

## **Elimination of active pharmaceutical ingredients (APIs) and other problematic components from wastewater**

Pharmaceuticals and their metabolites are detected on an increasing scale in the aquatic environment. The pharmaceuticals (such as drugs) mostly get into the surface and drinking water through the excretions of humans and animals; however, the wastewater of pharmaceutical production facilities can also be contaminated with active ingredients.

The production of pharmaceuticals takes place in two steps. In a first step, APIs as the central ingredients are produced by raw material. APIs can incorporate all kind of active substances such as antibiotics, or chemical products such as paracetamol or other special products. The excipient is the inactive substance in the drug that is mixed with the active substances into tablets, filled capsules or solutions.

This article mainly addresses the production of APIs. Driven by lower costs, API production has slowly been shifting to new firms – especially in India and China.

During the production process, wastewater containing the APIs is created as a by-product of cleaning processes. Today, pharmaceutical products have become a serious problem to the aquatic environment. More specifically, when antibiotics end up making their way into the environment with the discharged wastewater, this really can pose a serious threat. This is due to the fact that highly dangerous, multi-resistant bacteria can be generated in this environment and subsequently transported all over the world.

With the above in mind, technologies are required that treat the arising wastewater and eliminate these APIs before they are discharged into the environment. It is also essential to ensure that the APIs are not simply separated from the wastewater (by means of a membrane process or activated carbon, for example), as this will only shift the problem elsewhere. Ultimately, what is needed is a technology to destroy the APIs.

### **EnviroChemie provides the proven Envirochem AOP technology for this exact purpose.**

EnviroChemie has more than 40 years of experience with this technology. The concept is to destroy these components through a combination of UV/ hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) or ozone (O<sub>3</sub>), with other special applications also available.

EnviroChemie engineers are able to call upon their extensive experience to develop customised solutions, which include the following steps:

- On-site visit to determine all wastewater streams
- Laboratory test or test with pilot plants on site
- System scale-up
- Design, delivery, installation and commissioning of the system
- Aftersales support

## Practical examples of API elimination

### 1. Efficient decomposition of pharmaceuticals through ozonisation

Roche AG commissioned EnviroChemie to develop a new procedure for a new production facility in Mexico. This procedure was designed to not only prevent the undesired release of ecotoxicologically contaminating drugs into the environment, but also eliminate pharmaceuticals in the wastewater directly at the point of origin before they enter the general sewage treatment plant. In the first step, the three different methods of UV/H<sub>2</sub>O<sub>2</sub> oxidation, ozone oxidation and adsorption on activated carbon were tested on a laboratory scale, and evaluated with regard to their ecological and economical aspects. When comparing the validated procedures, ozonisation proved to be the most effective method in this specific case when it came to efficiently destroying the active ingredients in the wastewater both safely and completely. Based on these results, EnviroChemie's second step involved designing and implementing a large-scale technical plant.

The Roche production site in Mexico is home to the production of two highly effective medications for the treatment of cancer. In-depth analyses have shown that the two agents Capecitabin (Xeloda) and Mycophenolat Mofetil (Cellcept) could be ecologically critical and should therefore not enter the wastewater. During galenic production, approximately 10,000 litres of wastewater are generated daily, which need to be processed. Only one agent is treated per day. Roche commissioned EnviroChemie to test different procedures for decomposing Mycophenolat Mofetil on a laboratory scale and to implement the results in a large-scale technical plant. The aim was to find a cost-effective and, at the same time, affordable method with which the drugs could be fully eliminated. Tests with Capecitabin were carried out in the Institute for Energy Management and Environmental Engineering in Duisburg (IUTA), Germany. Tests for adsorption on activated carbon were performed at Roche Basel in Switzerland.

The specifications for the technology are:

- Deliver reliable results
- Ensure a very high level of operational safety
- Provide a high degree of automation
- Offer a compact construction for the processing plant
- Ensure minimal handling of chemicals
- Generate as little waste as possible

EnviroChemie showed that the two agents can essentially be removed from the wastewater via all three methods. In the present case, ozone treatment of the wastewater best met the requirements within the scope of the patented EnviroChemie technology by EnviroChemie and proved to be the optimum method.

