

Industrial water reuse and recycling

Why measurement matters when every drop counts



Introduction

In the face of escalating global water scarcity, exacerbated by climate change and a growing population, the imperative for sustainable water management practices in the industrial sector has never been more acute.

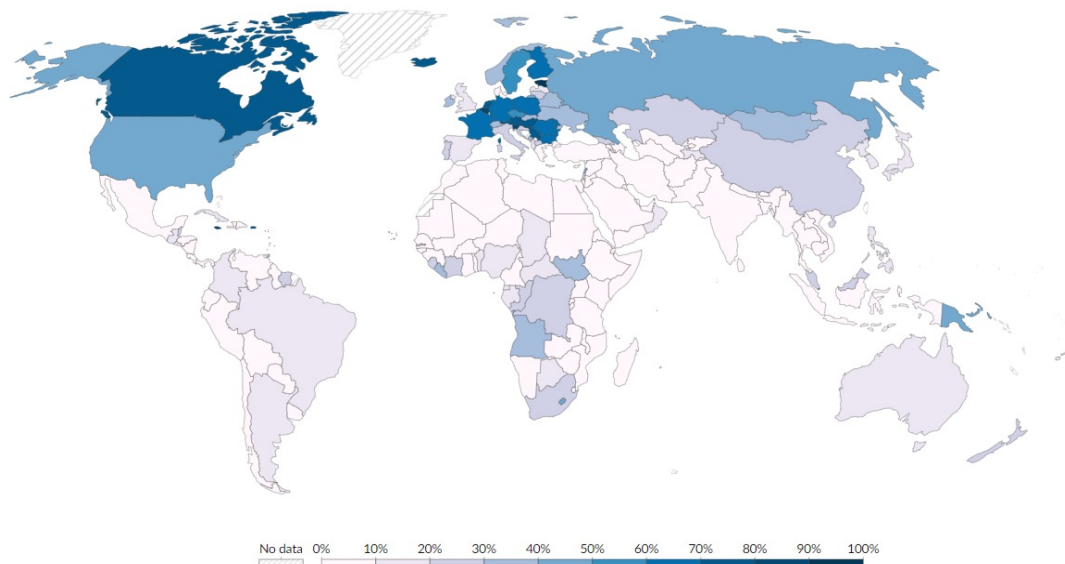
With the global demand for freshwater expected to exceed supply by 40% by 2030, according to the United Nations, industries worldwide are increasingly turning to water recycling and reuse technologies as vital components of their sustainability strategies.

“In contrast to the global distribution of agricultural water withdrawals, industrial water usage tends to dominate in high-income countries and is small in low-income countries”.

The adoption of industrial water recycling is influenced by a variety of economic drivers. The rising costs of water procurement and disposal are significant factors, with industries reporting up to a 50% reduction in water costs following the implementation of recycling systems.

“Technological advancements are at the forefront of the trends in water recycling and reuse. The use of advanced treatment technologies, such as reverse osmosis and membrane bioreactors, has surged, enabling industries to achieve up to 95% water reuse rates in processes.”

Regulatory pressures also play a crucial role; for instance, the European Union’s Water Framework Directive imposes strict standards on water quality and reuse, compelling industries to adopt sustainable practices. Moreover, increasing consumer and shareholder pressures for greater sustainability are driving companies to invest in advanced water management systems as part of their CSR initiatives. The integration of digital tools and IoT for real-time water quality monitoring and system management has revolutionized water use efficiency. For instance, smart sensors and meters facilitate the precise control and reduction of water losses, contributing to the system’s overall efficiency and reliability.



Data source: Food and Agriculture Organization of the United Nations (via World Bank)

Note: The industrial water sector refers to self-supplied industries not connected to the public distribution network. The ratio between net consumption and withdrawal is estimated at less than 5%. It includes water for the cooling of thermoelectric and nuclear power plants, but it does not include hydropower. OurWorldInData.org/water-use-stress | CC BY.

Economic drivers and technological advancements in water recycling

The economic rationale for adopting water recycling technologies is strong, with industries witnessing up to a 50% reduction in water costs following the implementation of such systems. Advanced treatment technologies like reverse osmosis and membrane bioreactors have enabled industries to achieve impressive water reuse rates of up to 95%. Furthermore, regulatory frameworks such as the European Union's Water Framework Directive impose stringent standards on water quality and reuse, propelling industries towards sustainable practices. Consumer and shareholder demand for sustainability also play significant roles in encouraging companies to invest in advanced water management systems as part of their Corporate Social Responsibility (CSR) initiatives.

