The 2016 World Congress on
Advances in Civil, Environmental, and Materials Research (ACEM16)
Jeju Island, Korea, August 28-September 1, 2016

Effects of sodium hydroxide cleaning onPVDF fouledwith humic water

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Abstract. This study investigated effects of NaOH cleaning on intrinsic permeability of PVDF membranes and on recoveries of flux and membrane resistance at various conditions encountered at ultrafiltration in the water treatment plants. The NaOH cleaning at 10,000mg/L showed discoloration of PVDF membrane while little effect has made on water flux recovery. The NaOH cleaning was efficient to remove fouling layer by humic water. However, long filtration induced the fouling layer which were not removed easily by NaOH cleaning.The filtration temperature yielded different TMP variation after NaOH cleaning. The alkaline cleaning of PVDF changed the membrane properties such as hydrophobicity and morphology. Consideration on foulants properties, operational conditions such as temperature and chemical agent should be integrated for cleaning strategies of PVDF applied in ultrafiltration.

Keywords: NaOHcleaning; PVDF; ultrafiltration; flux recovery; resistance

1. Introduction

Low-pressure membrane processes such as microfiltration (MF) and ultrafiltration (UF) have been frequently applied in water treatment plants. The membrane materials frequently applied in recent years is polyvinylidene fluoride(PVDF), which shows higher mechanical strength, thermal stability, and chemical resistance compared to other polymeric materials such as polysulfone and polyethersulfone. In addition, the raw materials of PVDF have great solubility on solvent and thus make easy to build porous structure, which gives an advantage for commercialization.However, high degree of hydrophobicity of PVDF might have weakness for fouling due to organic adsorption on membrane surface.

Deterioration of water flux, i.e., membrane fouling is the main problem in thmembrane processes. Membrane foulants have been typically reported as particulates, organic matter, inorganic ions and microbial products. In both MF and UF, organic fouling by natural organic matter has been recognizedas the most troublesome foulant. Application of rigorous pretreatment and enhanced backwash often reducesthe organic fouling in the membrane processesbut could not prevent decline of initial flux of the membrane and fouling which eventuallyoccurred in the membrane.

To overcome the fouling, periodic chemical cleaning is recommendedto remove fouling by natural organic matter. Foulants in feed water deteriorate the water permeation by blocking the water path in the membrane pores, by making a cake layer on the membrane surface, or by adsorbing organic foulants on membrane as the filtration is operated.

For organic fouling, alkaline solution, especially sodium hydroxide (NaOH) is typically usedto removal foulants from membrane surfaces. The use of NaOH as a cleaning agentin membrane processesincludes skim milk production, bovine serum albumin filtration, sweet whey production, whey protein concentrate filtration, and surface water treatment (Regula et al., 2014). Zondervan and Roffel (2007) revealed that the best cleaning performance was obtained by NaOH cleaning for

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ultrafiltration made from polysulfone membranecompared to other cleaning agents. The main cleaning mechanism was known to be hydrolysis and solubilizaiton (Porcelli and Judd, 2010). Blanpain-Avet et al. (2004) also verified that the removal of majority of the fouling layer was occurred for species with loosely bound and easily solubilized by NaOHin approximately 12 min.

However, the increases in hydrophobicity after NaOH cleaning werereportedto aggravate permeability of membranes manufactured from regenerated cellulose and fluoropolymer. Hashim et al. (2011) also revealedseveralnegative effects of NaOHon PVDF membranes including degradation, polymer modification and discoloration. Lie et al. (2011) provedthat gradual hydrolysis of the esters linkages and the dissolution of the upper surface of the PVDF in 1 N of lithium hydroxide

This study investigated effects of NaOH cleaning on intrinsic permeability of PVDF membranes at low and high concentrations of alkaline solution applied in water treatment plant in usual operation. In addition, effects of the NaOH cleaning on flux recovery and changes in resistances of fouling layer were evaluated in terms of filtration duration and temperature when humic water was filtered.

2. Materials and Methods

2.1 Membranes

A hollow fiber type of membrane module (Zeeweed 500, GEZenon, Canada) was obtained fromGE/Zenon Company. The material was polyvinylidene fluoride (PVDF) and the pore size was 0.04 μm**.** The fibers were 50 cm long. The fibers were cut to be 25 cm long. A single fiber was connected to a tube for suction and the single module was fabricated to a membrane area of 14.92 cm2. The detailed specification of the module was summarized in Table ##.

Table 1. Specification of PVDF membrane used in this study

Properties	Specification
Material	Polyvinylidene Fluoride (PVDF)
Nominal pore size	0.04㎛
Surface properties	Non-ionic & hydrophilic
Fiber diameter	1.9 mm OD / 0.8 m ID
Flow path	Outside-in

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