Optimization of Fuel Cell Generation Environment by Observation of Water Using Neutron Radiography

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Fuel cell electric vehicles are seen as holding considerable promise as an ultimate ecologically friendly vehicle. We are also proceeding with development in this area, for example in the leasing of the FCX Clarity.[(1)]

However, in order to develop fuel cells displaying both high performance and high durability, it is essential to control accumulated water and water content in the cell. While a specific minimum amount of water is necessary to help ensure the proton conductivity of the membrane electrode assembly (MEA), if the amount of water is excessive, accumulated water impedes the gas diffusion necessary for the generation of electricity. It is therefore important in fuel cell development to understand the internal water environment and to clarify the relationship between water and performance.

The research discussed in this paper sought to elucidate the relationship between electric generation and water environment in fuel cells using neutron radiography measurements, an effective means of observing the behavior of water. In order to realize this goal, the research made possible the following types of observation and attempted to clarify the mechanism of water behavior in the cell:
-Observation was performed from both the through-plane and the in-plane directions to accurately observe the distribution and locations of accumulated water.
-Observation in the through-plane direction was performed using an actual cell in order to observe the accumulated water distribution conditions in the cell installed in the vehicle. (Fig.1)
-The in-plane direction was performed using a specially designed cell for isolating the positions of the accumulated water in each gas channel.

The following results were obtained:
・The effects of accumulated water on the cell voltage behavior during electric generation with a neutron radiography were clarified.
・The relationship between the standard deviation (SD) of cell voltage behavior and the average volume of accumulated water during the same time period (Fig. 2) demonstrated that the cell water environment had an effect on voltage behavior during power generation .
・Observations of water in the in-plane direction indicated that the water environment differs depending on the stacking position and the gas channels, and this phenomenon originates in the generation environment.
This paper will discuss this research, together with the results of applying its findings in an actual vehicle system.

(1) N. Saito, H. Kikuchi, Y. Nakao, : New Fuel Cell Stack for FCX Clarity, Honda R&D Technical Review, Vol. 21, No. 1, p. 16-23

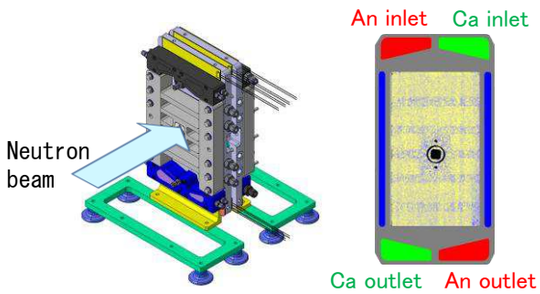

Figure 1. Schematic and neutron images of through-plane cell

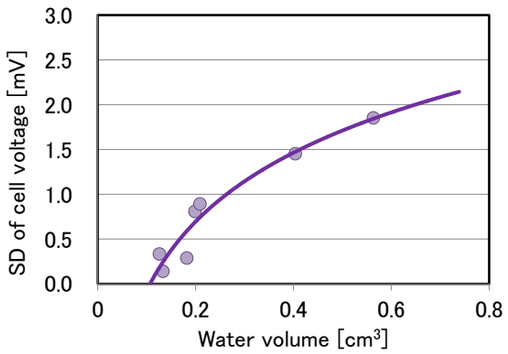

Figure 2. Standard deviation (SD) of cell voltage and water volumes