Digital innovations in water management

The integration of digital tools and the Internet of Things (IoT) for real-time water quality monitoring and system management has revolutionized the efficiency of industrial water use.

Technologies such as smart sensors, meters, and digitally enabled instruments like flow meters and TOC analyzers are critical for the precise measurement and management of water recycling processes.

These instruments not only ensure compliance with environmental regulations but also enhance operational transparency and enable predictive maintenance to avoid costly downtime.



Digital instruments & analysers

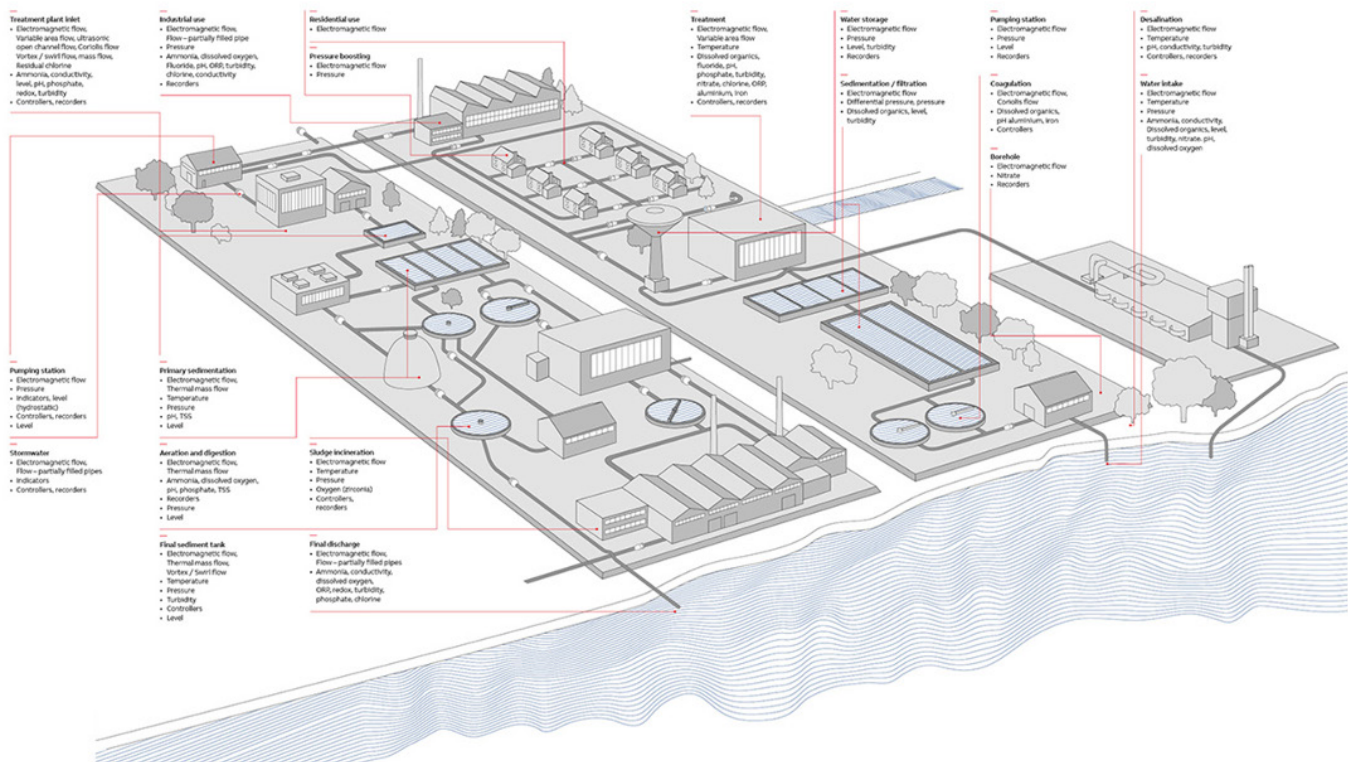
In the intricate ecosystem of industrial water reuse and recycling, the role of precise measurement is fundamental. Advancements in digitally enabled instruments and analyzers have transformed how industries manage water resources, ensuring efficiency and compliance with stringent environmental regulations. These technologies provide the backbone for sophisticated water treatment systems, enabling real-time monitoring and optimization of water quality and usage.

