

Requirements for water reuse in industry

Challenges

The use of water for different industrial processes (including power generation) requires different service water qualities. Alongside cooling water, flush-, transport-, wash-, product-, and boiler feed water play an important role but in terms of the amount of water required, cooling water is the most important product from this list.

The most crucial quality parameters for the industry are turbidity, suspended solids, dissolved minerals (salts), disinfectants and specific anorganic and organic contaminations. One special focus lies on the microbial contamination relating to biofouling and biofilm formation or through exposure by potential pathogens, such as legionella, coliform bacteria and viruses. The most common water quality problems in cooling water systems are corrosion, biological growth and the formation of boiler scale. In regards to the reuse of treated wastewater special attention has to be brought to these aspects.

Procedure for the regulation of quality requirements

In order to select suitable industrial sectors for the MULTI-ReUse procedure, the industrial water demand of producing industries in Germany was assessed. Sectors with the biggest water demand and use are the chemical industry, followed by the metal industry, food and beverage industry as well as the paper and textile industry. This doesn't change in the international context. The main challenge for wastewater reuse in

the industry is the implementation of the different requirements and qualities for service waters. With the help of modular process chains in MULTI-ReUse, different qualities of service water can be provided.



Figure 1: Chemical industry – Pipelines (©industrieblick - stock.adobe.com)

In Germany there is no general legal framework for wastewater reuse in industry but different guidelines, standards and regulations exist for different process waters, especially for cooling and boiler feed water (see table 1). Also, there are different regulations for the general water management that need to be taken into consideration (see table 1). Therein the handling of water-polluting substances as well as the directive for registration and supervision of industrial wastewater treatment plants plays an important part. The specifications of the European Water Framework Directive (WFD) are fully implemented in German law, e.g. the

list of priority substances is implemented in the Ordinance on the Protection of Surface Waters (Oberflächengewässerverordnung – OGewV). From industrial side, the *Directive 2010/75/EU on industrial emissions* needs to be taken into consideration and the related ‘Best Available Techniques’ have to be implemented.

Based on the directives and guidelines and the challenges mentioned above, three different quality levels of service water were defined: (1) Cooling water, (2) boiler feed water, (3) other process water.

Cooling- and boiler feed water belong to the most important process waters in the industry, which was the reason for defining them as a service water for MULTI-ReUse. Important parameters to consider from the guidelines and DIN-standards in table 1 are: turbidity, pH-value, electrical conductivity, total hardness, acid capacity, solute oxygen, alkaline earths, chloride, sulphate, phosphate, nitrate, ammonium, iron, copper, nickel, chromium, silicate, pesticides, TOC, legionella, pseudomonads and total number of colonies. The quality for the third service water (other process water) is based on the requirements of the German Drinking Water Ordinance to guarantee a broad spectrum of fields of applications. These include the listed chemical, physical as well as microbiological parameters.

International perspective

Since the German requirements are derived from the European requirements, they are similar, and the reuse of water is not regulated uniformly in Europe either. In general, the WFD is used as a guideline for a uniform water policy. Of special importance for the industry are the Industrial Emissions Directive to avoid and reduce environmental pollution and the binding ‘Best Available Techniques’ conclusions. The European Drinking Water Directive has an important meaning especially for the food processing industry. Next to this general legal framework, a few European countries (see table 2) passed national laws, resp. standards for industrial water reuse.

In Greece for example two different process water qualities are distinguished. The most important parameters here are: *Escherichia coli* as microbiological parameter, BOD₅, turbidity and suspended solids. Spain has a similar approach; here there are two process water qualities as well. The first quality is mainly used

Table 1: Most important guidelines, standards and regulations for water management and water reuse of the industry in Germany.

General (Waste) water management
<ul style="list-style-type: none"> Wastewater Ordinance (Abwasserverordnung, AbwV) Surface Water Ordinance (Oberflächengewässerverordnung, OGewV) Groundwater Ordinance (Grundwasserverordnung, GrwV) Ordinance about the handling of water-polluting substance for facilities (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen, AwSV) Registration and supervision directive for industrial waste water treatment plants (Industriekläranlagen-Zulassungs- und Überwachungsverordnung, IZÜV) Water resources act (Wasserhaushaltsgesetz, WHG)
Cooling water
<ul style="list-style-type: none"> Guideline series VDI 3803 „Ventilation technology, equipment needs“ (Richtlinienreihe VDI 3803 „Raumluftechnik, Geräteanforderungen“) Guideline series VDI 2047 „Hygiene for recooling plants“ (Richtlinienreihe VDI 2047 „Hygiene bei Rückkühlwerken“) BREF (12.2001): „Reference Document on the application of Best Available Techniques to Industrial Cooling Systems“
Boiler feed water
<ul style="list-style-type: none"> DIN EN 12953-10 Shell boilers: Requirements for feed water and boiler water quality (DIN EN 12953-10 Großwasserraumkessel: Anforderungen an die Speisewasser- und Kesselwasserqualität) DIN EN 12952-12 Water tube boilers: Requirements for feed water and boiler water quality (DIN EN 12952-12 Wasserrohrkessel: Anforderungen an die Speisewasser- und Kesselwasserqualität) TRD 611 Feed water and boiler water of steam generators (TRD 611 Speisewasser und Kesselwasser von Dampferzeugern) VdTÜV MB TECH 1453 VdTÜV Directive for feed water, boiler water and steam of steam generators up to a allowed working overpressure up to 68 bar (VdTÜV MB TECH 1453 VdTÜV-Richtlinien für Speisewasser, Kesselwasser und Dampf von Dampferzeugern bis 68 bar zulässigem Betriebsüberdruck) VGB R 450 L Feed water, boiler water and steam quality for power plants/industrial power plants (VGB R 450 L Speisewasser-, Kesselwasser- und Dampfqualität für Kraftwerke/Industriekraftwerke) Directives, resp. guidelines of the respective boiler manufacturer (Richtlinien bzw. Betriebsvorschriften des jeweiligen Kesselherstellers)
Other process water
<ul style="list-style-type: none"> Drinking Water Ordinance (Trinkwasserverordnung, TrinkwV)