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Effects of high turbidity inflow on PAC contactor operation and strategy for membrane fouling control in PMR (PAC membrane retrofitting) process

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ABSTRACT

Recently, global climate change has led to more frequent droughts and torrential rains. It could be reason of unexpected bad effects for water treatment such as taste and odor problems and decreasing of removal efficiencies. In case of membrane process, the inflow of high turbid raw water due to heavy rains may bring sudden increase in the membrane fouling caused by thick and dense cake formation on the membrane surface. Therefore, preparing proper operation methods is necessary for preventing system shutdown due to the membrane fouling, when high turbidity raw water is introduced. Powdered activated-carbon (PAC) membrane retrofitting (PMR) process has been developed as a hybrid process of coarse powder activated carbon (C-PAC) contactor with slurry blanket and submerged membrane for advanced drinking water treatment. PMR pilot plant was installed at W water treatment plant in Korea. Surface water was directly introduced to the plant as raw water. An ultrafiltration membrane module (ZeeWeed® 500C, GE, USA) with 603 m^2 of effective membrane surface area was used in this study. The purposes of this study were to assess the effect of the inflow of high turbid water on the performance of the C-PAC contactor and membrane fouling and to propose a fouling control strategy by adjusting recovery rate. Dissolved organic carbon removal efficiency of the C-PAC contactor was decreased when the high turbidity water was fed. The suspended solids (SS) in the raw water hindered the contact with organic matters and bio-film of biological activated carbon surface. It was confirmed by recovery of the removal efficiency after the raw water turbidity became a normal level. The correlation between SS concentration of the membrane tank and variation of transmembrane pressure (TMP) was observed during a rainy season. The SS concentration of the membrane tank was selected as a criterion of recovery rate adjustment. When the turbidity of the raw water increased more than 550 NTU with the operating flux of 40 LMH, TMP increased gradually as the suspended solids were accumulated in the tank up to the concentration of 13,000 mg L^{-1}. However, TMP increased sharply when the SS concentration in the tank was over 13,000 mg L^{-1}. The SS concentration limit of the membrane tank was set

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conservatively below 5,000 mg L^{-1} for stable operation. The SS concentration of the membrane tank was controlled by adjusting recovery rate, and TMP was maintained stable during the inflow of high turbidity raw water. During which applied operating flux was 40 LMH and recovery rate changed between 99.5 and 98%. The SS concentration of the membrane tank was estimated by a mass-balance model which incorporates raw water turbidity with the ratio of SS and NTU. Recovery rate was adjusted according to the estimated SS concentration in the tank and stable operation could be achieved.

Keywords: Membrane; Powdered activated carbon; PMR process; High turbidity; Recovery rate