

Dead-end ultrafiltration without backflushing and chemicals for decentralized water purification

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Inadequate access to safe drinking water threatens the health of over a billion people in developing countries. Although ultrafiltration technology has become affordable for decentralized water treatment in developing countries, its widespread application is limited by membrane fouling and biofouling. In order to limit fouling, chemical cleaning, addition of disinfectants, regular backflushing and extensive pre-treatment are usually applied, resulting in complex and expensive systems.

The focus of our work was on membrane fouling in ultrafiltration systems operated in a dead-end mode under ultra-low hydrostatic pressure (40-150 mbar), without backflushing and addition of chemicals.

Dead-end ultrafiltration (100 kDa) membrane modules were operated at laboratory scale under hydrostatic pressure of 100 mbar, without any backflushing or chemical cleaning for the period of 5 month. After the initial decrease of flux during 2-3 days of operation, the stabilization of the flux occurs at a value of 7-10 L/h/m² for river water (TOC 2.5 mgC/L, Turbidity 2-4 NTU) and 4-7L/h/m² for diluted waste water (TOC 20-25 mgC/L, Turbidity 20-40 NTU). The flux values are independent of transmembrane pressure (TMP) for the TMP range of 40-500 mbar, indicating that the fouling layer resistance is higher at higher TMP.

Suppression of the biological activity in the system with Sodium Azide leads to the continuous decrease of flux and increase of resistance. In not disinfected systems, the measurement of ATP (adenosinetriphosphate) showed the existence of a stable amount of active biomass in the fouling layer. Investigation of the fouling layers with Confocal Laser Scanning Microscopy showed the existence of a porous inhomogeneous fouling layer, subjected to compression with the increase of TMP.

Thus, our results show that biological processes occurring in the biofouling layer formed under ultra-low pressure on the ultrafiltration membrane cause stabilization of the flux for at least 5 month of operation without flushing or cleaning. While no pumps, chemicals or process control is required, the system costs could be kept low, especially when such systems can be produced locally. The membrane costs for point-of-use application are estimated at about 0.7 - 1.7 \$ per household and year, while for community water supply at about 0.8 - 2 \$ per person and year.