The destruction of endocrine disruptors in wastewater

In Canada, endocrine disruptors are a very topical issue in wastewater effluent quality. We define endocrine disruptors as chemicals that can interfere with the endocrine or hormone systems in wildlife and humans. Results can vary from different forms of cancer, birth defects and developmental disorders. Since these substances are considered to represent a chronic toxicity issue, and since federal wastewater treatment regulations have focused acutely toxic substances such as ammonia, nitrates/nitrites, suspended solids and carbonaceous biochemical oxygen demanding matter (BOD) their treatment has been not been overtly considered since they do not cause acute toxicity at the end of the pipe.

Endocrine disruptors (EDCs) EDCs come from a variety of sources such as industrial run-off, personal care products, hormone based contraceptives, leachate from a variety of plastics and even medicine from hospital waste. Importantly, certain chemicals have different concentrations in wastewater effluent and different potencies. We targeted those endocrine disruptors that have high concentrations and high potency to research potential EDC treatment methods and policy responses.

Sources and attributes
17beta-Estradiol (E2) is a synthetic and naturally occurring steroid hormone. As a medication, E2 is frequently used in hormone replacement therapy and for birth-control. E2 is also produced in women and men naturally. For women, this is largely during the developmental stages and during fertile adulthood. This compound usually enters the wastewater stream through normal bodily functions.

Effects on fish
EDCs can have very serious effects on fish, both behaviourally and the effects may range from reproductive issues to evidence of intersex fish.

Effects on Humans
The human body’s normal endocrine system is affected by very small changes in hormone levels. EDCs can mimic these hormones and exposure can cause dramatic changes in these hormone levels in humans When absorbed these EDCs can decrease and increase certain hormone levels, mimic some of the body’s natural hormones and even alter natural hormone production, thereby reducing male fertility, reducing the number of males being born, interfering with male reproductive organs, causing female reproductive issues, increasing mammary, ovarian and prostate cancer and increasing autoimmune.

Current Technology
Activated sludge treatment is a commonly used secondary treatment method in wastewater treatment that uses a biological process to treat ammonia and remove the biological oxygen demand (BOD). Importantly, E1, E2, EE2 can be treated by the activated sludge treatment

process. During the activated sludge process the offending EDCs are mineralized in lieu of absorbing into the sludge. This is done by creating a situation in which the bacteria inhabiting the wastewater treatment process break down the pollutant as a carbon and energy (food) source.

There are several newer technologies that can be used for EDC removal. Photocatalysis and membrane nanofiltration technologies are typically classified as tertiary treatment and are currently not mandatory as part of the wastewater treatment, per the current regulations for wastewater treatment in Canada.

Policy Context
In July 2014, the European Commission voted on an EU policy on endocrine disruptors. They advanced the first regulatory system in the world with legally binding criteria to define what an endocrine disruptor is. The adopted criteria will provide a stepping stone for further actions to protect health and the environment by enabling the Commission to start working on a new strategy to minimise exposure of EU citizens to endocrine disruptors.

The current Canadian Government Wastewater Systems Effluent Regulations falls under the Fisheries Act. The goal of the effluent regulations is to ensure there is no acute toxicity in wastewater effluent for the protection of fisheries and aquatic life. The extent of effluent regulations is specific to a facility's effluent quality and the timeline is based on the severity of the processes requiring upgrades to meet the new mandated effluent quality for that facility.

In the Province of Ontario the 'Design Guidelines for Sewage Works' document sets the standard for the designs of wastewater treatment facilities in Ontario, and references the 'Guideline F-5, Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters (1994)'. The second document is the 'Guideline F-5, Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters (1994). (Province of Ontario 1994). Guideline F-5-1 details the effluent design objectives for various treatment levels and processes for BOD, suspended solids, total phosphorous, ammonia/ammonium and the effluent guidelines for BOD and suspended solids. The levels of treatment described are secondary treatment or better.

Finally, Annex 3 of The Great Lakes Water Quality Agreement commits Canada and the United States to prepare and issue Binational Strategies to reduce the release and impact of Chemicals of Mutual Concern (CMC). The 2012 Great Lakes Water Quality Agreement requires the United States and Canada to identify Chemicals of Mutual Concern (CMC) that are potentially harmful to human health or the environment and that originate from anthropogenic.

We suggest that the next set of CMCs include the EDCs we discuss herein, to "contribute to the achievement of the General and Specific Objectives of this Agreement by protecting human health and the environment through cooperative and coordinated measures to reduce the anthropogenic release of chemicals of mutual concern into the Waters of the Great Lakes."

Since 90% of the "important" endocrine disruptors can be treated using the denitrification process, we suggest their treatment be considered in amending existing policy.

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Publication

Feasible policy development and implementation for the destruction of endocrine disruptors in wastewater.
Krantzberg G, Hartley P
Sci Total Environ. 2018 Aug 1