Membrane fouling control using high-frequency power vibration, in an SMBR pilot system—preliminary studies

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ABSTRACT

Membrane bioreactors (MBRs) in wastewater treatment have gained significant popularity recently, especially due to reclamation needs. Submerged membrane bioreactors (SMBRs) are considered to be an extremely successful method for this purpose. However, membrane fouling is one of the most critical problems of the SMBR systems, and the used techniques to avoid this problem have the disadvantage of the high energy needed. The objective of this study was to introduce an alternative cleaning technique of submerged membranes, with reduced energy consumption. A lot of lab studies have been published concerning the impact of mechanical action in the removal of foulants from the membranes (e.g. vibration, buck-pulse, and ultrasound). In this preliminary study, the feasibility of high frequency power (or powerful) vibration (HFPV), as cleaning technique, on fouled membrane modules, in a small pilot-scale SMBR system, treating a novel synthetic wastewater was examined. This pilot-scale system comprised from small copies of commercialized filter modules working under low aeration mode, in order to study the membrane fouling in a relatively short time period. Two new membrane filter modules (hollow fiber (HF) and flat sheet (FS)) consisting of three filter elements each, were used in the SMBR unit. After working the unit for a long time period, where trans-membrane pressure (TMP) exceeded the specified values or where membrane fouling blocking phenomena were observed, various time-period HFPV schemes were applied on the filter modules, via two different in power commercial pneumatic vibrators. These vibration schemes give distinct vibration characteristics (frequency, displacement, acceleration, etc.) to the membrane modules and their effectiveness on filter fouling was monitored continuously via TMP and flux values vs. time, without interrupting the operating mode of the whole SMBR system. After a continuous working period of 19 d with HF filter module, where TMP values reaches the upper set point of 200 mbar, different HFPV schemes were implemented within a day. This results a considerably lower TMP values (to 100 mbar), while flux was recovered to initial values and the system after that, behaved similarly with that of having new filter modules in terms of TMP and flux values. Medium HFPV schemes were subsequently applied for about

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two-day period, giving a conservation of TMP values at previous levels. Similar promising results were obtained using various time-period HFPV schemes on FS membrane filter module. The above results confirm a clear influence of the HFPV technique on reducing the severe membrane fouling at first and then preserving the good membrane operating conditions. HFPV technique seems to be very promising with respect to energy savings, compared to conventional air cleaning systems in SMBRs because it contributes to a low air-scouring operation due to the periodic application of vibration. Additionally, this technique copes with the problem of membranes fouling in real time, by applying HFPV schemes without interrupting SMBRs operation mode.

*Keywords:* Membrane bioreactor; Synthetic wastewater; Membrane fouling; Vibration