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Health Warning

drugs and cosmetics in our wastewater

By Heather Kent

DEALING WITH PHARMACEUTICALS AND PERSONAL CARE PRODUCTS COULD BE A COSTLY PROBLEM FOR THE WASTEWATER INDUSTRY.

Every day, residual metabolites from an estimated 4,000-10,000 pharmaceutical compounds and active ingredients in personal care products such as cosmetics and toiletries enter Canada's wastewater systems.

"We are facing a huge issue of thousands of chemical products that are going down the drain," says Duncan Ellison, chief executive officer of the Canadian Water and Wastewater Association in Ottawa. "You can't deal with this at the end of the wastewater pipe. If we can treat the substance, we will. If we can't, someone has to stop it from getting into the system."

The issue of how to deal with pharmaceuticals and personal care products -- known collectively as PPCPs -- has been an emerging issue to environmentalists for the past 10 years. For the wastewater industry it could end up being a costly problem. At present, however, it is not clear what the environmental and health dangers of these chemicals might be.

"We have a reasonable amount of data about some substances and none about others," says Ellison. "There seems to be a very strong view that since these substances are coming from wastewater treatment plants, they have to invest millions of dollars in ozonation and other technologies. But these are effective against only a very narrow range of substances -- maybe only 5% to 10%. Our association has been urging authorities to think prevention rather than treatment," Ellison says.

Dr. Joanne Parrott, an aquatic toxicologist and research scientist with Environment Canada in Burlington, Ontario, estimates about 4,000 substances are entering wastewater plants, and of those, only about 150 have been detected and can be tested at the end of treatment processing.

She admits that we are only "scratching the surface" of the problem. "In terms of the degradation of all of these compounds," Parrott says, "if we had to pick the worst 10, it would be really hard to say definitively which ones to choose. We would probably be wrong on about half of them."

"Testing is in its infancy because it is so difficult," Parrott explains. Some pharmaceuticals are water soluble, others lipid soluble, and yet others are activated in the human body and when excreted can be freed up as different molecules. And technology to detect pharmaceutical residues in wastewater in the parts-per-billion and per-trillion range has only been available for

the past five to 10 years.

Take aspirin for example. While 99% of aspirin can be broken down during treatment, says Parrott, the scale of its use means the residual amount may be an environmental problem. There is evidence that anti-depressant residuals may cause damage to fish. The worst case scenario occurs when the breakdown compound is equally potent as the parent compound, as is the case with Fluoxetine (Prozac). She explains that the metabolites of substances have been measured in just 10 drugs to date.

In Canada, a colleague of Parrott's, Dr. Jim Sherry, is researching the effects of municipal wastewater effluents by caging fish such as rainbow trout downstream of wastewater plants. Estrogens in some effluents can feminize males, causing increases in egg protein, and in rare cases causing eggs to develop in testes. Parrott says they don't really know whether estrogens, or some other compounds, are the main problem, but says certainly, "evidence is building that some effluents are causing effects in exposed fish."

Can we remove them?

Mike Pearce, P.Eng., a senior process engineer with Associated Engineering in Toronto, confirms the complexity of dealing with the wide range of pharmaceutical compounds entering wastewater plants. Some PPCPs are biologically treatable, Pearce explains, which means they can be treated using activated sludge processes which are commonly used for secondary treatment in municipal plants. However, many PPCPs do not respond to these conventional treatments and require separate treatment processes.

The cost of upgrading older, wastewater plants is already an ongoing challenge. Provinces require municipalities to provide wastewater treatment systems but local governments bear the operating costs.

Ellison explains that both ozone and chlorine are effective at treating some PPCPs but not all. "Ozone is the stronger of the two substances," explains Ellison, "but is more difficult to transport and therefore requires on-site generation. Chlorine has been used for more than 80 years. However, municipalities are moving towards ozonation in addition to, or in place of, disinfection by chlorine for reasons not related to PPCPs but because of the problem with chloramines. In Ontario, many large chlorination plants plan to convert to ozonation as costs permit. Quebec has long used ozonation methods in preference to chlorine.

According to Ellison, a combination of ultraviolet treatment and ozonation appears to be optimal. Other measures can include microfiltration techniques such as reverse osmosis, which is capable of removing larger chemicals from the effluent. "But then what do you do with the concentrate?" he asks.

Prevention first

Regulatory initiatives to address the issues of PPCPs are in progress. A recently formed federal government Environmental Assessment Working Group of Health Canada, Environment Canada, pharmaceutical industry and environmental group representatives has begun work to recommend procedures for the environmental risk assessment of substances that fall under the Food & Drugs Act such as PPCPs.

And Parrott says that pharmaceutical companies "are more and more aware" of the need to assess the potential environmental impacts of their products. But she also says that experience in Europe suggests that "an unfavourable environmental assessment won't usually stop approval of a drug." The question of PPCPs is an exercise in seeking balance between the assumed benefits of a drug to human health and the perceived risks to the environment, Parrott says.

What about the U.S.?

Dr. Diana Aga, an assistant professor of chemistry at the University of Buffalo, explains that the U.S. Environmental Protection Agency has been identifying active contaminants in wastewater plants since 2005 and is now working with eco-toxicologists on which compounds to regulate first. Estrogens, are at the top of the list, says Aga. A study of carp in Lake Erie found a protein marker was present in 50% of the fish. While PCBs may also be a contributing factor, the many wastewater discharge locations in the lake make residual compounds another likely contributor.

Aga is investigating the long-term effects of residual compounds on agricultural plants. Synthetic hormones and residual antibiotic metabolites are major environmental concerns, she says. Research on pinto bean crops suggests that tetracycline antibiotic residues in soil manure could be stunting plant growth.

She says the U.S. is considering new procedures to dispose of unused chemicals in landfills instead of wastewater plants, and it is considering requiring wastewater plants to remove pharmaceutical compounds at the initial stage of treatment.

Facing an unknown future

In Canada Ellison waits for a definitive statement from the federal government regarding the status of pharmaceuticals and cosmetics entering wastewater systems. "Either, tell us they are not of concern or make changes to their formulation if they are," he says.

Pearce of Associated Engineering sees regulations and technology are moving forward in tandem. "The nature of the problem becomes more complicated the more we learn about it. That's where we are at -- the science is evolving, driven by research and development and regulations."

Parrott looks on the positive side. She says the development of further tests "will tell us more about the potential environmental risks, which will help us make some decisions on which compounds to allow where." Hopefully, she says, we may eventually feel better about some compounds we are using. "Just because you can detect very low levels chemically, doesn't mean there will be a risk."

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