Why is industrial wastewater difficult to treat?

Industrial groups are striving to treat their wastewater in the best possible environmental and economic conditions.

The Veolia Group supports them in their environmental approach and search for compliance, performance, reliability and safety. Technological innovations are crucial for optimizing the pollution control of these multiple and complex types of wastewater. Development of analytical methods, improvement in existing processes, configuration of global treatment lines: the Water Research Center works in several areas, with a specific focus on saline wastewater, which is a significant issue in numerous industries and is very difficult to treat. Its advances contribute to the preservation of ecosystems by avoiding the direct discharge of untreated industrial wastewater into the natural environment and sparing natural resources.
What is industrial wastewater?

“It consists of liquid discharges generated by raw material extraction or transformation processes with a view to manufacturing industrial products or consumer goods. This type of water is extremely heterogeneous. Its quantity and quality vary depending on the process implemented and industrial domain. It often contains a broad range of chemical pollutants: solid or dissolved compounds, organic and mineral materials, metals, hydrocarbons, solvents, polymers, oil, grease, salts etc., with various toxicity levels. This large diversity requires a specific approach for each type of wastewater. We are talking about tailor-made work! We must be able to provide, for each type of wastewater, a process with the performance and reliability criteria meeting regulatory discharge and safety requirements, economic constraints and even sometimes the more specific constraints of the industrial client, such as available space. The treatment of production water on an oil rig in the North Sea poses different problems than a refinery with several acres of land! We must adjust our solutions to each specific problem. We are talking about tailor-made work! We must be able to provide, for each type of wastewater, a process with the performance and reliability criteria meeting regulatory discharge and safety requirements, economic constraints and even sometimes the more specific constraints of the industrial client, such as available space. The treatment of production water on an oil rig in the North Sea poses different problems than a refinery with several acres of land! We must adjust our solutions to each specific problem. We are talking about tailor-made work! We must be able to provide, for each type of wastewater, a process with the performance and reliability criteria meeting regulatory discharge and safety requirements, economic constraints and even sometimes the more specific constraints of the industrial client, such as available space. The treatment of production water on an oil rig in the North Sea poses different problems than a refinery with several acres of land! We must adjust our solutions to each specific problem. We are talking about tailor-made work! We must be able to provide, for each type of wastewater, a process with the performance and reliability criteria meeting regulatory discharge and safety requirements, economic constraints and even sometimes the more specific constraints of the industrial client, such as available space. The treatment of production water on an oil rig in the North Sea poses different problems than a refinery with several acres of land! We must adjust our solutions to each specific problem. We are talking about tailor-made work! We must be able to provide, for each type of wastewater, a process with the performance and reliability criteria meeting regulatory discharge and safety requirements, economic constraints and even sometimes the more specific constraints of the industrial client, such as available space. The treatment of production water on an oil rig in the North Sea poses different problems than a refinery with several acres of land! We must adjust our solutions to each specific problem.

What is the emphasis on saline wastewater?

“A lot of industries generate saline wastewater. For example, it plays a large part in the wastewater generated by the chemical, food and beverage (cured products) and tanning industries. It is also present in landfills (leachates). In addition, saline wastewater is difficult to treat: most of the time, it contains high amounts of salts – such as sulfates, chlorides or sodium – and organic materials. This mix creates problems. The treatment technologies currently used are often efficient for one specific type of pollutants, saline or organic; but the challenge is to manage a combination of processes without however impeding their respective efficiency. For example, the presence of salts can significantly disrupt the running of biological processes applicable to organic wastewater, which explains the importance of constantly improving our knowledge of saline wastewater, in order to develop increasingly efficient processes.”

What is the impact of saline wastewater when discharged untreated into streams?

“Saline wastewater does not have the same toxicity image as other compounds such as cyanide for example. However, when heavily concentrated, it can lead to an “osmotic shock” phenomenon at its point of discharge, i.e. sizeable disruption affecting local animal and plant life. Of course, this phenomenon rapidly reduces as the distance from the point of discharge increases, because of the diminishing concentration. In specific hydrogeological contexts, saline wastewater discharge can also cause groundwater salinization and result in brackish water.”

What are the regulatory constraints relative to industrial wastewater?

“European discharge standards are enforced with regard to local situations. In France, depending on their activity, certain facilities are labeled ICPE (Facilities subject to Environmental Protection Statutes) and, in this respect, must comply with the discharge authorizations defined (by Prefectoral Order) by the DRIRE (Regional Directorates for Industry, Research and the Environment). Threshold discharge values are established by taking into account the nature of the pollutant, the cha-
characteristics and sensitivity of the milieu into which the pollutant is discharged: stream flow rate, sensitive area, milieu listed in a sensitive area, presence of bathing water or drinking water supply resources nearby etc. Maximum discharge limits are expressed in terms of flow (quantity discharged per day) and concentration (mg/L) to avoid pollution peaks.”

