VEOLIA

Transforming the future of **wastewater treatment plants** with digital solutions

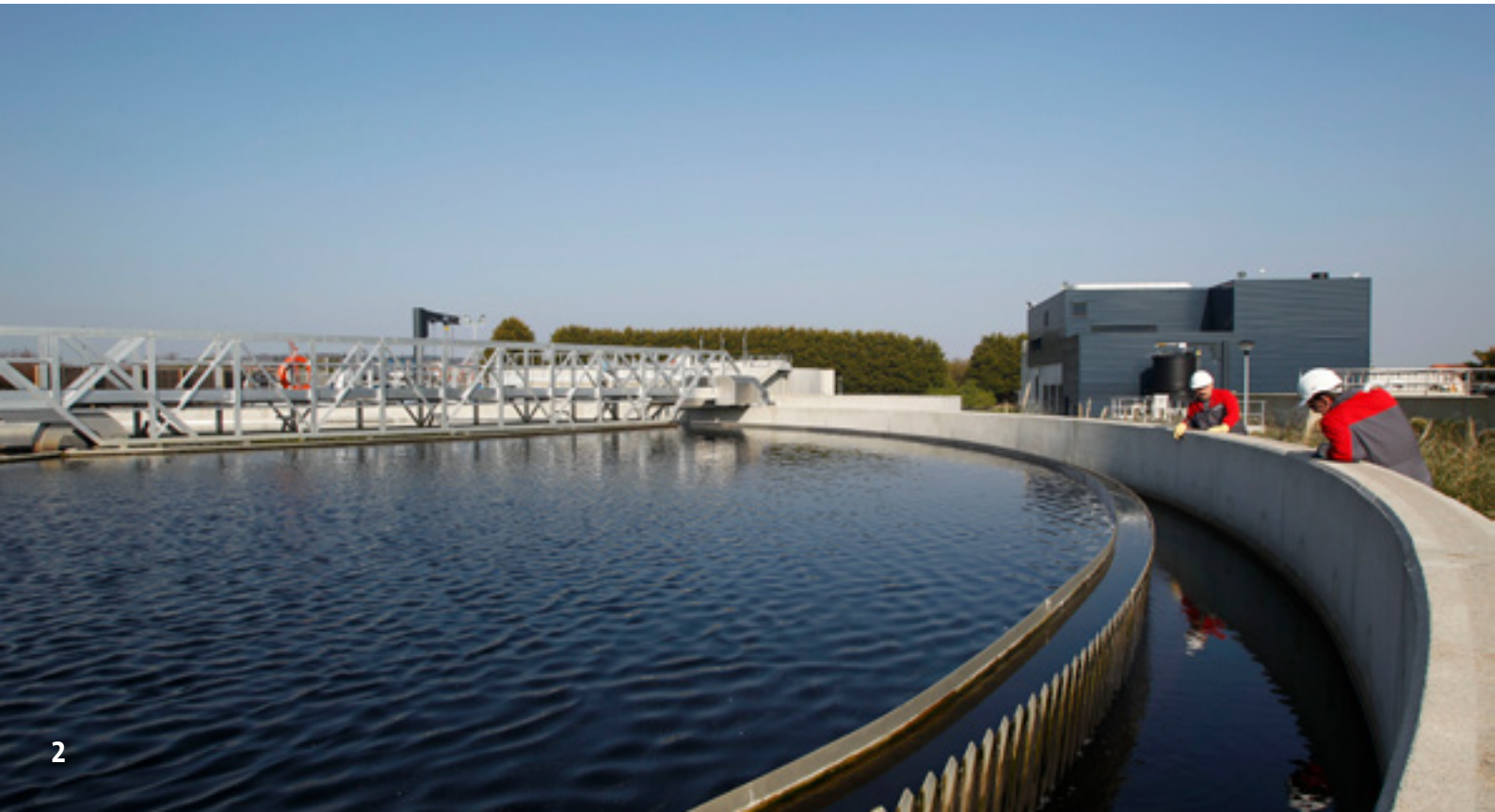
WATER TECHNOLOGIES

ABSTRACT

This white paper explores the significant impact of digital solutions on the operation of wastewater treatment plants, with a specific focus on digital twin technologies. As the world becomes more interconnected and industries embrace digitalisation, wastewater treatment plants are leveraging advanced technologies to enhance efficiency, reduce costs and ensure sustainable operations.

This paper is a valuable resource for plant operators, managers and decision-makers; highlighting the potential benefits, challenges and implementation strategies for digital twin technologies in wastewater treatment plants, emphasising their role in revolutionising plant operations and driving long-term success.

