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Biological degradation of dissolved organic carbons and ammonia oxidation by biological activated carbon in PAC and membrane applied process

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ABSTRACT

Membrane filtration process has been developed to overcome the weakness of conventional water treatment process for the removal of particulates and some pathogens such as cryptosporidium and giardia. Although suspended particulate, including pathogens and bacteria, can be effectively removed by membrane, the trace organics and soluble matters are hard to remove. To overcome this limitation, membrane filtration is required to be associated with other technologies such as adsorption and oxidation. PAC membrane retrofitting (PMR) process is one of the new processes for removing not only particulate but also soluble matters. PMR process consists of a coarse powder-activated carbon (C-PAC) contactor and a subsequent submerged membrane tank. Powdered activated carbon (PAC) with high concentrations of 30,000 mg L^{-1} is suspended as a slurry blanket in the PAC contactor and soluble matters are removed by the slurry blanket. Most particulates are separated by the membrane. Membrane module used in this study was ZeeWeed® 500℃ with 603 m^2 of effective surface area. The membrane is made of polyvinylidene fluoride (PVDF) with nominal pore size of 0.04 μm. Operating flux of membrane varied from 21 L m^{-2} hr^{-1} (LMH) to 42 LMH. Recovery rate of the process was maintained at 99.5%. The purpose of this study was to investigate the biological removal performance of PMR process. Dissolved organic carbon (DOC) concentration of influent and effluent of each unit process were measured. Ammonia step-feeding tests were performed to evaluate the oxidation of ammonia by microorganisms attached on the PAC. Also, the number of bacteria on PAC surface was counted to estimate the build-up of bio-film. After the PAC in the PAC contactor was exhausted and turned into biological activated carbon (BAC), the average bio-film density of BAC was 10^6 cfu g^{-1}. Ninety-four percentage of the bacteria were attached on the BAC in PAC slurry blanket, and the rest was suspended. When the contact time of raw water through the slurry blanket was prolonged from 23 to 45 min, average NH_4^+-N removal was increased from 76 to 97% and

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average DOC removal was raised from 7 to 17%. Ammonia and DOC were consistently and effectively removed by the BAC in the PMR process.

Keywords: Membrane; Biological activated carbon (BAC); PMR process; Dissolved organic carbon (DOC)