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Membrane fouling control in centralized and decentralized Bf-MBR wastewater treatment plants

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Abstract: In the context of the growing water scarcity, current work focuses on process control optimizations in biofilm membrane bioreactors (Bf-MBRs) as one of the most prospective technological solutions for water reuse. The study demonstrates efficiency and feasibility of chemical enhancement in Bf-MBR tackling membrane fouling, comparing cases of decentralized and centralized wastewater treatment plants.

Keywords: process control; membrane fouling, biofilm membrane bioreactor

The future global water demand will raise primarily due to population growth, increasing wealth and changing diet preferences. The biggest contributors to these changes will be emerging markets and developing countries that are already suffering from water, food and health.

Increasing water use and scarcity may impose constraints on the economic growth of emerging markets and developing countries (Dinar and Schwabe, 2015). In the present conditions, it will be necessary to reduce the growing stress on natural water sources, both in terms of pollution and in terms of water abstraction. There will be a need to gradually make multiple alternative water sources available to complement current abstraction from ground and surface waters, with useable water from additional sources (i.e. brackish, salt, and recycled water), in a cascading and "fit-for-use" approach (WssTP, 2016).

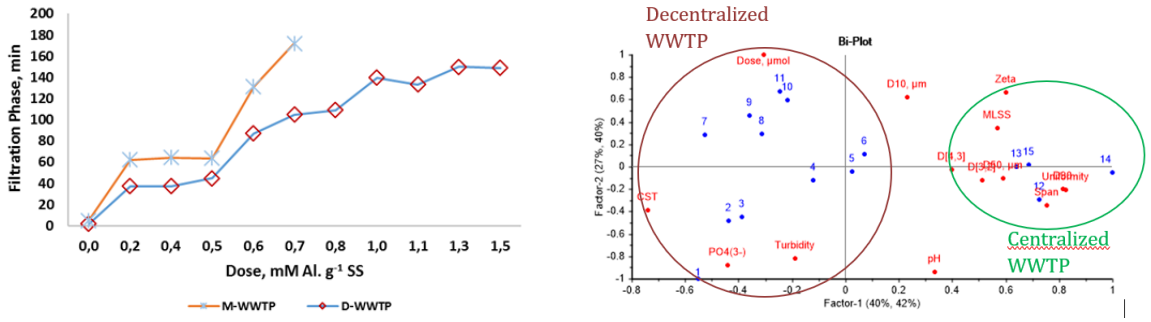
Moving bed biofilm and membrane bioreactors developed in parallel as technological advance of activated sludge process. Anticipating synergism between biological treatment in biofilm and membrane separation of suspended solids, they were evolutionary combined in biofilm membrane bioreactor (Bf-MBR). This technology is increasing role of point-of-use wastewater treatment applying membranes by providing unique capabilities of low footprint, high level of automation and good cost-benefit ration due to lower degree of membrane fouling and energy consumption (Duan, Li, et al., 2015), higher membrane permeability, better recovery after cleaning and lower production of excess sludge (Zhang, Tang, et al., 2017). These advantages make Bf-MBR attractive as a technological solution for water reuse.

To date, the investigation on the effects of operating conditions on membrane fouling in Bf-MBR is still limited (Fu, Yue, et al., 2017), therefore the current study focuses on laboratory evaluation of impacts of coagulation on membrane fouling in Bf-MBR systems, considering both centralized and decentralized applications for water reuse.

Two mixed liquors (MLs) have been studied from centralized MBBR and decentralized Bf-MBR wastewater treatment plants. Three different chemical enhancers were evaluated based on iron (ALS-LC) and aluminium inorganic salts (PAX-18, PAX XL-61). Bench-scale membrane separation chamber with ceramic membrane has been used for Total Recycle Tests, applying different dosages of selected chemical enhancers.

The best results for membrane fouling control were obtained with Al-based chemical enhancers: addition of 0.21 mM-Al prolonged the filtration phase of the mixed liquor from the decentralized system by 20 times and by 10 times for centralized system (Figure 1a).

Further studies, applying advanced statistic methods, revealed that samples from the decentralized system are characterized by high levels of orthophosphates, turbidity, CST, and coagulant dosage, while the samples from the centralized plant have high values of PSD parameters, such as span, uniformity, D50, D90, D [4,3], D[3,2]; MLSS, and zeta potential. It is worth noting that the latter group of samples is characterized by partially pre-coagulated sludge, resulting in higher zeta potential. Thus, the dosage required to reach the neutralization of the system, in this case, was lower than for the pilot plant samples, which merely contained the activated sludge.



(a) (b)

Figure 1 Combined results of the total recycle tests: duration of filtration cycle (a) and exploratory Bi-Plot of mixed liquor characteristics

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