CONTENTS



INTRODUCTION

Background on wastewater treatment plants

Wastewater treatment plants play a vital role in safeguarding public health and protecting the environment. This includes reducing the effect of excess phosphorus on aquatic plants and animals and minimising harmful pollutants in wastewater. The importance of effective wastewater and water treatment is further highlighted by the fact that by 2030, the global demand for freshwater is projected to exceed supply by 40%[1]. Wastewater treatment plants are at the forefront of combating these challenges by ensuring effective treatment and reuse of wastewater. The water sector is also under pressure to improve the resilience of supply, decarbonise its operations and control the costs to homes and businesses.

[1] Global Commission on the Economics of Water - https://www.theguardian.com/environment/2023/mar/17/global-fresh-water-demand-outstrip-supply-by-2030.

The growing need for digital solutions

To fulfil this vitally important role and meet their objectives, wastewater treatment plants must optimise their efficiency, minimise downtime, secure compliance and reduce operational costs. This means that digital solutions and the benefits they offer are now more important than ever. It is estimated that the global smart water market will reach a value of $22.4 billion by 2026, driven by the adoption of advanced technologies. Furthermore, the COVID-19 pandemic emphasised the need for remote monitoring and control capabilities in wastewater treatment operations. Digital solutions offer unprecedented opportunities to revolutionise the way wastewater treatment plants are operated, enabling real-time insights, predictive analytics, and data-driven decision-making.

WHAT IS DIGITAL TWIN TECHNOLOGY?

Digital twin technologies represent a revolutionary approach to wastewater treatment plant management. A digital twin is a virtual replica of a physical asset, process or system that combines real-time data, mathematical models and advanced analytics. It consists of three main components:

- The physical asset - the wastewater treatment plant, including its equipment, pipelines and control systems.
- The virtual model - encompassing the mathematical algorithms, simulations, and data-driven models that replicate the behaviour of the physical asset.
- The communication infrastructure – which facilitates the seamless exchange of real-time data between the physical asset and the virtual model.

By creating this virtual representation, operators gain a holistic view of the plant, enabling them to monitor, analyse and optimise processes more effectively. To achieve this, sensors are placed throughout the wastewater treatment system to collect data on various parameters such as flow rates, pollutant levels, temperature and pressure. This data is transmitted to the virtual model, where it is processed and analysed.

BENEFITS FOR WASTEWATER TREATMENT PLANTS

The use of digital twin technology has several key advantages. However, to maximise the benefits it is important to work with a water treatment technology specialist, such as Veolia Water Technologies, that can provide support in understanding the data and implementing optimisations.

Enhanced plant performance and optimisation

Studies have shown that implementing digital twin technologies can lead to significant improvements in energy efficiency. For example, businesses that have worked with Veolia Water Technologies to implement this type of digital technology have achieved up to a **30%** reduction in energy consumption.

By integrating real-time data from plant equipments and combining it with mathematical models, operators gain comprehensive insights into the behaviour of the wastewater treatment plant. They can identify inefficiencies, bottlenecks and anomalies as well as optimise process parameters and fine-tune operations to achieve maximum efficiency. This leads to improved treatment outcomes, reduced energy consumption and enhanced overall plant performance.

Predictive maintenance and asset management

By continuously monitoring equipment conditions and performance indicators, potential failures can be identified in advance, enabling any issues to be addressed proactively. This approach minimises downtime and reduces costly emergency repairs, optimises maintenance schedules and extends the lifespan of assets, resulting in significant cost savings. Additionally, the virtual model provides valuable insights into asset lifecycles, enabling optimised asset management and replacement planning, leading to further cost savings.

Real-time monitoring and control

Operators can remotely access the virtual model, observe plant operations, manage processes and monitor critical parameters in real-time. This empowers operators to make data-driven decisions, respond swiftly to anomalies and optimise plant operations from anywhere. Real-time control of processes allows dynamic adjustments and ensures optimal performance, while also providing a platform for remote troubleshooting and operational support.

Efficient resource utilisation and energy management

The virtual model can also provide detailed insights into water and energy consumption patterns, allowing operators to identify opportunities for improvement. By analysing data, operators can implement targeted strategies to reduce water and energy consumption, optimise chemical dosing and minimise waste generation. Veolia Water Technology customers have achieved up to a **100%** reduction in chemical dosing.

Regulatory compliance and reporting

Furthermore, the virtual model captures real-time data and monitors key performance indicators to confirm compliance with all regulatory standards. Operators can also generate accurate and timely reports, demonstrating adherence to water regulations. Digital twins also enable the simulation of different scenarios, helping operators evaluate the potential impact of changes in regulations or process parameters, allowing proactivity and avoiding penalties.

