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Subject Area	Water treatment

Effect of Algae on Gravity-Driven Membrane (GDM) Filtration of Surface Water

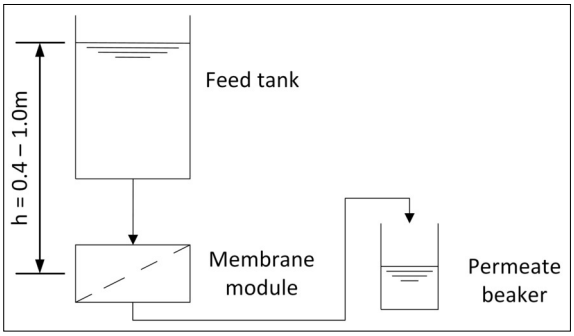

Fig. 1: Schematic of a GDM filtration process
Own presentment

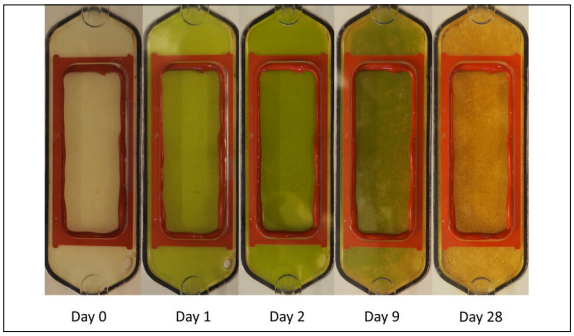

Fig. 2: Cake layer development over time on the UF membrane sheet in the presence of a high concentration of green algae
Own presentment

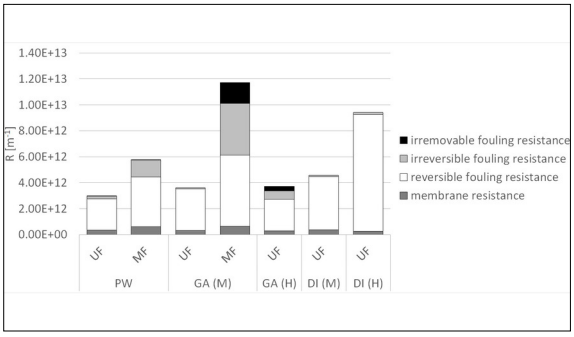

Fig. 3: Resistance caused by the membrane and different types of foulant at the end of the experimental period
Own presentment

Introduction: The scarcity of drinking water is increasing due to climate change and population growth. Additionally, water on Earth is most commonly found as seawater (≈96%) or inaccessible fresh water (≈3%). The remaining accessible fresh water is often polluted and must be purified before it can be used for drinking. Gravity-driven membrane (GDM) filtration has a huge potential as a pre-treatment in desalination plants or as a purification process for polluted fresh water. A schematic of a GDM filtration process is shown in Figure 1. The height difference between the water level of the feed tank and the membrane module leads to the required pressure for water to flow through the membrane. The flux of the permeate in a GDM filtration process stabilises due to a biofilm on the membrane surface, where fouling of the membrane is a major problem. In this study, the effect of algae on GDM filtration of surface water was investigated with the use of diatom and green algae. Microfiltration (MF) and ultrafiltration (UF) membranes were employed in the GDM systems. The membrane performance and water quality parameters were monitored during the experiments.

Result: The results revealed the membrane permeability declined rapidly up to 90% and stabilised after five days in all experiments. This phenomenon was associated with the rapid formation and stabilisation of the cake layer, an accumulation of suspended solids, on the membrane. Figure 2 demonstrates the cake layer development on the UF membrane in the presence of a high concentration (H) of green algae. The membrane performance of the MF membrane was 50% lower than that of the UF membrane. The presence of green algae in all tested concentrations had no remarkable effect on the UF membrane performance. The presence of diatom on the other hand resulted in a decrease of the permeability of the UF membrane by 20 – 35% in low (L) and medium (M) concentration and by almost 70% in a high (H) concentration compared to the control experiment. Figure 3 shows the resistance caused by the membrane and different types of foulants. In the presence of diatom (DI) and green algae (GA), reversible fouling resistance was predominant on the UF membrane. On the MF membrane, the presence of diatom and green algae led to irreversible fouling resistance up to 80% and reversible fouling resistance up to 45% of the total resistance.

Conclusion: The effects of two algal species at different concentrations on GDM performance of surface water were investigated in this study and the following conclusions can be drawn:

- The UF membrane performance was remarkably better compared to the MF membrane in treating algae-contained surface water.
- The presence of diatom showed a greater negative effect on the membrane performance compared to green algae. The voidage of the cake layer increased in the presence of both algal species.
- The predominant fouling resistance on the UF membranes was reversible fouling resistance, whereas on the MF membrane, reversible and irreversible fouling resistance were dominant.
- The microscopic analysis of the cake layers showed the accumulations of prokaryotes (bacteria) and movement of eukaryotes (animal cell) in the cake layers within all tested conditions.
- The MF and UF membrane did not lead to significant difference in the permeate water characteristics.