Flow meters, pressure sensors, pH sensors, conductivity sensors, turbidity sensors, Total Organic Carbon (TOC) analyzers, level, and temperature sensors represent the gamut of tools essential for the successful management of water recycling processes. Each type of instrument is tailored to perform specific functions that collectively enhance the treatment and reuse of industrial wastewater.

The digital capabilities of these instruments revolutionize water management by providing data that is not only precise but also immediately accessible.

This real-time data is integral to dynamic monitoring and control systems, allowing for adjustments that optimize water use and treatment processes. The ability to integrate data from various sources into a unified management system facilitates comprehensive analytics, enhancing decision-making and operational transparency. Furthermore, digital instrumentation supports predictive maintenance strategies. By analyzing trends and identifying potential issues before they escalate, industries can avoid costly downtime and extend the lifespan of critical infrastructure. The remote monitoring capabilities enabled by digital technologies also add a layer of convenience and safety, allowing operators to manage systems from afar and respond swiftly to any arising issues.

The integration of digitally enabled measurement technologies in industrial water reuse and recycling is essential for driving operational excellence and sustainability. As industries face ongoing challenges from water scarcity and environmental impacts, these advanced tools will become increasingly crucial in developing sustainable practices that meet global standards and future needs.



Applications for industrial water reuse and recycling

Boiler feed water

Reusing treated water as boiler feed is a highly efficient and cost-effective strategy for industries looking to enhance water management and reduce environmental impact. Specifically, industries such as those in the chemical and power sectors can decrease water usage by 20-30% through the adoption of this practice. This not only translates into substantial cost savings by reducing the energy required to treat and heat fresh water but also supports environmental efforts by lowering freshwater extraction and wastewater discharge. Ensuring the purity of boiler feed water is critical, and using advanced treatment technologies guarantees that recycled water adheres to the rigorous quality standards necessary for boiler operations. The integration of digitally enabled instruments such as pH/conductivity sensors, turbidity sensors, and flowmeters significantly boosts these benefits. pH/conductivity sensors play a vital role in the real-time monitoring of water quality, crucial for preventing scale and corrosion in boilers which can lead to costly repairs. Turbidity sensors help in assessing the clarity of the water, ensuring it remains within the required specifications for safe boiler operation. Flowmeters are essential for accurately measuring the rate of water entering the boiler, aiding in the precise control of water treatment chemicals, and optimizing the overall system efficiency.

These smart technologies enable continuous monitoring, allow for instant adjustments to the water treatment process, and facilitate predictive maintenance strategies. By employing these sophisticated instruments, industries not only uphold high operational standards but also enhance their environmental and economic sustainability through smarter water reuse practices.

Cooling Water Reuse

Cooling water reuse is an essential practice in industries such as power generation, manufacturing, and refining, where it helps manage the high water consumption typical of these sectors.

Industrial cooling systems, which are integral to maintaining optimal operating temperatures, can consume vast quantities of water, often accounting for 40-60% of a facility's total water use. By implementing cooling water reuse strategies, these facilities can reduce their water footprint significantly, sometimes by as much as 50%, depending on the scale of reuse implemented.

From an economic standpoint, the benefits are equally compelling. The costs associated with water procurement, treatment, and disposal are considerable. By reusing cooling water, industries can cut these costs dramatically, achieving savings in both water consumption and wastewater management. Moreover, cooling water reuse contributes to a sustainable water management approach, lessening the burden on freshwater resources and promoting environmental stewardship. The environmental advantages are clear: reducing withdrawal from natural water bodies minimizes ecological disruption while decreasing the energy used for water treatment and pumping contributes to lower carbon emissions. Additionally, since cooling water often requires less rigorous treatment than water used in other processes, the reuse approach can simplify treatment demands and further reduce costs.

Digitally enabled instruments like flowmeters, pressure sensors, and pH/conductivity sensors boost the effectiveness and efficiency of cooling water reuse systems. Flowmeters are essential for monitoring water distribution and optimizing flow rates to ensure the system functions within its designed parameters. Pressure sensors maintain system integrity and prevent leaks that could lead to significant water waste or downtime. pH/conductivity sensors are crucial for tracking water quality, keeping it within safe chemical limits to avoid corrosion or scaling in cooling equipment. These instruments are critical in managing the water reuse process, facilitating real-time adjustments and predictive maintenance, which support energy savings, cost reductions, and a smaller environmental footprint.