With decades of experience on water treatment plants around the world, Veolia Water Technologies is able to use these digital tools to help operators reduce non-compliant effluent by up to **100%.**

Addressing the skills shortage and attracting young talent

The wastewater treatment industry faces challenges in attracting skilled professionals. Digital solutions, including digital twin technologies, offer an opportunity to showcase the industry's innovation and appeal to new and young talent. In fact, the industry has much to offer those who are beginning or changing their careers. By engaging with cutting-edge technologies and real-time data analytics, professionals can contribute to a more sustainable future.

IMPLEMENTATION CONSIDERATIONS

Data acquisition and integration

Implementing digital twin technology in wastewater treatment plants requires proper data integration and infrastructure.
To harness the full potential of the technology, it is paramount to establish a reliable data acquisition system that can draw from various sources, including sensors, supervisory control and data acquisition (SCADA) systems and laboratory analysis. Additionally, investing in cloud computing platforms and scalable infrastructure ensures efficient storage, processing and analysis of the large volumes of data required.

Scalability and flexibility

These are essential considerations when implementing digital technology on this scale within wastewater treatment plants. As plants expand or undergo modifications, the technology must be able to adapt accordingly. Scalable architecture allows for seamless integration of new assets and processes over time. Furthermore, the flexibility will enable customisation to meet the specific needs and objectives of each wastewater treatment plant, ensuring performance and usability.

Data security and privacy

Ensuring data is transmitted and held securely is paramount in the implementation of digital twin technology. Wastewater treatment plants generate sensitive operational and process data that must be protected from unauthorised access and cyber threats. Investing in digital technology solutions that have robust cybersecurity measures and access controls is essential in safeguarding data integrity and ensuring privacy compliance. It is also crucial to carry out regular vulnerability assessments.

Costs and return on investment

While digital twins offer significant benefits, it is important to consider the associated costs and expected return on investment (ROI). The

Hubgrade by VEOLIA

THE ANSWER TO YOUR CHALLENGES: HUBGRADE PERFORMANCE PLANT

Hubgrade is Veolia Water Technologies' remote monitoring, process control and optimisation platform. The Hubgrade Performance package aggregates real-time data and applies analytics and algorithms, developed using our specialist experience in designing and operating water and wastewater treatment plants worldwide, to continuously benchmark and optimise the performance of the water treatment plant.

The Plant module of Hubgrade Performance creates an online digital twin of the wastewater treatment plant and/or sewer network; applies predictive AI models, real-time analysis of key parameters of the asset and delivers performance enhancing process control optimization as well as valuable insight to the operators, process engineers and plant or sewer management.

To find out more visit: https://www.veoliawatertechnologies.co.uk/services/customer-portal-remote-monitoring

implementation costs depend on various factors, including the size of the plant, complexity of processes and level of digitalisation required. However, real case studies have shown that digital twins can deliver a compelling ROI - often between 2 to 3 years - through improved plant performance, reduced maintenance expenses and optimised resource utilisation. Therefore digital twins can prove to be a worthwhile investment for wastewater treatment plants.

Training and workforce development

Successful implementation of digital twins requires training and development of staff to ensure effective utilisation of the technology. Collaborating with industry associations, universities and training providers can facilitate access to specialised training programs that meet the unique needs of wastewater treatment plant operators and foster a skilled workforce capable of maximising the benefits of digital twins.

SUCCESS STORIES

Improved operational efficiency

Ede is a 300,000 population equivalent (PE) wastewater treatment plant (WWTP) located in the central Netherlands. The plant consists of two process lines and treats 40,000 m^3 of effluent per day. An increase in plant loads over a number of years meant that compliance with EU effluent standards was a challenge. A further load increase of 20 percent was expected over the next 5 years, which meant that the Dutch water board, Waterschap Vallei en Veluwe, would have to extend the plant by adding a third process line.

To help postpone or even avoid a costly extension of the plant, Veolia Water Technologies implemented its digital twin system (now called Hubgrade Performance Plant), with a focus on optimisation of the biological treatment capacity.

Hubgrade Performance Plant has helped Ede WWTP to achieve a **100% increase in hydraulic** capacity, a 44% reduction of total nitrogen and a 60% reduction of total phosphorus without investment in a new plant. Significant OPEX savings from energy, chemical and sludge reduction were also achieved.

Cost reduction and return on investment

Nosedo Wastewater Treatment Plant is Milan's main municipal wastewater treatment facility with a 1,250,000 population equivalent. As part of a wider initiative to combat water scarcity, approximately 60 to 70% of the wastewater treated by the Nosedo plant is reused for agricultural purposes.

For Nosedo, Hubgrade Performance provides critical water quality data and ensures processes are optimised to steadily reuse standard quality treated wastewater at minimum cost. A 20% higher hydraulic capacity has been achieved while reducing chemical coagulant usage by 58%, lowering sludge volumes by 114 tonnes per year and reducing energy consumption. In the third year of operation the OPEX savings amounted to **€1,200,000** compared to an initial target of €400,000 per year.

