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Behavior of Nafion membrane at elevated temperature and pressure

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ABSTRACT

Nafion membrane was studied as a potential electrolyte for a polymer electrolyte membrane (PEM) reactor operating at temperatures in the range of 100–160°C. An attempt was made to avoid the well known problem of the decrease in the conductivity of Nafion at elevated temperatures caused by its insufficient humidification. Elevated pressure was applied. In the first instance the influence of elevated temperature and pressure on the ion exchange capacity of a Nafion membrane, one of the main characteristics, was tested in selected environments. One environment tested was 14.7 M H_3PO_4 used nowadays generally for the high temperature proton conducting polymer electrolytes. 0.5 M H_2SO_4, demineralized water and an open atmosphere represent the remaining environments under study. The most significant deterioration of the ion exchange capacity of the membrane was observed in 0.5 M H_2SO_4. In contrast to this, 14.7 M H_3PO_4 and an open air atmosphere left the membrane properties almost unchanged. Subsequently Nafion's conductivity was determined in the temperature range of 110–150°C at pressure up to 0.65 MPa. As anticipated, it was found that Nafion also exhibits sufficient conductivity above 100°C at 100% relative humidity of the environment. The conductivity decrease was observed during prolonged experiments. Surprisingly enough, no related changes in the structure of Nafion were indicated by IR spectroscopy, one exception being the sample stored in an autoclave for a prolonged time in 0.5 M H_2SO_4.

Keywords: Polymer electrolyte; Perfluorosulfonic acid; Membrane conductivity; Elevated temperature; IR analysis

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