

고정화 광촉매/UV와 NF막을 이용한 광촉매 막반응기

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A photocatalytic membrane reactor using immobilized photocatalyst/UV and NF membrane

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1. Introduction

Nanofiltration(NF) of drinking water may offer an economically competitive process to remove natural organic matter (NOM), the precursors to disinfection by-product (DBPs) formed upon chlorination. Halogenated compounds resulting from chlorination of drinking water containing concentrations of NOM has been a major concern since their discovery in the early 1970s as some of chlorination by-products are carcinogenic. The removal of NOM is therefore a major treatment requirement in the production of potable water.[1-4] Fouling is a major obstruction for efficient use of membrane technology for treatment of NOM. Membrane fouling due to NOM exemplified by humic substances, polysaccharides, and proteins, is a major cause for flux decline. Humic acid fouling is a complex set of phenomena involving both reversible (concentration polarization) and irreversible (humic acid adsorption and deposition) processes. In order to remove NOM, pretreatment processes were employed. Prior to the use of NF membrane processes, photocatalysis/UV pretreatment has been employed. Photocatalysis allows in many cases a complete degradation of NOM in very small and harmless

species, without using chemicals, avoiding sludge production and its disposal. These processes are based on the electronic excitation of a molecule or solid caused by light adsorption (usually UV light) that drastically alters its ability to lose or gain electrons and promote decomposition of pollutants to harmless by-products. The primary action of oxygen is as an efficient electron trap, preventing the recombination of electrons and photoproduced electrons and holes in semiconductors markedly reduces the efficiency of photocatalytic reaction, thus limiting its application. Photodegradation catalyzed by TiO_2 particle provides a technological method for the treatment of water. In most of the such suspensions are characterized by a major disadvantage since, in water treatment, there is a need to recover TiO_2 particle and this creates several technological difficulties. In this work, we immobilized the TiO_2 particle into hollow fiber and chopped to solve the recovery problem.[4–9] This paper discusses the applications of Photocatalysis/UV oxidation pretreatment for the performances of nanofiltration processes. And the objective was to evaluate the impact of photocatalysis/UV pretreatment on the performances of NF processes with fouling mitigation.

2. Experimental

The bulk of the experimental studies were performed using a humic acid obtained from Aldrich (Milwaukee, WI). Humic acid concentrations were evaluated using a OPTIZEN 2120UV spectrophotometer with the absorbance measured at 254nm. The overall humic acid concentration was then determined by comparing the absorbance data with an appropriate calibration curve.

A commercially available NF-270 membrane from Dow Chemicals used in this study.

TiO_2 was the predominantly anatase grade P 25 (65% anatase, 35% rutile, average particle diameter 30nm, surface area $50\text{m}^2/\text{g}$) provided by Degussa (Frankfurt, Germany). The TiO_2 particles were dispersed in the polymer solution. The TiO_2 -dispersed polymer solution was spun into a hollow fiber and then the fiber was chopped. The chopped hollow fiber was used as a photocatalyst. In the laboratory experiments the light source was used 60W Hg lamp.

The humic acid fouling experiments were performed using the above test unit equipped with the polyamide NF-270 membrane. CaCl_2 (50, 100 and 200ppm) was added in the model feed solution contained 1000ppm humic acid. In all fouling experiments, feed solution temperature was kept at 25°C. The experiments were carried out at a feed pressure of 50psi and a feed flow rate 3L/min. The feed solution was run for 24hr and a permeate flux was continuously monitored.

3. Results and Discssions

The chemical composition of feed water greatly influences the fouling rate of NF membranes by humic acid. The co-presence of divalent cations, such as calcium, and organics has a marked effect on membrane fouling. Figure 1 shows the membrane fouling by humic acid and calcium salts. The results clearly demonstrate that product water flux decreases dramatically as calcium concentration increases. In the presence of calcium ions, the charge of humic acid is reduced significantly not only due to effective charge screening but also due to complex formation. The complex formation is attributed to the specific binding of the divalent calcium ions to acidic functional group of humic acid. This paper demonstrate that the application of Photocatalysis/UV oxidation pretreatment for the performances of nanofiltration processes reduce the membrane fouling and flux decline.

4.Reference

1. C. Jucker and M.M. Clark, *J. Membrane Sci.*, **97**(1994), 37-52.
2. W.Song, *J. Membrane Sci.*, **241**(2004), 143-160.
3. S. Hong, M. Elimelech, *J. Membrane Sci.*, **132**(2)(1997), 159-181.
4. A.I. Schafer, A.G. Fane, T.D. Waite, *Desalination* **118**(13)(1994), 109-122.
5. A. Seidel, M. Elimelech, *J. Membrane Sci.*, **203**(2002) 245-255.
6. R. Molinari, L. Palmisano, E. Drioli, M. Schiavello, *J. Membrane Sci.*, **206**(2002) 399-415.
7. R. Molinari, *Chemical Eng. and Processing*, **43**(2004) 1103-1114.
8. M. Qamar, M. Saquib, M.Muneer, *Dyes and Pigments*, **65**(2005) 1-9.

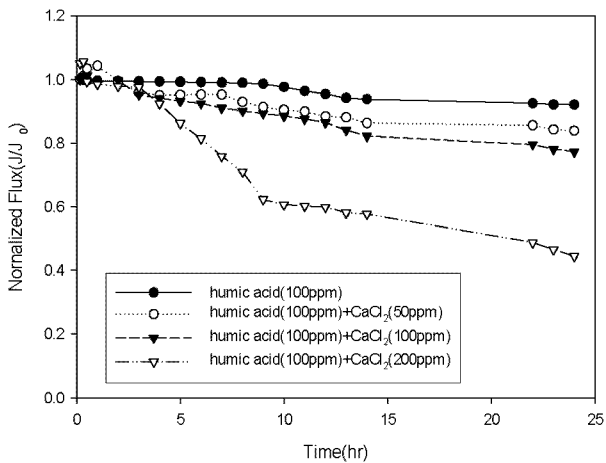


Fig. 1. Effect of calcium concentration on humic acid fouling.