Modeling biological fouling in an autotrophic Membrane BioReactor

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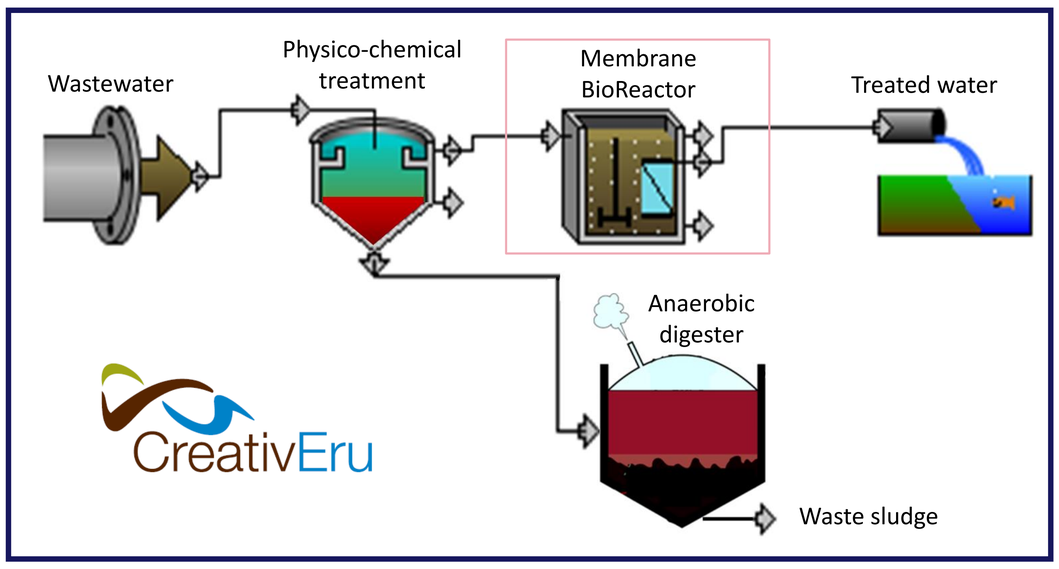
Context

Introduction

- CreativEru proposes a new wastewater treatment process to reduce energy requirements. For this purpose, highly fermentable organic matter is extracted, by a physico-chemical treatment, and sent to an anaerobic digestor whose biogas production would be increased.
- Thereby, the development of heterotrophic species, growing on organic matter, is decreased. Whereas the development of autotrophic species, growing on nitrogen, is enhanced. Consequently, this kind of MBR is called autotrophic.
- However, fouling is still the major phenomenon preventing MBR marketing due to Soluble Microbial Products (SMP) who are known to be main fouling agents. So, the objective of this study is to model the SMP production in such MBR.



Soluble Microbial Products

Experimental set-up

Reactor

- A 30L reactor
- Submerged membrane module
- Constant flow filtration

Membrane

Geometry	Hollow fibers
Material	Polysulfone
Pore size (µm)	0,05
Length (cm)	34,5
Outer diameter of fibers (mm)	2,6
Filtering surface (m^2)	0,22

Analytical techniques

Offline

COD, TOC, MLSS, MLVSS, OUR, SMP, Filterability, Multi-scale hydraulic resistance

Online

pH, T, TransMembrane Pressure Nitrogen forms, Conductivity, Dissolved Oxygen, Redox Potential

