World Academy of Science, Engineering and Technology
International Journal of Civil and Environmental Engineering
Vol:10, No:01, 2016

Control of Biofilm Formation and Inorganic Particle Accumulation on Reverse Osmosis Membrane by Hypochlorite Washing

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Abstract : Reverse osmosis (RO) membranes have been widely used for desalination to purify water for drinking and other purposes. Although at present most RO membranes have no resistance to chlorine, chlorine-resistant membranes are being developed. Therefore, direct chlorine treatment or chlorine washing will be an option in preventing biofouling on chlorine-resistant membranes. Furthermore, if particle accumulation control is possible by using chlorine washing, expensive pretreatment for particle removal can be removed or simplified. The objective of this study was to determine the effective hypochlorite washing condition required for controlling biofilm formation and inorganic particle accumulation on RO membrane in a continuous flow channel with RO membrane and spacer. In this study, direct chlorine washing was done by soaking fouled RO membranes in hypochlorite solution and fluorescence intensity was used to quantify biofilm on the membrane surface. After 48 h of soaking the membranes in high fouling potential waters, the fluorescence intensity decreased to 0 from 470 using the following washing conditions: 10 mg/L chlorine concentration, 2 times/d washing interval, and 30 min washing time. The chlorine concentration required to control biofilm formation decreased as the chlorine concentration (0.5–10 mg/L), the washing interval (1–4 times/d), or the washing time (1–30 min) increased. For the sample solutions used in the study, 10 mg/L chlorine concentration with 2 times/d interval, and 5 min washing time was required for biofilm control. The optimum chlorine washing conditions obtained from soaking experiments proved to be applicable also in controlling biofilm formation in continuous flow experiments. Moreover, chlorine washing employed in controlling biofilm with suspended particles resulted in lower amounts of organic (0.03 mg/cm²) and inorganic (0.14 mg/cm²) deposits on the membrane than that for sample water without chlorine washing (0.14 mg/cm² and 0.33 mg/cm², respectively). The amount of biofilm formed was 79% controlled by continuous washing with 10 mg/L of free chlorine concentration, and the inorganic accumulation amount decreased by 58% to levels similar to that of pure water with kaolin (0.17 mg/cm²) as feed water. These results confirmed the acceleration of particle accumulation due to biofilm formation, and that the inhibition of biofilm growth can almost completely reduce further particle accumulation. In addition, effective hypochlorite washing condition which can control both biofilm formation and particle accumulation could be achieved.

Keywords : reverse osmosis, washing condition optimization, hypochlorous acid, biofouling control
Conference Title : ICWWTP 2016 : International Conference on Water and Wastewater Treatment Plants
Conference Location : Singapore, Singapore
Conference Dates : January 07-08, 2016