The obtained data was used as a basis to develop an individually adapted wastewater processing plant that meets all requirements. The resulting EnviroChemie system is housed completely in a six-metre-long EnviModul container and is designed to run fully automatically 24 hours a day, so that the wastewater can be treated in a continuous process. The system is equipped with software that enables simple operation of all installed elements and allows

the complete process to be visualised. The user can access the measurement values and the process runs at any time. The generated data is displayed in a table and can be archived easily. An optional system enables remote maintenance and control measures by EnviroChemie to ensure action can be taken quickly in the event of an emergency.

The plant solution was commissioned in Mexico under the guidance of EnviroChemie. All measuring instruments and process control systems for the equipment pre-installed in the EnviModul – including a breakdown – were tested in Germany. In order to verify the functionality of the system, a factory acceptance test (FAT) was performed together with Roche.



Image: Elimination of APIs with ozonisation

## 2. Elimination of APIs with UV/hydrogen peroxide

In this application for a producer of pharmaceuticals, the Envirochem AOP wastewater oxidation technology – with its combination of UV/H<sub>2</sub>O<sub>2</sub> – was selected in cooperation with the client.

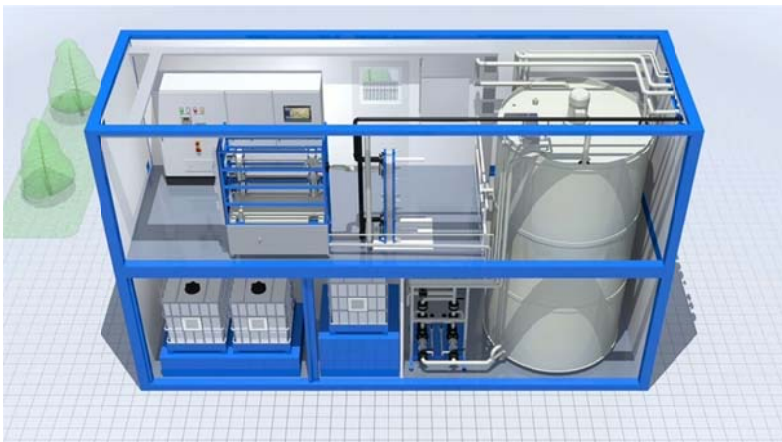


Image: Compact installation of all plant components for the elimination of APIs in an EnviModul



Image: This complete technology can be installed in EnviModul.



Image: Enviochem AOP plant installation; inside view of an EnviModul

### 3. Wastewater inactivation

Another type of wastewater is the contaminated wastewater arising from the production of vaccines. This wastewater can contain viruses, and a different type of technology is required in order to eliminate these in the form of Enviochem DTS thermal disinfection. With this technology the viruses are eliminated by heating the wastewater to a certain temperature (such as 125°C) and a certain retention time (for example, 20 minutes).



Image: EnviroDTS continuous wastewater inactivation



Image: EnviroDTS wastewater inactivation plant

### **Zero liquid discharge (ZLD)**

Once these components – which are extremely dangerous harmful to health – have been eliminated, further treatment may still be required. This is because the wastewater still contains organic and inorganic components that cannot be discharged. To this end, EnviroChemie offers technology-based solutions for the zero liquid discharge concept. These concepts are necessary in plants where no access to sufficient public sewers and treatment systems is available and it is not possible to discharge into rivers due to the remaining contamination. These concepts are a combination of the Biomar biological technology, the Envopur membrane process and the Envochem evaporation process.



Image: EnviroChemie Envopur technology (view of the workshop)



Image: Envirochem evaporator plant unit

## **Conclusion**

The contamination of the environment with pharmaceutical products (especially antibiotics) and the serious problems arising as a result –such as the formation of multi-resistant bacteria – require measures to be taken to ensure that these products will not end up in rivers and in the sea during the production process.

Due to the company's long-standing experience with the aforementioned proven technologies, EnviroChemie can provide a complete service from the development of the most economic technology in cooperation with the client right through to ZLD concepts.

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