

NOK's Humidifying Membrane Module

1. Introduction

Fuel Cells are gradually increasing in acceptance and use due its energy efficiency and are environmentally-friendly. The most popular, the Polymer Electrolyte Fuel Cell (PEFC), generates electricity transferring hydrogen-derived protons from the anode-side to the cathode-side within an ion exchange membrane. Water retention is desired in order to improve the efficiency of the exchange process. A humidifying membrane module has attracted attention as the premiere technology to supply water to the fuel cell (Figure 1). In this page, we'll introduce the principles and methodologies of humidifying membrane modules.

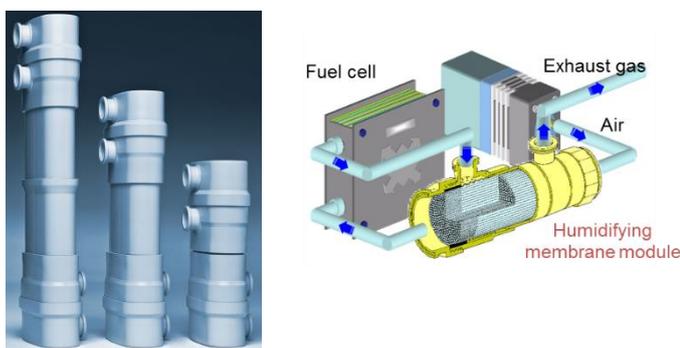


Figure1. Humidifying Membrane Module and its Application

2. Operating principle of humidifying membrane

NOK's current production humidifying membrane is a hollow fiber membrane, with pore sizes in the nano-filtration range (Figure 2). When this membrane exterior contacts air containing water vapor (a Wet Gas), the vapor is condensed within the pores of the membrane according to the capillary condensation theory under the Kelvin Equation. This liquefied water quickly permeates through the pore and becomes water vapor again at the inner membrane surface (Figure 3). This water vapor is then transferred to the fuel cell stack by supplied air (Dry Gas). In addition, since humidifying membranes requires durability and heat resistance, NOK employs Polyphenylsulfone (PPSU Tg:220°C), one of the super-engineered plastics.

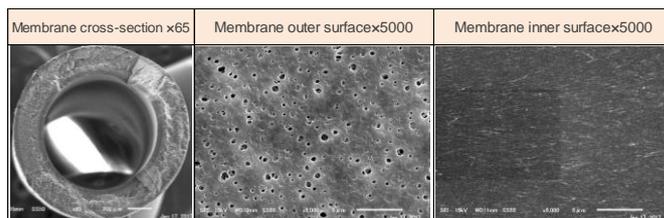
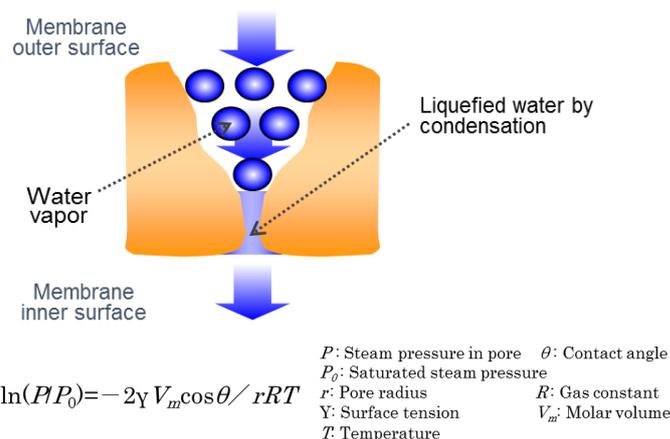


Figure2. Membrane Surface SEM Image



⇒The smaller the pore radius r is, the smaller the steam pressure in pore P which gas (water vapor) is easily condensed in the membrane pore.

Figure3. Capillary condensation at membrane surface and Kelvin equation

3. Manufacturing Methods and Evaluation of Humidifying Membrane Modules

A humidifying membrane module is manufactured by centrifugal potting with epoxy-based adhesive after the membranes are placed into a module case. The humidifying membrane module requires heat resistance (about 110°C), acid resistance, and low elution properties. Therefore, components such as the membrane, epoxy resin for potting, and the case material are carefully selected only after thorough testing.

4. Conclusion

We discussed about the operating principles and manufacturing methods of a humidifying membrane module. Looking towards the forthcoming “hydrogen society”, NOK continues to offer highly effective humidifying membrane modules which meet the customer's needs.