Investigating the effect of influent composition on full-scale MBR filtration performance through lab-scale research

T. Maere*, G. Bellandi*, M. Lousada-Ferreira, L. De Temmerman*, J.W. Mulder**, I. Nopens***

*BIOMATH, Department of Mathematical Modelling, Statistics and Bioinformatics, Ghent University, Coupure Links 563, B-9000 Gent, Belgium (thomas.maere@ugent.be, giacomo.bellandi@ugent.be, lieven.determmerman@ugent.be, ingmar.nopens@ugent.be)
**Evides Industriewater, Schaardijk 150, 3063 NH Rotterdam, The Netherlands (m.ferreira@evides.nl, j.mulder@evides.nl)

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Introduction

The full-scale MBR "De Drie Ambachten" in Terneuzen (The Netherlands) is operated by Evides Industriewater NV to provide demineralised water to industry after further treatment steps. At times, when the MBR influent flow is not sufficient to satisfy the water demand, additional effluent from the nearby conventional activated sludge treatment plant is fed to the MBR. Since the permeate production as proposed in the design phase could not be reached, the question arises if this modus operandi could be a cause of sludge filterability issues and membrane permeability decline. The latter has been investigated in this study by running a lab-scale MBR at Ghent University under similar conditions as the full-scale installation.

Materials and methods

A detailed description of the used lab set-up can be found in Jiang et al. (2009). A reference state was established after running the lab-scale MBR at fixed operational settings (see Table 1) for two months on wastewater coming from the conventional wastewater treatment plant (WWTP) in Destelbergen (Aquafin NV, Belgium). After this period the operation was changed whereby the effluent from the WWTP of Destelbergen was used as 30% of the MBR input. Measurements entailed the characterisation of normal influent, effluent and sludge parameters (COD, BOD_5, TN, NH_4, NO_3, TP and TSS) next to standardised sludge filtration tests (Thiemig, 2012) and particle size distributions (PSD - EyeTech, Ankersmid).

Table 1 - Main MBR parameter settings

Bioreactor	
DO setpoint (intermittent aeration)	2 mg l^{-1}
Temperature setpoint	15 °C
X-flow airlift membrane module	
Cross flow velocity (50-50 air/water)	1 m s^{-1}
Average filtration flux	31.8 LMH
Backwash flux	106 LMH
Influent carbon addition	
BOD_5/TN setpoint	3

Results and discussion

Figure 1 (left) shows the evolution of bioreactor and membrane compartment sludge concentrations since the change of operation on March 27. Despite 30% of the MBR input being WWTP effluent, with average COD and BOD_5 values of respectively 35

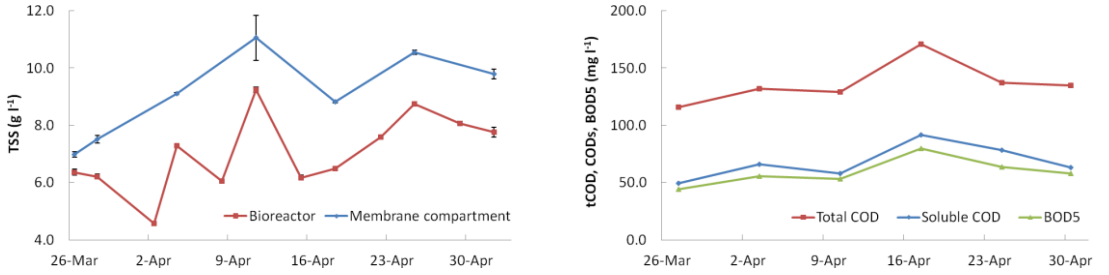

Figure 1 - Evolution of sludge concentrations (left) and raw wastewater strength (right) as of the change in MBR input regime introduced on March 27

mg l^{-1} and less than 10 mg l^{-1}, the sludge concentrations increased. This was unexpected and can only partly be explained by the higher raw wastewater strengths that are shown in Figure 1 (right). Figure 2 shows a slight rising trend in the standardised filtration test values, indicating a mild deterioration in sludge quality and filterability over time. The latter was also corroborated by the somewhat higher transmembrane pressure values that were recorded during filtration (the TMP results are not shown in this abstract). Despite being normalised for sludge concentration variations, the results in Fig. 2 do show some resemblance with the sludge concentration measurements in Fig. 1.

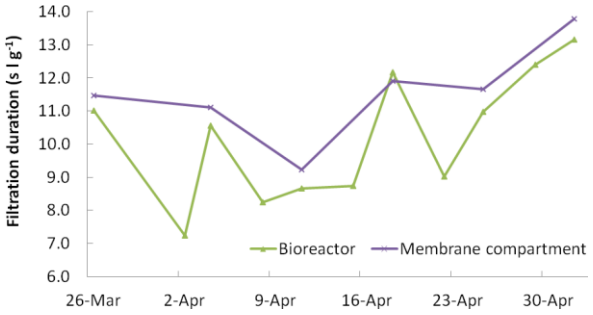

Figure 2 - Standard sludge filtration test values

The curves in Figure 3 depict volume-based particle size distributions for bioreactor sludge samples at various time instances. As a reference, a sample was taken just before the change in input regime. One can clearly see a shift towards smaller particles (indicated by the blue arrow) after changing the input regime. However, it does not appear that the build-up of small particles increases further with time. The number-based distribution curves show similar results (not shown). This is an important finding as the increase in the amount of small particles may form an indication of worse filterable sludge.

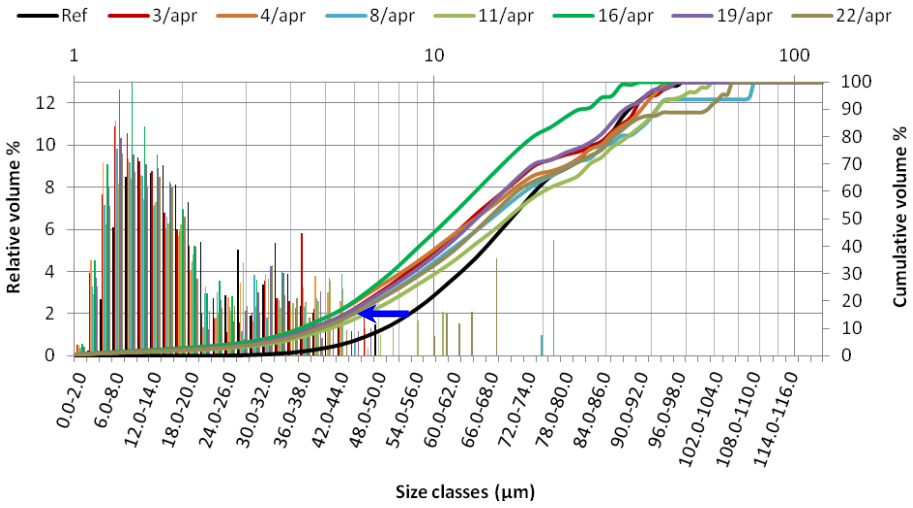

Figure 3 - Volume-based particle size distribution curves of bioreactor sludge samples measured with the laser channel of the EyeTech

Conclusions

The change in MBR influent regime has affected the sludge filterability of the lab-scale MBR, albeit only minor. The slight decrease in sludge quality is possibly caused by an increase in small particles which originate from the added effluent. In the full paper results will be shown with the amount of effluent addition doubled as well as the effect of some industrial waste streams such as leachate on PSD and sludge filterability.

References

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