Project Subjects

Transport and Storage for Recyclable Nuclear Fuel

Background and Objective

Japan's basic policy has been to reprocess spent fuel (recyclable nuclear fuel) and to effectively utilize collected plutonium and uranium, etc. Under this basic policy, various efforts should be made as far as reasonably practicable considering some delays in the schedule of the Rokkasho reprocessing plant and the improvement of the plant capacity factor in future.

In this project, to support nuclear power generation with excellent stability and flexible nuclear fuel cycle, we accomplish the early realization of the economical and reliable storage technologies with a large capacity for recyclable nuclear fuel. Furthermore, we propose the safe and rational transport technologies considering the future demand (three times increase as much as now transported) of the shipments of the radioactive materials due to the full operation of the nuclear fuel cycle.

Main results

1. Development of the economical concrete cask storage technologies

For early realization of the austenitic stainless steel canister for the concrete cask storage technology, it is very important to establish a method to prevent penetration through the canister wall thickness due to the stress corrosion cracking (SCC) in salty environments. Therefore, from improvements from the materials and environmental aspects, we proposed the practical solutions for the reduction of welding residual stress of the metal canister and sea salt particles in the cooling natural air [N09]. The salt particle collection device with a low flow resistance for the air inlet of the storage building was proposed. In order to get more assurance of this device, we have started the field test at a coastal site (Fig.1). Furthermore, with the test device simulating the inlet air duct configuration of the concrete cask, we obtained the chloride deposition velocity on the heated stainless steel test specimens installed in wind tunnels in the test house near the sea (Fig.2).

2. Development of the next generation storage system with a large capacity

As a vault storage technology with a large capacity has an economical advantage, under the cooperative research agreement with CEA and EDF, a large reinforced concrete vault structure was heated to around 80°C which could correspond to the evaluation of the thermal cracking and matrix transition, and improvement in the design temperature of 65°C currently applied to the nuclear building. We measured the thermo-hydro-mechanical behavior of such a structure over time (Fig.3).

3. Long-term integrity of the confinement of the transport cask of fresh MOX fuel

To propose the practical inspection period related to the confinement of the transport cask of fresh MOX fuel, we performed the heating-acceleration aging test using several types of erastomer gasket. As a result, their integrities for the long term usage (f years) under 70°C were demonstrated [N09002].

4. Radiological impact assessment at the release from a hypothetically submerged transport package of fresh MOX fuel

Using an ocean general circulation model applied to the projection of global warming, we evaluated concentrations of radioactive materials at the release from sea bottoms due to the hypothetical submergence of the transport package of fresh MOX fuel. We confirmed the estimated dose equivalents for the public were quite smaller than the ICRP recommendation (1mSv/year) (Fig.4) [V09041].

Other reports [L09001]

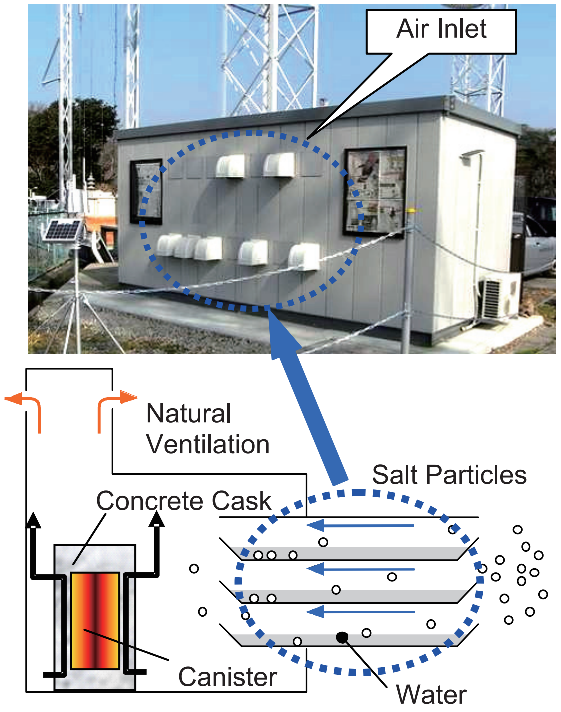

Fig.1 The salt particle collection device

The device is installed at the inlet and composed of multiple trays filled with water.