Process water in production

Many manufacturing processes, Recycling and reusing water within these processes can minimize the demand for freshwater, reduce waste, and lead to substantial cost savings and environmental benefits. Industrial water reuse and recycling for in-process applications are pivotal in optimizing water consumption across a wide array of sectors, each benefiting environmentally and economically. In the textiles industry, for example, using recycled water in the dyeing process helps reduce water and chemical use significantly. Similarly, in the paper industry, reused water is integral to the pulp washing process, substantially lowering freshwater intake, and decreasing wastewater volume. Further applications can be seen in the food and beverage sector, where recycled water is employed for tasks like cleaning and processing, crucial for maintaining hygiene without excessive freshwater use.

The automotive industry also benefits from utilizing recycled water for component washing and paint dilution, which requires substantial volumes of clean water. In the specialty chemicals industry, recycled water is used for various chemical processes and cooling, where high-quality water standards are maintained to prevent contamination and ensure product purity.

In the semiconductor manufacturing sector, ultra-pure water recycled from process steps is used for wafer washing, critical to maintaining product quality while managing resource use efficiently.

Overall, by reusing water in these various industrial processes, companies not only reduce their freshwater demands—often by up to 50%—but also achieve considerable reductions in operational costs and environmental impacts, promoting a more sustainable and cost-effective industry standard.



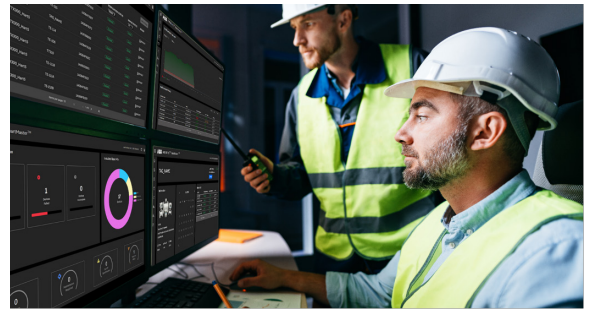
Digital asset performance monitoring

In the contemporary landscape of industrial water reuse and recycling, Digital Asset Performance Monitoring (DAPM) plays a critical role in enhancing operational efficiencies and maintaining compliance with environmental standards. As industries grapple with the challenges posed by an aging workforce and dwindling in-house expertise, the need for advanced digital solutions that can oversee the health management of instruments and analyzers becomes increasingly vital.

The advent of IoT and AI technologies has significantly revolutionized asset health management, making it possible to monitor the entire fleet of instrumentation devices remotely. This shift is crucial as it helps mitigate the risk of delays in critical processes that could otherwise lead to unnecessary costs. For example, studies have shown that integrating IoT with asset management can reduce downtime by up to 35% and increase productivity by up to 20%.

DAPM systems utilize the power of the cloud to transform complex data into actionable business insights, effectively improving the uptime of the field instrumentation devices. By connecting the physical and digital worlds, these systems enable real-time data transmission from field devices directly to smartphones, tablets, or other digital platforms. This connectivity ensures that operators have an always-on overview of the device health status, promoting proactive maintenance strategies rather than reactive responses.

The capability for self-health monitoring in instruments is particularly crucial. It allows for continuous verification and calibration, ensuring that the instruments operate within the required specifications, thus maintaining accuracy and reliability in monitoring water quality and other critical parameters. This not only ensures quality and compliance with stringent environmental regulations but also enhances overall productivity by minimizing equipment failures and downtime.



Moreover, the implementation of a fleet monitoring solution removes the operational complexity and empowers businesses to maximize instrument utilization. With features such as multiple connectivity options and support for predictive maintenance, DAPM systems are at the forefront of industrial innovation. These systems are designed to predict potential failures before they occur, allowing maintenance to be scheduled at convenient times and thereby minimizing operational disruptions.

In summary, as industrial entities move towards more sustainable water management practices, the role of Digital Asset Performance Monitoring becomes increasingly integral. By leveraging IoT and AI to ensure the health and efficiency of water management instruments, industries can improve operations, reduce costs, enhance productivity, and most importantly, support environmental sustainability.