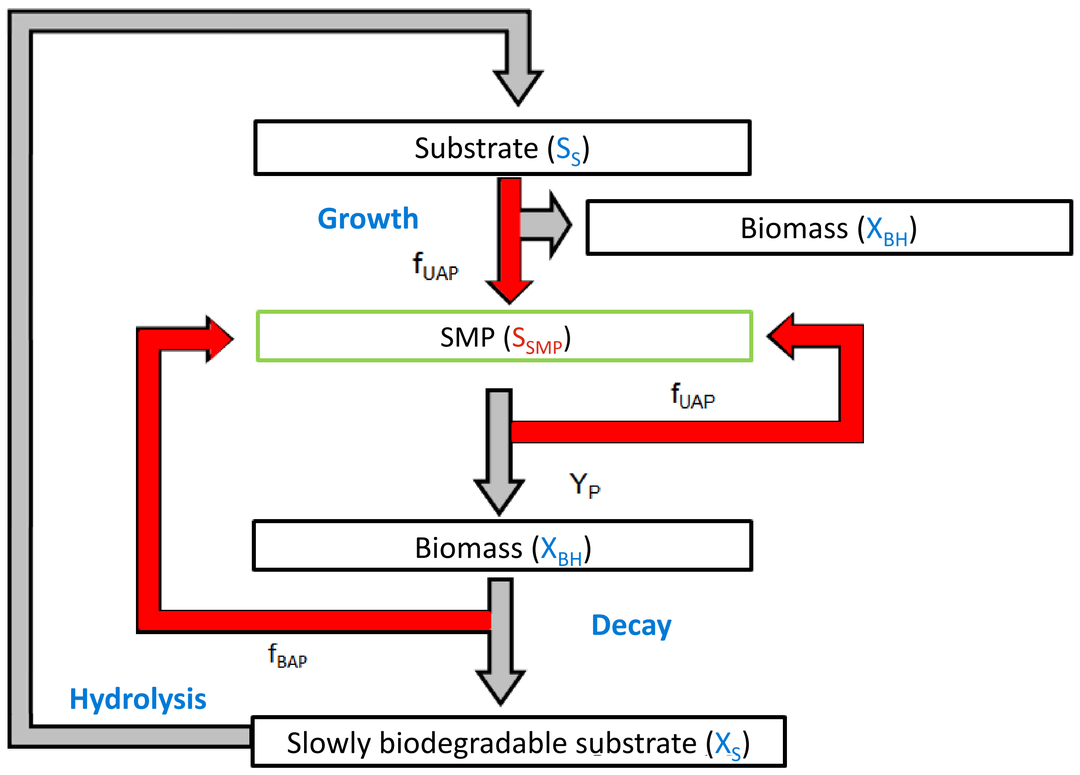
Definition

SMP are poorly defined, mainly, because of the difficulty while identifying them experimentally and the microbial behavior comlexity towards various entries.

According to **Barker and Stuckey**, SMP are considered as **"any soluble material leaving the effluent of a biological system that was not present in the influent"**. This definition is adopted for this study.

Developed model

A hybrid model, called **ASM1-SMP**, is used. It is a version of ASM1 model that is extended in order to include processes controlling SMP concentration.

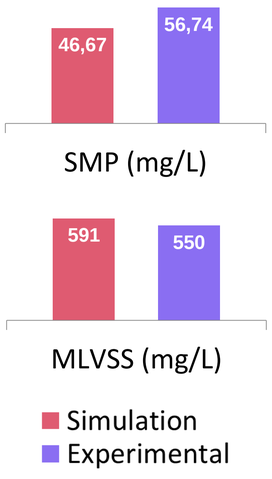


Main processes included in ASM1-SMP model

Model validation

SMP and MLVSS concentrations in the MBR

Operating conditions	
Flow rate (L/h)	5
Filtration flux ($L/m^2/h$)	20
Hydraulic Retention Time (h)	15
Solid Retention Time (d)	20
Nitrogen loading (g N/L/h)	0,02
Organic Matter loading (g COD/L/h)	0
Sludge extraction (L/d)	1,5
Dissolved Oxygen Concentration (mg O_2/L)	6



Conclusion

- The developed ASM1-SMP model allows a well accepted simulation for concentrations of different components (biomass, MLVSS, substrate, SMP…).
- Based on prospective simulations and according to the system input, optimal operating conditions would be identified.
- This model, associated with a physical model, could be able to describe processes leading to fouling in an autotrophic MBR.

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