06 May 2016
Issue 455
Subscribe to free weekly News Alert

Source: Chen, X., Vollertsen, J., Nielsen, J., Gieraltowska Dall, A. & Bester, K. (2015). Degradation of PPCPs in activated sludge from different WWTPs in Denmark. *Ecotoxicology*, 24(10): 2073–2080. DOI 10.1007/s10646-015-1548-z

Contact: kb@envs.au.dk

Read more about:
Chemicals, Environment and health, Waste

European Commission

Science for Environment Policy

Biodegradation of PPCPs in wastewater treatment plants — a Danish case study

The non-restricted production and use of pharmaceuticals and personal care products (PPCPs) has led to their presence in effluents from treatment plants, which can pose a threat to aquatic organisms downstream. This study analysed the breakdown of six common chemicals in four Danish treatment plants. The findings shed new light on the factors affecting removal of PPCPs from waste, showing that the composition of waste is more important than the design of the treatment plant.

PPCPs are a large group of chemicals including drugs, shampoos, soaps, fragrances and cosmetics. Following use, PPCPs are generally excreted into the sewage system. The main aim of urban wastewater treatment plants (WWTPs) is to minimise the amount of organic pollution, pathogens and nutrients in untreated waste water, that would otherwise adversely affect the nearby water bodies, soils and the environment in general. It is not the primary objective of the treatment plants to remove all the polluting substances that can be found in urban wastewater; for instance, PPCPs are not totally removed and can, therefore, be released into surface waters (or onto land, as sewage effluent is sometimes used as a fertiliser), where they may have negative effects on nearby biota[1].

PPCPs have been detected in natural environments worldwide. Although they have been found at low concentrations (generally in the nanogram-per-litre range), research has shown that some PPCPs can have an environmental impact even at these low concentrations.

This study focused on three PPCPs in particular: non-steroidal anti-inflammatory drugs (NSAIDs), the anti-convulsant carbamazepine, and the antibacterial compound triclosan, all of which have been detected at ecologically relevant levels in sewage effluents, surface water, rivers and sediment.

Studies have shown that these compounds can exert a large biological effect even at very low concentrations. In some cases, concentrations have been sufficient to disrupt the endocrine systems of aquatic organisms, which means they could have effects including feminisation of male fish, impaired growth and mortality.

This study looked at how these substances are biodegraded (broken down by bacteria or fungi) in treatment plants. PPCPs can be broken down in 'activated sludge', waste which contains microorganisms cultivated to break down organic matter. Although this is a common process for treating sewage and generally considered the most effective process for removing PPCPs from wastewater, the rate of biodegradation in activated sludge is low for most compounds.

However, degradation rates vary widely between WWTPs. To determine the factors that affect the rate of degradation, this study measured the breakdown rates of six PPCPs — four NSAIDs (naproxen, ketoprofen, fenoprofen and diclofenac), carbamazepine, and triclosan — by activated sludge systems. They compared the degradation rate of the PPCPs in sludge collected from four WWTPs in Denmark, each representing a different design. The plants differed in terms of their overall capacity, average flow, operating temperature, sludge retention time (the time the activated sludge is in the treatment system) and methods of nitrogen and phosphorus removal, for example.

Continued on next page.

1. When the treated waste-water discharges negatively affect the quality of a water body, it is the Water Framework Directive that regulates and decides the need to remove them, the thresholds to be reached and, if need be, the necessary measures that should be taken by the responsible authorities under the corresponding river-basin management plan(s) (e.g. at treatment plant level, at preventive level, etc.).

European Commission

Science for Environment Policy

Biodegradation of PPCPs in wastewater treatment plants (WWTPs) — a Danish case study *(continued)*

06 May 2016
Issue 455
Subscribe to free weekly News Alert

Sludge from each plant was incubated in a glass reactor for five days, with PPCPs at a concentration of 0.1 milligrams per litre. Although this concentration is higher than would be expected in municipal WWTPs, it enabled the team to identify the concentration decrease due to biodegradation of the compounds.

The most rapidly degraded chemicals were the NSAIDs, followed by triclosan. However, diclofenac (also an NSAID) did not break down, as was the case for carbamazepine. Degradation rates may differ between compounds due to different physical and chemical characteristics, which may explain why some chemicals showed consistently high degradation rates while others were persistent.

There were also differences between treatment plants. For example, fenoprofen was removed with a half-life of two hours in the reactor with sludge from Aalborg West, while its half-life in the Aalborg East sludge was 25 hours.

Factors that influence the breakdown of PPCPs include biomass concentration, sludge retention time, temperature and pH. The physico-chemical conditions of the treatment process can also have an influence, but in this study were kept the same between bioreactors. Furthermore, all bioreactors were kept at room temperature and no pH changes were detected.

Although biomass concentration is thought to be important in the degradation of chemical pollutants, the researchers could not find any correlation with PPCP degradation. However, sludge retention time was associated with PPCP degradation. The optimal time was found to be between 14 and 20 days. With retention times under 14 days, less degradation was likely to occur, but retention periods above 20 days did not improve PPCP degradation any further.

Overall, the researchers conclude the biological composition of the sludge itself (e.g. the number of specialised microbes it contains) is more important for degradation than the design of the treatment plant.

Source: Chen, X., Vollertsen, J., Nielsen, J., Gieraltowska Dall, A. & Bester, K. (2015). Degradation of PPCPs in activated sludge from different WWTPs in Denmark. *Ecotoxicology*, 24(10): 2073–2080. DOI 10.1007/s10646-015-1548-z

Contact: kb@envs.au.dk

Read more about:
Chemicals, Environment and health, Waste