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Development of Helium Leak Detection Methods for Canisters (Part 1) -Evaluation of Minute Gas Leaks from Canisters by Small-scale Models

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As for the concrete cask, because its canister is a welded construction, a helium leak from the canister wasn' t considered in the past. However, during long-term storage of spent fuel, stress corrosion cracking (SCC) could occur at welded parts of the canister, so that a loss of sealing performance is concerned now. To resolve this concern, we have been developing methods for detecting the leak by using a canister surface temperature change which occurs when the gas leaks from the canister. We performed leak tests using full-scale concrete cask models in 2003, and found the phenomenon that the temperature at the lid part (TT) of the canister decreases and the temperature at the bottom (TB) of the canister increases when the gas leaks from the canister. As a result, we proposed a method for monitoring the temperature difference ΔTBT (= TB-TT) instead of the internal pressure. Recently, we proposed new detection methods using only the temperature of either the lid or the bottom of the canister in consideration of easy installation and maintenance of temperature sensors. Besides, we conducted leak tests using a 1/18-scale canister model, and succeeded in the reproduction of the phenomenon that the temperature of TT decreases and the temperature of TB increases during the leak from the canister. A mechanism of this phenomenon was verified by performing numerical analysis. We also performed leak tests by using a 1/4.5-scale cask model based on the similarity law of thermal hydraulics. In the tests, air was used for an inner gas of a canister of the model, and the heat flux of the canister surface had the same value as that of the actual canister surface. Thus, the Ra*number of the model could be made to coincide with that of the actual canister. Besides, the Gr* number and Bo* number were almost equal to those of the actual canister. In these tests, we generated minute leaks of the inner air, and measured the temperatures of the canister surface and outside air at the inlet. Then, we evaluated an early leak detection method based on the correlation of those temperatures.

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