Current Distribution Measurement in a Large-Scale PEM Fuel Cell

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The polymer electrolyte membrane (PEM) fuel cells are expected as the automotive power sources. Among the difficulties of this application, the broad range of the load and the various operating conditions make it difficult to optimize the cell design. Because of the large active area in addition to the variety of the operating conditions, it is nearly impossible to obtain the uniform in-plane internal conditions. The current distribution measurement using the segmented cell is a well-known method to understand such nonuniformities. In this study a new configuration of the segmented cell is introduced and the effectiveness of this method is presented.

The configuration of a segmented cell in this study is shown in Fig. 1. Most remarkable characteristic in this cell is, different from the reported studies, that the current collector in the anode side is the only segmented component. Therefore this segmentation has little effect on the overall performance. The current of each segment is measured using the Hall-type current sensor and discharged by the common electric load.

Fig. 2 shows the flow pattern of this cell. The reactant gases flow through the vertical path (manifold) and are distributed to the horizontal, parallel channels. The current collector segments are aligned in 3x2. The total active area of the cell is 300cm2.

Fig. 3 is a typical result of the current distribution measurement. Since the relative humidity of the reactant gases are 30%, in the upstream of the each channel (segments 1, 2, 3) the membrane tends to dry out and the resistance increases. On the other hand, the gases are humidified in the upstream and enter the downstream of the channels (segments 4, 5, 6). Therefore the membrane in the downstream gets hydrated. Hence, in Fig. 3 the upstream segments 1, 2, 3 have less currents than those of the downstream segments 4, 5, 6. Furthermore, the gases provided to the segments 3 and 6 are more than the other segments due to the stagnation effect of the inflow, therefore the flow rate and the velocities of these segments are larger than other segments. It causes the more removal of the water from the membrane. Thus the current of the segment 3 is less than other upstream segments 1 and 2. Subsequently, because of the less consumption of the gases in the upstream segment 3, more gases are provided to the segment 6. As a result the segment 6 has the largest value of the current.

Thus, the current distribution measurement of this configuration can be a powerful tool to diagnose the internal condition of the cell and optimize the cell design. In the future this method will be applied to the other flow patterns and the various operating conditions.

References

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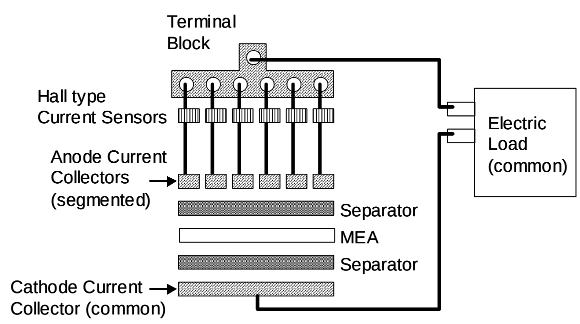

Fig. 1. Cell and measurement configuration

Fig. 2. Flow pattern and segmentation

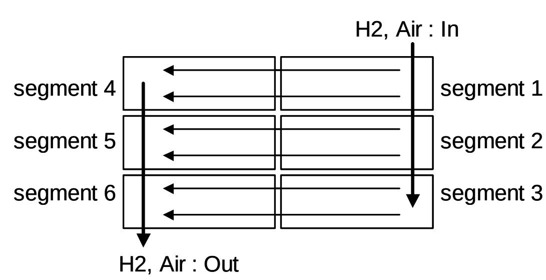

Fig. 3. Current distribution