Coagulation has been the most successful pretreatment for the mitigation of membrane fouling, the improvement of permeate quality, and the extension of membrane service life. Membrane coagulation reactor (MCR), which is a coupled coagulation and membrane filtration process, is a promising technology for surface water purification. In order to decrease footprint, promote flocculation efficiency, and mitigate efficiently membrane fouling, a submerged internal loop MCR with in-line coagulation, sludge thickening, and air sparging was developed. In the MCR, the internal loop flow induced by air lift through a flocculation region can cause a continuous flocculation of raw water and consequently avoid the accumulation of fine flocs prone to blocking membrane pores and forming a compact cake layer. Furthermore, the flocs with a large size and a fast settling velocity can consecutively settle into the sludge thickening region and then are discharged for controlling sludge concentration. The MCR with hollow fiber microfiltration membranes and with polyaluminium chloride (PACl) as coagulant exhibited excellent performance in removing the turbidity, total organic carbon (TOC), and dissolved organic carbon (DOC) of surface water at bench-scale test. The turbidity and TOC of the permeate met the needs of centralized water supply set by “Standards for Drinking Water Quality” (GB 5749–2006) of China, below 1 NTU and 5 mg/L, respectively. The water flux above 55 L/(m² h) was achieved at the transmembrane pressure of 0.025 MPa. Air sparging could effectively control membrane fouling of the MCR and continuous air sparging was more favorable than intermittent air sparging. The observations by scanning electron microscope showed that the cake layer on membrane surface was loose and irregular and easily cleaned by air sparging, but CaCO₃ was difficult to be removed compared to other precipitates, such as those of Al, Si, and Fe. The experimental results indicated that the MCR has a promising application in treating surface water for drinking.

**Keywords:** Membranes; Filtration; Coagulation; Polyaluminium chloride (PACl); Drinking water; Air sparging

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