**What are the objectives of R&D work on industrial wastewater?**

“Our primary objective is to constantly improve treatment processes so that the wastewater discharged into the natural environment complies with the regulation. Our research platform on industrial wastewater implements different processes (thermal, physical-chemical, biological, membrane technologies) to separate the liquid matrix of the substances it contains. One of R&D’s priorities is to optimize these existing processes. We are also trying to recover wastewater as much as possible, either by recycling the treated water or by using some of its compounds in new production processes. Technological advances are crucial for preserving ecosystems and sparing natural resources.”

**What are the ways of improving treatment processes?**

“Improving treatment processes means, above all, optimizing their efficiency and making them more reliable, from a technical and economic perspective. Increasing treatment efficiency, reducing energy consumption, making them more reliable and sustainable, meeting safety requirements, sometimes even minimizing the footprint: all this must help our clients reduce their pollutant emissions at a reduced cost and control industrial risks. Therefore, we are wholeheartedly committed to examining the potential of existing technologies and developing new ones by taking these criteria into consideration. This approach can apply to a single process or a complete treatment line.”

**Can you tell us about some of the innovative technologies?**

“We are designing advanced process steering systems to help staff operate their structures. The development of on-line analysis tools provides real-time information, which can result in improving process efficiency and reliability. The real-
time adjustment of the optimal chemical dosage within a process makes it possible to minimize non-compliance risks for the wastewater treated, but also to optimize costs. Insufficient dosage would reduce treatment efficiency. Excessive dosage would generate cost overruns and may create malfunctions...

Modeling is also an innovative tool used to help gauging a process or to provide solutions to certain types of malfunctions. Innovations also focus on developing wastewater characterization tools. Dynamically assessing wastewater variability and providing operators with real-time information on the changing quality of the wastewater to be treated has a major impact on the reliability of the process implemented.

The range of processes or technologies used in water treatment is considerable! As a result, innovation also frequently focuses on improving existing technologies and designing processes better suited to the different constraints.

**Do you work on groundbreaking technologies?**

“We just filed for a patent for a new type of heat exchanger, for which the technology used is genuinely groundbreaking compared with the existing ones. The prototype will be tested on the Bouqueval research platform. It should generate lower manufacturing costs than traditional exchangers and enhanced modularity adapted to the requirements – according to the wastewater flow rate for example.

We are also trying to transfer technologies used in various industrial areas to the water treatment domain, which can result in totally new concepts.”

**What about material recovery?**

“This is also one of our main objectives. We must find ways to isolate the compounds that can be recovered. Wastewater often includes materials, dissolved or otherwise, which could be reused in a production process, in order to limit the amount of waste and spare natural resources – in particular costly rare metals. In Bouqueval, we are testing an ammonium sulfate production system to be used as fertilizer, generated by waste containing ammonium. Waste can become a raw material. This is one of the principles of industrial ecology, inspired by the way ecosystems operate.”

---

**Sulfuric acid discharge recovered as gypsum: a step towards industrial ecology**

Specializing in the production of titanium-based compounds, used in particular to manufacture paints and surface coatings, the Millennium Chemicals plant, located in Le Havre, generates 700 m³/hour of acid wastewater (sulfuric acid and organic materials), which is dispatched for treatment via pipelines to Veolia Water’s Hode plant, situated ten kilometers away. Veolia Water reduces its pollution load, in compliance with the regulation, before discharging it into the Seine river, and recovers part of it as white gypsum, which is used to manufacture plasterboard partition walls in a nearby cement plant.
The research program carried out in Bouqueval relates to a specific saline wastewater category: landfill leachates. From the Latin lixivia, meaning washing, and commonly called “waste juice”, they are formed by biodegradables waste deterioration and rainwater seepage. They contain organic materials, salts (sulfates, chlorides, ammonium) and hydrogencarbonate. They are collected by a drainage system and treated.

Four treatment processes

Ten Veolia researchers apply several treatment categories to the leachates: thermal, with evaporation processes (water evaporation and pollution concentration); biological treatment, using supports onto which microorganisms are attached, like polystyrene balls for example; physical-chemical processes (treatment by chemical addition) and membrane processes, to filter micro-pollutants. The research team develops characterization tools, assesses process performance, the pros and cons as well as costs. It also tests different mixes in order to find optimal combinations, which can be offered in the form of complete treatment “kits”.

