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Development effort on mitigation and detection of aging of canisters

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In order to use the concrete cask system for the storage of spent fuels in Japan, it's necessary to establish method to manage aging effect, especially SCC (Stress Corrosion Cracking). Therefore, the methods are under development to mitigate SCC, to inspect crack, and to monitor confinement of a canister. For the mitigation of SCC, one of following factors should be kept in the certain conditions; residual stress, environment and material. The method has been chosen to make surface residual stress compressive by ZSP (Zirconium Shot Peening) and WJP (Water Jet Peening). At a fabrication factory, ZSP is used because of its economic advantage. At a nuclear power plant, WJP is utilized because its garbage, water is easy to treat at a nuclear power plant. The value of compressive residual stress and the depth of its layer induced by ZSP and WJP have been experimentally confirmed. Pitting corrosion can occur on a metal surface regardless of its conditions. Once pitting corrosion penetrates the compressive residual stress layer, SCC may occur at the tip of pitting corrosion and finally penetrates the canister shell. The pitting corrosion depth on SS Type 316L surfaces has also been measured for 10,000 hours under various conditions, and estimated its growth rate. The estimated depth of pitting corrosion during the storage period is shallower than that of the compressive residual stress layer induced by ZSP and WJP. Additionally, the development of Non-Destructive Testing (NDT) method to inspect cracks in case SCC penetrates the compressive residual stress layer has been succeed. As the canisters is loaded with spent fuels, the method should be available in radiation environment. Eddy Current Testing (ECT) is chosen from various NDT methods because it is easy to operate ECT automatically and remotely. The magnetized weldment of a canister made of SS Type 316L interferes with inspection of cracks with ECT. It has been succeed in improving ECT method which is able to remove the magnetic noises. This improved ECT method allows to detect cracks by a millimetre unit.

Relating to the method to monitor confinement of a canister, the principle of this method is that it's only necessary to check the temperature difference between top and bottom of the canister in order to monitor the inner gas leakage. The principle has been confirmed experimentally and analytically. As mentioned above, the authors have established the methods to mitigate SCC, to inspect crack, and to monitor confinement of a canister.

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Country or International Organization

Japan

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