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Performance Analysis of a Planar Membrane Humidifier for PEM Fuel Cell

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Abstract : In this work, the experimental measurement was applied to examine the membrane type and flow field design on the performance of a planar membrane humidifier. The performance indexes were used to evaluate the planar membrane humidifier. The performance indexes of the membrane humidifier include the dew point approach temperature (DPAT), water recovery ratio (WRR), water flux (J) and pressure loss (P). The experiments contain mainly three parts. In the first part, a single membrane humidifier was tested using different flow field under different dry-inlet temperatures. The measured results show that the dew point approach temperature decreases with increasing the depth of flow channel at the same width of flow channel. However, the WRR and J reduce with an increase in the dry air-inlet temperature. The pressure loss tests indicate that pressure loss decreases with increasing the hydraulic diameter of flow channel, resulting from an increase in Darcy friction. Owing to the comparison of humidifier performances and pressure losses, the flow channel of width W=1 and height H=1.5 was selected as the channel design of the multi-membrane humidifier in the second part of experiment. In the second part, the multi-membrane humidifier was used to evaluate the humidification performance under different relative humidity and flow rates. The measurement results indicate that the humidifier at both lower temperature and relative humidity of inlet dry air have higher DPAT but lower J and WRR. In addition, the counter flow approach has better mass and heat transfer performance than the parallel flow approach. Moreover, the effects of dry air temperature, relative humidity and humidification approach are not significant to the pressure loss in the planar membrane humidifier. For the third part, different membranes were tested in this work in order to find out which kind membrane is appropriate for humidifier.

Keywords : water management, planar membrane humidifier, heat and mass transfer, pressure loss, PEM fuel cell
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