Supporting Information

Combining MIEX and micro-sand before coagulation as pre-treatment for submerged ultrafiltration: biopolymers and small MW organic matters

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The apparatus and operation of membrane systems

Synthetic raw water was fed into a constant-level tank to maintain the water head for the membrane tanks. A dose of 0.15 mM (calculated as Al) alum ($Al_2(SO_4)_3$) was continuously added into the rapid mixing units; the dose was chosen to achieve a near zero zeta potential of the resulting flocs. For the MS-CUF system, the MIEX and micro-sand were added to the adsorption tank (#8 in Figure S1; 200 rpm, 46 s^{-1}) *before* addition of the coagulant in the subsequent mixing unit (#9 in Figure S1). The rapid mix speed in the mixing units was 200 rpm (equivalent to a velocity gradient of 184 s^{-1}), and the hydraulic retention time (HRT) was 1 min. After mixing, the flow passed to three flocculation tanks, each with a HRT of 5 min and a mixing speed of 50 rpm (23 s^{-1}). Subsequently, the flow passed directly to the UF membrane chambers/tanks which contained a submerged polyvinylidene fluoride (PVDF) hollow-fiber UF membrane module (Tianjin Motimo Membrane Technology Co., Ltd, China), with a nominal pore size of 0.03 μm and a surface area of 0.025 m^2.

A suction pump was used to collect UF permeate continuously at a constant flux of 20 L/(m^2 h), operated in a cycle of 30 min filtration and 1 min backwash (40 $L.m^{-2}.h^{-1}$). For each backwash, air was supplied to each membrane tank at 100 L/h (air: water ratio of 200:1), while making sure that the sludge in the bottom of the tanks was retained and not disturbed. The HRT of the membrane tanks was maintained at 0.5 h, and the membranes were operated continuously for a period of 60 days. In the middle of the period of operation (day 32), the membranes were washed by a high pressure tap water wash (1 min) and a sponge wash (10 times). In both membrane tanks, a quantity of retained sludge was released every day. The trans-membrane pressure (TMP) was monitored and recorded every day at the same time in the middle of each cycle (30 min filtration) by pressure gauge.

