



BIOMATH

Department of Applied Mathematics,
Biometrics and Process Control

The source of soluble microbial products and their impact on MBR fouling

Ghent University; UNESCO-IHE

11-07-2006

T. Jiang, S. Myngheer, V. De Schepper, I. Nopens, H. Futselaar,
W. van der Meer, M.D. Kennedy, G.L. Amy, P.A. Vanrolleghem

Introduction

- SMP (soluble microbial products)
= soluble EPS in the sludge water phase
- SMP
= BAP (Biomass associated products)
+ UAP (Growth associated products)

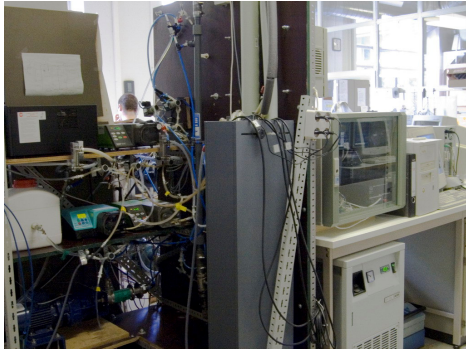
Problem definition

- SMP is the main foulant in MBR
- It is not clear the relative contribution of BAP and UAP to MBR fouling

Objective

- Differentiate the source of SMP (BAP + UAP)
- Quantify the impact of SMP on membrane fouling

Biomath MBR setup

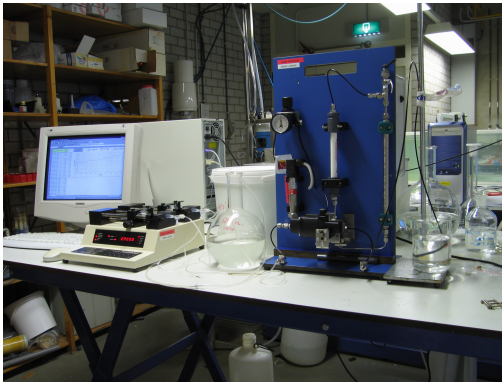


- An + Aero/Anox + Mem (BNR)
- Synthetic WW
- SRT = 17 days
- Fully automatic
- Temperature controlled
- Online TMP, DO, pH, ORP, Temperature monitoring
- Online particle size measurement

Batch SMP Experiment

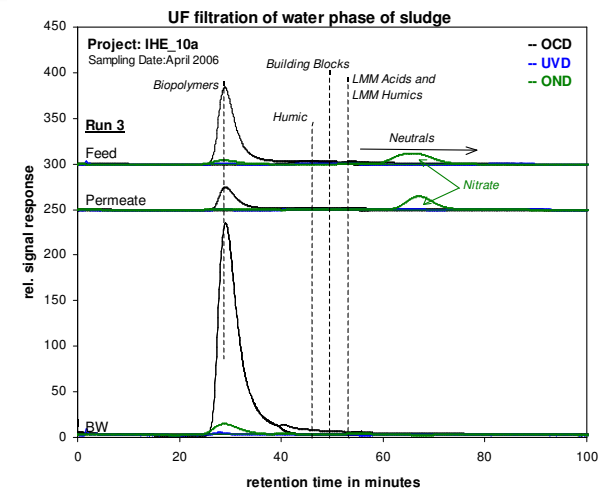
- Raw SMP (BAP+UAP)
 - Filtrate < 0.45 μm
- Batch BAP
 - Washed MBR sludge
 - Continuous aeration for 7 days
 - Room temperature, no pH and DO control
 - BAP < 0.45 μm
- SMP and BAP → Batch filtration

Batch Filtration Experiment

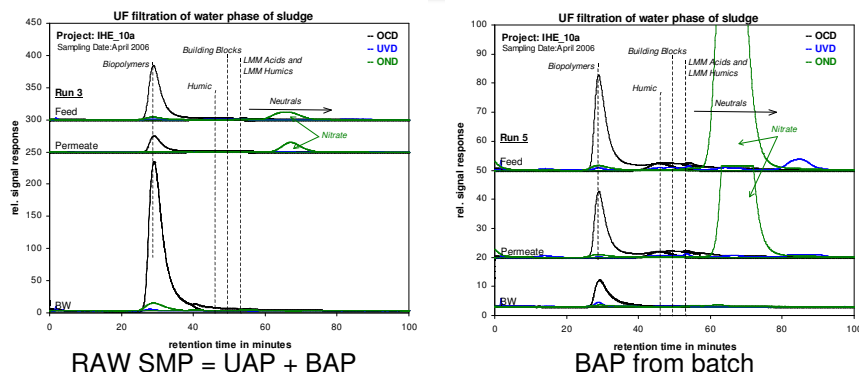


- Mem = MBR (0.03 μm)
- Const. flux = MBR (31.8 L/m²h)
- BW every 7.7 min for 1 min
- Dead-end filtration
- Online TMP
- Feed, perm. and BW water are collected

LC-OCD results (raw SMP)



LC-OCD results



- Major fraction of BAP > 20 KDa, similar to raw SMP
- Smaller inert BAP was also produced

Rejection of SMP

	SMP Raw (BAP+UAP)	BAP
Feed DOC (mg/L)	47.15	20.96
Permeate DOC (mg/L)	17.31	15.53
Feed SUVA (L/mg*m)	0.23	0.61
Permeate SUVA (L/mg*m)	0.35	0.64
Feed TON/TOC	0.04	0.041
Permeate TON/TOC	0.039	0.037
membrane retention rate	0.63	0.26

- SMP: strong hydrophilic, Low Org-N → Polysaccharide
- Lower SMP rejection in batches (26-63%) than in real MBRs (80-90%)

SMP fouling

	SMP raw	BAP
Starting TMP	0.03	0.03
End TMP after 7400 s	0.56	0.092
Milli-Q TMP after 7400 s (bar)	0.47	0.085
After BW TMP	0.05	0.03
Fraction of membrane resistance	0.05	0.33
Fraction of concentration Polarization	0.17	0.08
Fraction of reversible fouling by BW	0.96	1.00
Fraction of irreversible fouling by BW	0.04	0.00
Irreversible fouling resistance / clean membrane resistance	0.63	0.00
Normalized fouling rate (Δ TMP (bar)/del. DOC (mg/m ²) * 0.001)	0.192	0.050
Normalized fouling rate (Δ TMP (bar)/ret. DOC (mg/m ²) * 0.001)	0.303	0.193

UAP batch

- Experiment condition
 - Acetate as substrate
 - S/X (substrate/biomass) = 0.05
- Results:
 - Measure the change of COD in the water phase
 - No UAP detected

Conclusion

- The major fraction of BAP is colloids >20 KDa, polysaccharide nature
- The rejection of colloids is higher in MBR than in batch
- Raw SMP (BAP+UAP) has higher fouling potential and more difficult to clean hydraulically than BAP produced in batches

Perspective

- UAP tests to complete the mass balance of SMP (with higher S/X)
- Modelling the production of degradation of SMP
- Simulate the UAP and BAP concentration in MBR reactor
→ presenting in IWA 2006, Beijing

Acknowledgement

- Norit Process Technology, The Netherlands
- Vitens Fryslân, The Netherlands

Discussion points

- BAP produced in batch =? BAP in MBR sludge
- How to produce UAP in batch?
- Physical factors in SMP production (EPS→SMP)
- BAP produced in batch had lower fouling potential than SMP (lower specific cake resistance?)

	SMP raw	BAP
Normalized fouling rate (increased TMP/delivered DOC *0.001)	0.192	0.050
Normalized fouling rate (increased TMP/Retained DOC*0.001)	0.303	0.193