Polybenzimidazole membranes for zero gap alkaline electrolysis cells

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Citation (APA):
Membranes of m-PBI doped in KOH (aq), 15-35 wt%, show high ionic conductivity in the temperature range 20-80 °C. In electrolysis cells with nickel foam electrodes m-PBI membranes provide low internal resistance. With a 60 µm membrane thickness range 20-80 °C, ionic conductivity in the temperature range 20-80 °C, 60+35 wt%, show high m-PBI polymer membranes for zero gap alkaline electrolys.

For m-PBI membranes in aqueous KOH (aq) solutions of more than 15 wt%, KOH (aq), 15-35 wt%, show high ionic conductivity. Membranes of m-PBI polymer membranes for zero gap alkaline electrolys.

One of the distinct disadvantages of alkaline electrolysis is the use of a pH 13-14 depolarizer as an electrolyte-containing separator. Commonly investigated alternatives are often aromatic exchange polymer membranes or ion-exchanging polymer membranes.

A promising ion-exchanging polymer is poly(2,2’-(m-phe

nylene)-5,5’-bibenzimidazole), m-PBI. When equilibrated in aqueous KOH solution, the polymer deprotonizes, and at >15 wt% KOH (aq) the polymeric form predominates [1]. For membranes, this results in breaking of intermolecular hydrogen bonds, which decreases mechanical robustness and allows for significant swelling and electrolyte uptake. As a result, a ternary m-PBI-H2O-KOH system is formed which displays a high ionic conductivity.

Cell polarization

For zero gap electrolysis cell measurements, m-PBI membranes were equilibrated in aqueous KOH at a given concentration overnight prior to cell assembly. Electrodes were pressed (thickness = 210 µm) nickel foam. Figure 3.

Current-voltage curves are presented in Figure 4. Data were recorded by scanning the potential from 1.2 to 2.5 V at 2.0 mV/s. The cells were operated at 80 °C.

The cell house and external setup is displayed in Figure 5, on the right. Aqueous KOH with concentration identical to the doping solution is circulated on both sides.

Novel electrode concepts

Hydrogen evolution

Increasing the active surface area of nickel catalysts is an efficient way to improve the hydrogen evolution activity. This is commonly done by using Raney catalysts, or by immobilizing nickel powder through the use of a binder, e.g., PTFE, or both [3].

We are using m-PBI polymer as a binder to make porous electrodes. The good alkaline stability and hydrophilic properties makes this an interesting binder for alkaline electrolysis in particular.

So far, we have prepared electrodes by first dissolving ~5 wt% KOH and room temperature. Scan rate 2 mV/s.

Electrodes can be made in various ways, here, Figure 7, an electrode prepared by a hydrothermal process using urea, and nickel and iron nitrates is presented. This demonstrates the huge potential for overall cell improvements.

Oxygen evolution

Increasing the active surface area of nickel does not seem to have the same effect on the OER compared to the HER. However, recent research has shown that Fe-doped nickel hydroxide in a very active OER catalyst [6].

Electrodes can be made in various ways, here, Figure 7, an electrode prepared by a hydrothermal process using urea, and nickel and iron nitrates is presented. This demonstrates the huge potential for overall cell improvements.

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References


