastewater is an important part of the water cycle. It usually is fed into rivers, something that is acceptable from an environmental point of view but for the use in agriculture or industry the water often is unsuitable. MULTI-ReUse closes this gap by developing and implementing of new procedures for the reuse of service water. The aim of MULTI-ReUse therefore is the development, demonstration and evaluation of a modular water treatment system, in order to offer service water in different qualities and quantities for the different purposes and to competitive prices.

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IWW Rheinisch-Westfälisches Institut für Wasserforschung gemeinnützige GmbH
Moritzstr. 26
45476 Mülheim an der Ruhr
Germany

Website: https://water-multi-reuse.org/
E-Mail: info@iww-online.de

Legally responsible:
Dr.-Ing. Wolf Merkel (Chief Technical Officer)

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