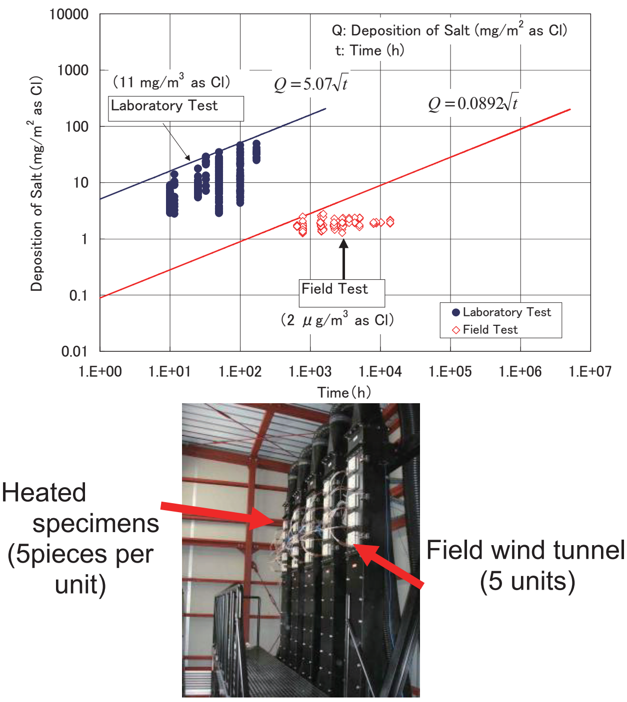

Fig. 2 Comparison of accumulated salt amount profile between laboratory test and field test

The relationship between laboratory test and field test (4km away from the coast) related to the chloride deposition velocity was obtained.

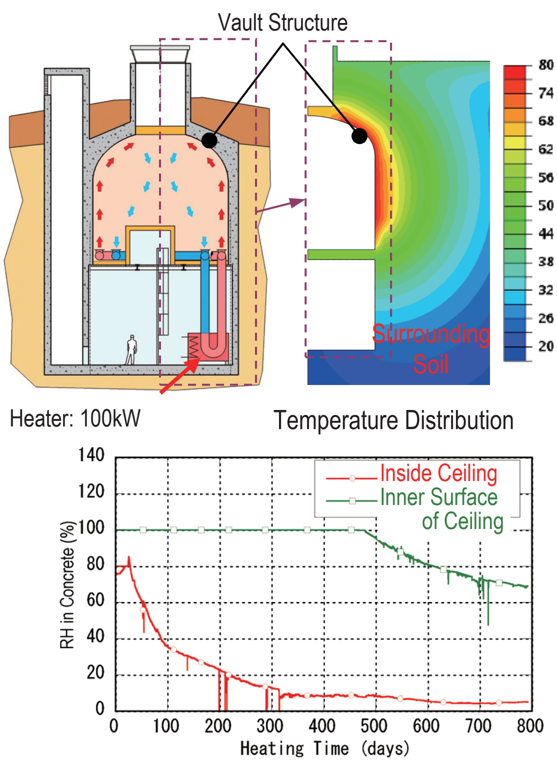

Fig. 3 Temperature profile in the vault and relative humidity evolution inside concrete

A large reinforced concrete vault structure has been heated to 80°C during two years, and the relative humidity evolution profile inside concrete (thickness 55cm) was obtained.

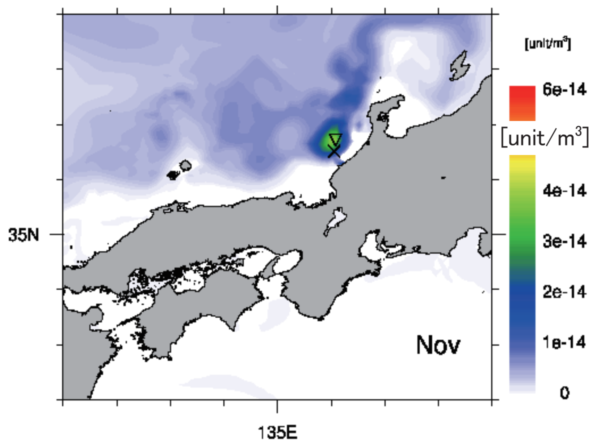

Fig. 4 Distributions of the radionuclides concentrations of radioactive materials at the release from a hypothetically submerged transport package of fresh MOX fuel

Using an ocean circulation model, the concentrations of radioactive materials at the release from sea bottoms for coastal areas were estimated. The monthly mean tracer concentration (unit/m^3) in the ocean surface layer (0-100m depth) was acquired from the simulation by the seasonal changed flow field. We confirmed that the patterns of seasonal change were same after second simulated years from the simulation for three years. X shows the release point of tracer in January of first simulated year. ▽shows the maximum concentration in November of third simulated year.