Global process configuration

Among the results of the work carried out since 2005, heat exchanger modularity should be highlighted (see interview with Jean Cantet), as should process optimization. For example, for the “evaporation” process, the energy consumption of the treatment process was reduced – by replacing the heat pumps with mechanical steam compression systems using a combination of technologies. Clogging problems are also controlled by the upstream application of a decarbonation process softening the wastewater. Finally, a process designed to recover the ammonium present in distillates (leftover residue in steam) was tested. Filtered by a membrane, the ammonium is transformed into ammonia which, once submerged in a sulfuric acid stream, creates ammonium sulfate – a substance used as fertilizer. Waste is thus transformed into a resource. Following the intrinsic performance analysis of each process, their economic assessment will be carried out in 2007. Once validated, these technologies will be implemented to treat leachates, the saline wastewater generated by the food and beverage, chemical and tanning industries, or even other types of industrial wastewater.
Respectively located in Houston (Texas) and Pittsburgh (Pennsylvania), Process Solution and North America Water System market the 3 physical-chemical crystallization & precipitation processes owned exclusively by the Group: Hardtac, Dense Sludge and Multiflow Turbomix. Mainly used to treat wastewater generated by the inorganic chemical and mining industry, the principle of these processes is relatively similar: produce crystals by adding chemicals and precipitate them. However, they each have their own specific characteristics. Faced with a given problem (initial wastewater quality and objectives set), which is the best suited?

In-depth comparative assessment

In order to help operators decide, researchers review the three technologies.

The objective is to design an assessment grid according to the initial wastewater characteristics and specifications to be complied with after treatment. These specifications relate, for example, to particle-size distribution or sludge or crystal quality. Using pilots, the water research Center conducted in-depth studies on the running of each process, their gauging criteria and operating conditions (effect of agitation speed, chemical concentration, injection points, temperature…). While the objective is to optimize their usage, this screening process is also a way to improve their respective efficiency. Initiated in 2006, it will result in a decision-making tool, used to increase their deployment on the group’s North American market and other markets.
Increase our knowledge of wastewater in order to improve pollution treatment

It is necessary to increase our knowledge of wastewater, i.e. identify the nature and concentration of the pollutants it contains, in order to apply the most appropriate treatment solution: that which will result in the highest treatment rate at the best possible cost and, if required, recover pollutants. In light of wastewater complexity and clashes of compounds, Veolia’s researchers must often develop their own analytical tools to obtain reliable data.

The crucial analysis stage

The existing measurement tools in the water sector are not always sufficient to analyze industrial wastewater: their results are sometimes distorted by disruptive elements! For example, in the case of saline wastewater (which most of the time contains a fraction of organic material), the presence of salts alters the analysis of the organic material. To be able to characterize this organic material, a laboratory technique must therefore be created to separate salts while preserving its initial characteristics. This is what the water research Center did. Researchers found a way to condition saline wastewater samples so that the tools used to measure the organic material concentration can be applied without interference.

“Veolia’s researchers must often develop their own analytical tools to obtain reliable data.”
**3 QUESTIONS FOR...**

**Marine Noël**

*Marine Noël, Marketing Director for Veolia’s industrial market division.*

---

**What is the industrial groups’ major concern with regard to wastewater treatment?**

“One of their main concerns is to respect the law. Industrial groups want to comply with regulatory requirements with regard to their sites’ liquid discharge into the environment. Their environmental commitment exceeds mere regulatory requirements: it is reinforced as companies are increasingly evaluated in light of their sustainable development performance. Another concern is to minimize the costs incurred by their wastewater treatment facilities by improving their productivity. Finally, certain industrial groups choose to focus their resources on the management of their production structures and free themselves of the peripheral functions such as wastewater treatment. All these concerns lead many of them to contract a specialist guaranteeing technical, economic and environmental performance while constantly complying with the regulation.”

**What do you expect from your service provider?**

“Our industrial clients expect from us a technical performance totally in keeping with our contractual commitments and a substantial saving in the running of their facilities – compared with direct management costs. They keep a watchful eye on the safety of people and equipment, demanding unfailing safety performance and management. They also require that the launch of the delegation contract be seamless. They expect regular activity reports in order to assess our performance and respond to any statutory control. Finally, in case of incidents, they must be informed and problems must be solved immediately.”

**What do your efforts focus on?**

“Each project requires a specific technical, economic, contractual and organizational solution, as each stream reflects the production of a unique plant. Most of our added value lies in our capacity to understand each industrial process in order to accurately analyze wastewater quality and apply the best suited treatment solution. Beyond our technical expertise, we must also be capable of supporting the plant’s evolutions in production: manufacturing a new product, changing a manufacturing process, switching from 7 to 5 day production... All these events have an impact on the volume and characteristics of the wastewater to be treated and require a lot of flexibility. We also adapt our offer to each industrial sector. When required, we integrate water management into a global industrial utility management contract. Finally, we pay close attention to recycling solutions to limit water withdrawals. Our efforts focus on industrial wastewater recycling on site (to be used in fire protection, washing of external areas, cooling water etc.). They also relate to recycling the domestic wastewater treated in an industrial environment. We put this type of arrangement in place in highly water-deficient countries such as the Republic of South Africa, Australia, Singapore, Honolulu...”