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Experimental and Numerical Studies on Hydrogen Behavior in a Small-Scale Container with Passive Autocatalytic Recombiner

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Abstract : One of the most important issue is to ensure the safety of long-term waste storage containers in which fuel debris and radioactive materials are accumulated. In this case, hydrogen generated by water decomposition by radiation is accumulated in the container for a long period of time, so it is necessary to reduce the concentration of hydrogen in the container. In addition, a condition that any power supplies from the outside of the container are unnecessary is requested. Then, radioactive waste storage containers with the passive autocatalytic recombiner (PAR) would be effective. The radioactive waste storage container with PAR was used for moving the fuel debris of the Three Mile Island Unit 2 to the storage location. However, the effect of PAR is not described in detail. Moreover, the reduction of hydrogen concentration during the long-term storage period was performed by the venting system, which was installed on the top of the container. Therefore, development of a long-term storage container with PAR was started with the aim of safely storing fuel debris picked up at the Fukushima Daiichi Nuclear Power Plant for a long period of time. A fundamental experiment for reducing the concentration of hydrogen which generates in a nuclear waste long-term storage container was carried out using a small-scale container with PAR. Moreover, the circulation flow behavior of hydrogen in the small-scale container resulting from the natural convection by the decay heat was clarified. In addition, preliminary numerical analyses were performed to predict the experimental results regarding the circulation flow behavior and the reduction of hydrogen concentration in the small-scale container. From the results of the present study, the validity of the container with PAR was experimentally confirmed on the reduction of hydrogen concentration. In addition, it was predicted numerically that the circulation flow behavior of hydrogen in the small-scale container is blocked by steam which generates by chemical reaction of hydrogen and oxygen.

Keywords : hydrogen behavior, reduction of concentration, long-term storage container, small-scale, PAR, experiment, analysis
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