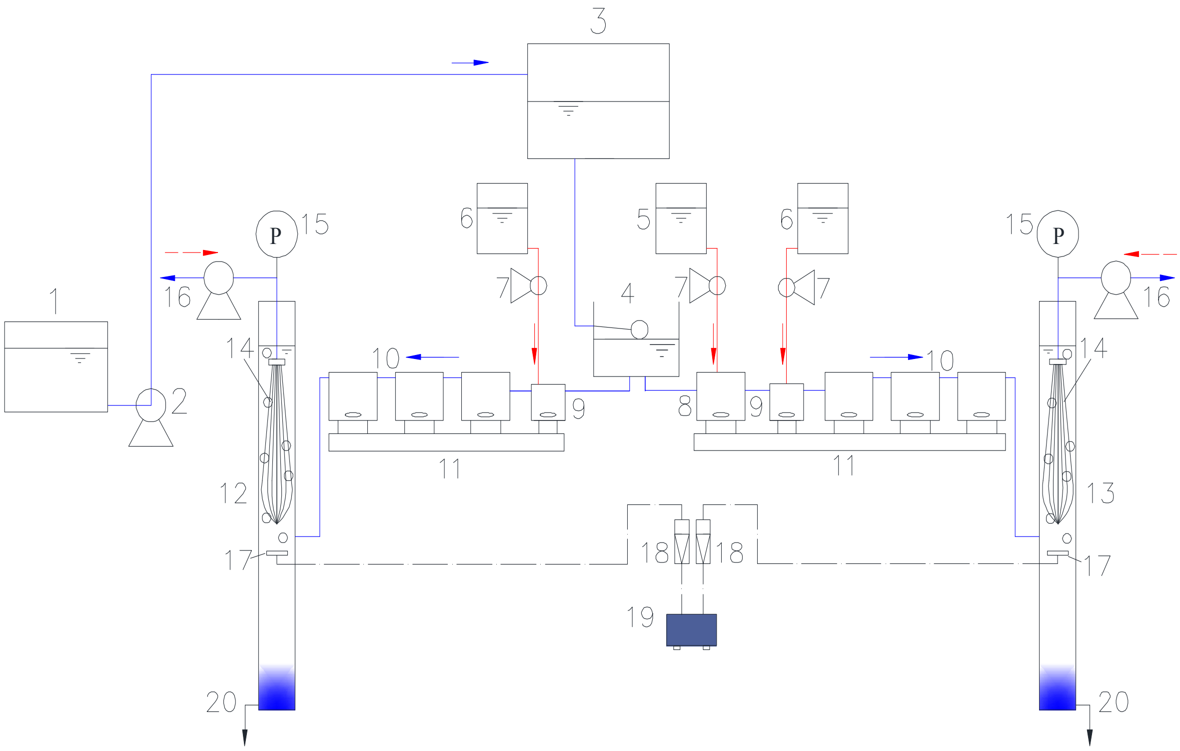

Figure S1. Schematic diagram of the experimental set-up (1 – raw water tank; 2 – feed peristaltic pump; 3 – high level water tank; 4 – constant level water tank; 5 – MIEX and micro-sand tank (mixed by magnetic stirrer); 6 —$Al_2(SO_4)_3$ tank; 7 – mini-peristaltic pump; 8 – adsorption tank (5 min); 9 – rapid mixing unit (1 min); 10 – flocculation tanks (5 min×3=15 min); 11 – magnetic stirrer; 12 – CUF tank; 13 – MS-CUF tank; 14 – UF membrane module; 15 – pressure sensor; 16 – suction peristaltic pump; 17– air blower; 18 – air flowmeter; 19 – air diffuser; 20 – sludge discharge valve).

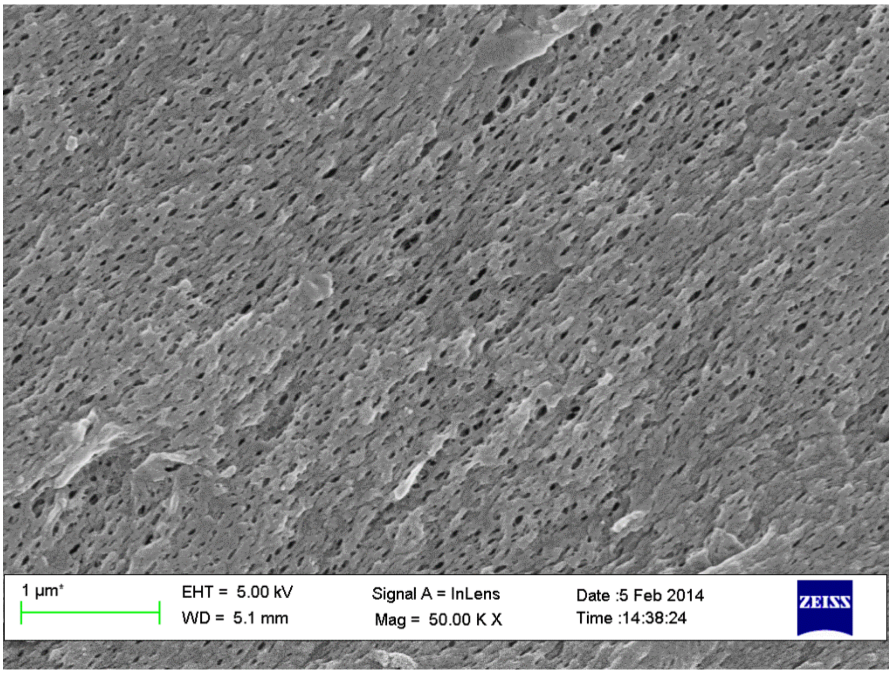

Figure S2 SEM image of new PVDF membrane