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Ecological Engineering to Promote the Degradation of Estrogens in Wastewater

Introduction

In recent years, trace contaminants are frequently recognized as important constituents within water affecting public health and system ecology. Steroidal estrogenic compounds (SECs), in particular, have emerged as potential threats due to the lack of elimination in conventional activated sludge treatment plants coupled with their ability to disrupt the endocrine system of animals at low levels (e.g., ppt). This study aims to utilize a novel technology, a membrane bioreactor (MBR), to systematically investigate the microbial degradation of the SEC 17α-ethynylestradiol (*EE2*).

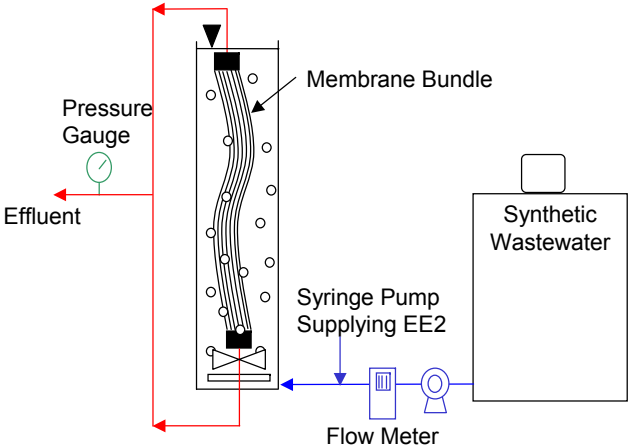

Figure 1. Schematic of a Submerged MBR to be implemented for this Study

Scientific Approach

• **Hypothesis:** The microbial population within an MBR lends itself towards the biodegradation of complex organics, such as 17α-ethynylestradiol (*EE2*)

• **Research Objectives**

- Perform a comparative study between MBRs (Figures 1,2) and activated sludge units in removing *EE2*

- Develop a model tracking the degradation and adsorption kinetics of *EE2* coupled with modeling the growth kinetics within an MBR

- Study the diversity and succession of microbial communities present in both reactor configurations over a minimum one-year period

- Determine whether a correlation exists between *EE2* degradation and microbial communities representative of MBR and activated sludge configurations

Figure 2. Image of a Hollow Fiber Microfiltration Membrane Bundle

Molecular Biological Approach

The author proposes a systematic approach that encompasses the 'Full rRNA Cycle' [1,2]. The author will utilize modern scientific tools including: terminal restriction fragment length polymorphism (T-RFLP), fluorescent in situ hybridization (FISH), confocal laser scanning microscopy (CLSM), and quantitative real-time PCR. Further, the research plans to establish a microbial database by cloning and sequencing of 16S rDNA. A schematic of how these methodologies work in concert is supplied in Figure 3.

An additional novel approach to that links function and phylogeney is stable isotope probing (SIP) [3]. Using SIP facilitates tracking of the ^{13}C label of *EE2* into microbial DNA and RNA, with subsequent identification of the organism(s) actively involved in metabolizing the substrate.

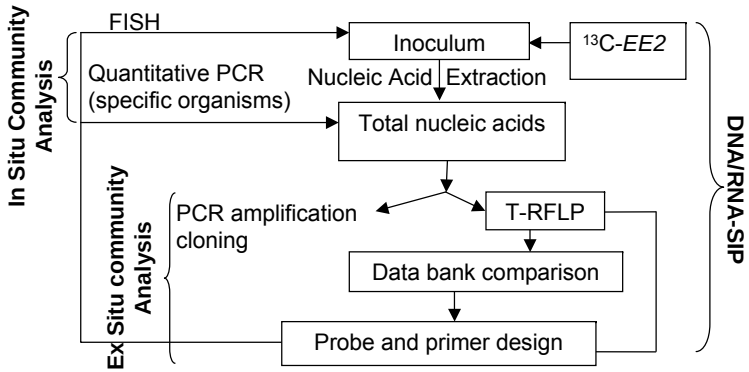

Figure 3. Overview of molecular methods to monitor ecological diversity, dynamics, stability, activity, and function

[1] Amann, R. I. 1995. In situ identification of micro-organisms by whole cell hybridization with rRNA-targeted nuclei acid probes. In: *Molecular Microbial Ecology Manual*. Ed. A. D. L. Akkermans, J. D. van Elsas and F. J. de Bruijn. Netherlands, Kluwers Academic Publishers: 1-15.
[2] Wilderer, P. A., H.-J. Bungartz, H. Lemmer, M. Wagner, J. Keller and S. Wuertz. 2002. Modern scientific methods and their potential in wastewater science and technology. *Water Research* 36: 370-393.
[3] Radajewski, S., P. Ineson, N. R. Parekh and J. C. Murrell. 2000. Stable-isotope probing as a tool in microbial ecology. *Nature* 403(6770): 646-649.

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