Environmental sustainability and regulatory compliance

Klaipeda Wastewater Treatment Plant is a 350,000 PE facility that has been in operation since 1998. Klaipeda is the main Lithuanian seaport and the country's third largest city. With ever increasing treatment requirements, the plant came to a point when it was nearing its maximum capacity, and effluent quality was extremely close to the permit limit of 10 mg/l tot-N (total nitrogen).

The results for the first 12 months following the implementation of Hubgrade Performance were excellent. There was an 11% reduction in effluent concentration of total nitrogen, an **85% reduction in carbon dosing,** a 41% and 34% decrease in energy used for mixing and recirculation respectively. In addition, only an 8% increase in aeration was required to handle the 28% increase in treatment load during those 12 months.

OVERCOMING CHALLENGES

Implementing digital twin technologies in wastewater treatment plants can bring numerous benefits, but it also comes with its fair share of challenges. By proactively addressing these challenges and cooperating with specialist digital solution providers, plants can successfully implement and maximise the value of their digital twin initiatives.

Initial investment and ROI justification

One of the primary challenges in adopting digital twin technology is the initial investment required for technology acquisition, infrastructure development and workforce training. Wastewater treatment plants typically need to justify the return on investment to secure funding and support from stakeholders. Conducting a comprehensive cost-benefit analysis is crucial to address this challenge. This analysis should consider factors such as operational efficiencies, energy savings, maintenance cost reductions and improved regulatory compliance. By quantifying the potential benefits and showcasing a compelling business case, plants can secure the necessary financial resources.

Data quality and standardisation

This is vital for the success of digitalisation initiatives. Wastewater treatment plants collect data from various sources and systems, leading to issues such as inconsistent formats and inaccuracies. To overcome this challenge, plants should establish data quality protocols and standardisation practices and implement data governance frameworks. By investing in data validation processes, data cleansing tools and data integration platforms, plants can ensure reliable and accurate modelling within the digital twin environment.

Interoperability and system integration

The integration of digital twins requires real interoperability and seamless integration of multiple systems and technologies. Legacy systems, disparate data sources and complex infrastructure can pose challenges to achieving interoperability. To address this, plants should adopt open standards and protocols that facilitate system integration. These standards, such as OPC-UA and MQTT, enable data exchange between different systems and devices. It is always valuable to look at industry best practices and collaborate with technology providers to overcome these challenges and create a cohesive digital ecosystem.

Future trends and opportunities

As the wastewater treatment industry continues to evolve, certain trends are poised to shape the adoption and implementation of digital technology. These trends will see the leveraging of emerging technologies and offer exciting possibilities for improved operational efficiency, enhanced decision-making and more sustainable wastewater treatment practices.

Integration of artificial intelligence and machine learning

The integration of artificial intelligence (AI) and machine learning (ML) holds tremendous potential for enhancing the capabilities of digital twins. By leveraging AI and ML algorithms, digital twins can analyse vast amounts of data, detect patterns and make predictive and prescriptive recommendations. Additionally, AI and ML enables proactive maintenance by predicting equipment failures and optimising maintenance schedules. By embracing AI and ML technologies within digital twins, wastewater treatment plants can unlock new levels of automation, intelligence and sustainability.

Advanced analytics and decision support systems

These systems play a crucial role in leveraging the digital twin data available. By applying advanced analytics techniques such as data mining, statistical modelling and predictive analytics, wastewater treatment plants can gain deeper insights into their operations. Decision support systems powered by advanced analytics can provide operators with real-time recommendations and actionable insights, enabling more informed decision-making. These systems can assist in process optimisation, energy management, asset performance optimisation and resource allocation.

CONCLUSION

The adoption of digital twin technology for wastewater treatment plants offers significant opportunities for the industry to address challenges, improve operational efficiency and pave the way for a sustainable future. As such it is crucial for plant managers and decision makers, industry leaders, and stakeholders to recognise the potential. In addition, by embracing digital technologies wastewater treatment plants can demonstrate the technologically advanced solutions of the industry that attract new talent while also driving innovation and ultimately fulfilling their role in providing safe and clean water to communities.

To find out more about Hubgrade Performance Plant and Veolia Water Technologies' digital solutions visit: www.veoliawatertechnologies.co.uk/hubgrade-performance

This White Paper has been written by the experts of Veolia Water Technologies - Louis Larsen, Mathieu Lamotte.

Resourcing the world

Veolia Water Technologies
Windsor Court, Kingsmead Business Park, High Wycombe HP11 1JU
tel. + 44 (0) 1628 897000
sales.watertech@veolia.com • www.veoliawatertechnologies.co.uk