Study on the Dissolved Oxygen Removal using Catalytic PP Membrane

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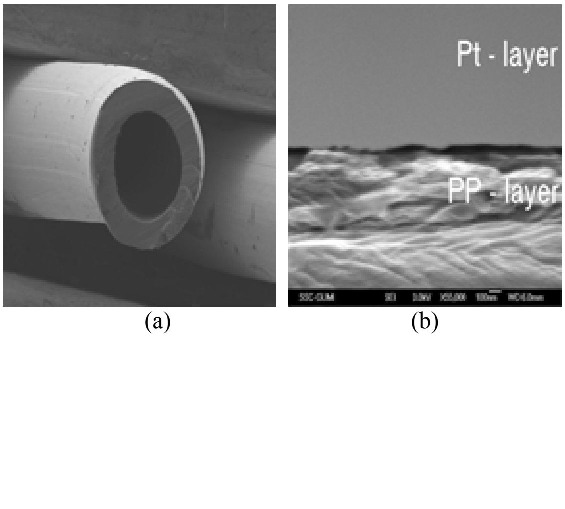
1. Introduction

In the Nuclear Power Plant of each country, catalyst resin or degassing membrane is used instead of chemical agents to remove the dissolved oxygen in the reactor water[1]. Westinghouse's Catalytic Oxygen Removal System(CORS)[2,3], which uses ion exchange resin impregnated with Pd, is known to have the best DO(Dissolved Oxygen) removal efficiency in once-through feed water system at present. Recently degassing membrane is widely used in power plant's feed water system for DO removal. Degassing membrane has some advantages; it removes other dissolved gases such as CO_2, N_2, as well as O_2, and is more economical than CORS. Although DO removal efficiency of degassing membrane is lower than CORS, this aspect can be overcome by adopting a recirculating water treatment system.

This study was performed to investigate the effect of impregnation of membrane module with a metal catalyst such as Pd and Pt on its DO removal efficiency.

2. Experimental

We impregnated the surface of the hollow fiber that was provided by Celgard company with Pt, Pd and radiation exposure in diverse ways[4]. We modified the surface of PP hollow fiber membrane by ion beam treatment. After exciting the surface of PP membrane by Ar ion, we sputtered Pd and Pt on the surface of membrane as metal catalyst. SEM Photographs of membrane impregnated with Pt as shown in Figure 1. The treated hollow fiber was used for making a standardized module, as shown in Figure 2. The DO removal efficiencies of all fabricated modules were investigated by changing factors such as treatment flow amount, hydrogen flow rate and the degree of vacuum.



(a) (b)

Figure 1. SEM Photographs of Membrane impregnated with Pt. (a) Cross-sectional figure of Membrane , (b) Cross-sectional figure of Membrane (X 55,000)

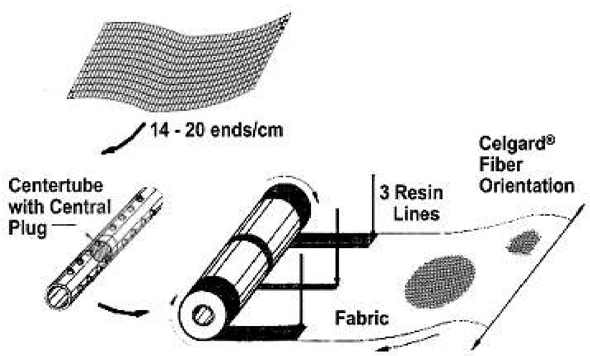


Figure 2. Schematic diagram of a making process for standardized module

2.1 Treatment by Plasma

We modified the PP hollow fiber membranes by plasma treatment and sputtered Pd, Pt as metal catalyst on the surface of the membranes[5]. Plasma treatment was carried out with atmospheric pressure plasma using dielectric barrier discharge (DBD) technology. By plasma treatment, free radicals were generated on the surface of PP membrane and hydrophobic characteristics were changed to hydrophilic.

2.2 Treatment by Radiation Exposure

To prepare the monomer grafting copolymer, PP hollow fiber membrane fabrics were irradiated by γ-ray from Co-60 under atmospheric pressure and ambient temperature for 24 hr.

2.3 Experimental Condition and Methods

The DO removal efficiency of the produced treated degassing modules by use of catalytic effect was compared with that of non-treatment specimen, Pt impregnation, Pd impregnation and treatment by radiation exposure. By letting a set amount of dissolved hydrogen flow into each degassing module, the catalyst surface was saturated with hydrogen.

Then, under a constant vacuum, the change in water temperature was set to 25, 38℃ to compare and assess the test results for the possibility of DO removal.

(Module size(D×L) 80 mm × 280 mm , Cartridge size 255 mm × 1000 mm)

3. Results and Discussion

As shown in Table 1, 2 the DO removal efficiency of the module with no metal catalyst was the lowest in the lab-scale test of degassing device . The module treated by radiation exposure showed almost similar DO removal efficiency with that of the non-treated module. On the other hand, the modules impregnated with a metal catalyst showed improved DO removal efficiencies. The highest DO removal efficiency (82%) was observed in the module impregnated with Pd. This efficiency is about 7% higher than those of the conventional modules. However, it seems that the increase in DO removal efficiency is not enough to improve the performance of DO removal system in case of once-through treatment of reactor water.

Table 1. Efficiency results of membrane (25℃)

Conditions	Non-treatment	Pt impregnation	Pd impregnation	Radiation exposure
Inlet DO (ppm)	5.7	5.8	5.7	5.7
Outlet DO (ppm)	1.43	1.10	1.03	1.37
DO removal Efficiency(%)	75	81	82	76

Table 2. Efficiency results of membrane (38℃)

Conditions	Non-treatment	Pt impregnation	Pd impregnation	Radiation exposure
Inlet DO (ppm)	5.5	5.6	5.5	5.5
Outlet DO (ppm)	1.27	0.67	0.83	1.21
DO removal Efficiency(%)	77	88	85	78

4. Conclusion

Various modules such as modules non-treated, impregnated with Pt and Pd, and treated by radiation exposure were made using the hollow fibers provided by Celgard company, and their DO removal efficiencies were assessed under hydrogen flow condition by changing the water temperature. The module impregnated with a metal catalyst, especially with Pd showed the highest DO removal efficiency (82%). Further study on DO removal efficiency with Activated Carbon Fiber(ACF) impregnated with Pd is considered for developing a hybrid DO removal technology.

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