Electrochemical conversion of Anhydrous HBr to Br_2 for Hydrogen Production

PremKumar Sivasubramanian & John W. Weidner
Center for Electrochemical Engineering
Department of Chemical Engineering
The University of South Carolina
Columbia SC 29208

Introduction

Energy sources that have the potential to produce hydrogen at costs competitive with gasoline will be essential components of long term supply of hydrogen[1]. A promising approach to produce hydrogen is via thermochemical cycles. One such thermochemical cycle is the modified UT-3 process. The reactions involved are:

$$H_2O + CaBr_2 \rightarrow CaO + 2HBr \qquad (1)$$

$$CaO + Br_2 \rightarrow CaBr_2 + ½\ O_2 \qquad (2)$$

The HBr thus obtained is fed in vapor phase as the anode feed of the polymer electrolyte membrane (PEM) electrolyzer. The electrochemical reaction is shown here:

$$2HBr \rightarrow H_2 + Br_2 \text{ (electrolysis)} \qquad (3)$$

Another competitive cycle is the Reverse Deacon Process. The reactions involved are:

$$MgCl_2 + H_2O \rightarrow MgO{+}2HCl \qquad (4)$$

$$MgO + Cl_2 \rightarrow MgCl_2 + 1/2O_2 \qquad (5)$$

$$2HCl \rightarrow H_2 + Cl_2 \text{ (electrolysis)} \qquad (6)$$

The electrolytic step in both the cases was carried out and the data is presented in figure 1. The reactor used was similar in construction to the one used by Sathya et al[2].

Experimental

The PEM had an active area of 40 cm^2. The active catalyst was ruthenium oxide coated on carbon cloth. The membrane used was Nafion 105. The flow fields were high flow carbon paper obtained from Spectracorp. The cathode flow field was machined to accommodate two phase flow. The experiments were conducted at a pressure of 30 psig. The anode gas consisted of pure HBr (technical grade). The catholyte was pure (DI) water. The water entered the cell at 75^0C. The cell was maintained at a constant temperature of 80^0C. The anode outlet when current was passed through the cell contained HBr, Br_2 and water with dissolved HBr and Br_2. The cathode outlet had water and hydrogen in a two phase flow coming out of the cell. The experiments were galvanostatic.

Results and Observation

The preliminary results from the test run of the cell are reported here in the figure 1. The figure shows almost a linear relationship between the current potential curves for the reverse Deacon and modified UT-3 cycle. As can be seen the modified UT-3 process shows us better VI characteristics in that a lower potential is exhibited for the same conversion and same amount of hydrogen produced. This has the added advantage that a higher conversion and current density can be used which reduces that capital cost due to lower foot print in terms of reactor area.

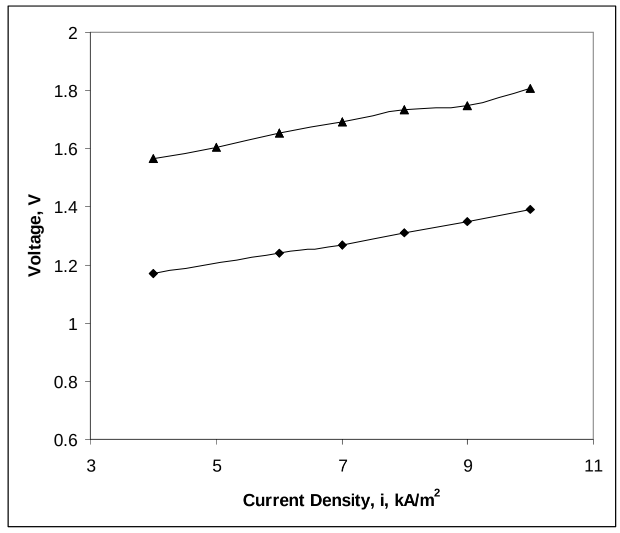

figure1: The ▲ represent the data from the Reverse Deacon cycle (reaction 6). The ♦ are the data from the modified UT-3 cycle (reaction 3). Both the runs were conducted at a pressure of 30 psig and a temperature of 80 ^{0}C.

Acknowledgement

We wish to thank DuPont and the USC research foundation for the support provided.

References

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2. S. Motupally, D.T. Mah, F. J. Freire and J. W. Weidner “Recycling Chlorine from Hydrogen Chloride” *Interface* 7(3), 32-36 (1998).