Review of the Appropriateness of the Steady State Thermal Analysis method for the safety analysis of a new CANDU Spent Fuel Disposal System

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1. Introduction

The thermal assessment of a new CANDU spent fuel disposal system, which improves the retrievability of a spent fuel and enhances the densification factor compared with the Korean Reference disposal System, was carried out in the Korea Atomic Energy Research Institute (KAERI). The steady state thermal analysis was performed to calculate the surface temperature of the disposal canisters in the disposal tunnel. In this study, we reviewed the appropriateness of the steady state thermal assessment method.

2. Methods and Results

Based on the result of KAERI's study, the transient state thermal analyses are performed at a part of the disposal tunnel wall and the disposal canister in the tunnel in this study.

2.1 The new disposal system for CANDU spent fuels.

The disposal canisters for CANDU spent fuels are stored for a long term and cooled by a natural convection. The steady state thermal analyses were carried out with the ANSYS 10.0 CFX code. The disposal tunnel is 510m long and it is located at a 500m depth from the ground surface. The 320 disposal canisters are accommodated in a disposal tunnel and 420 CANDU spent fuel assemblies are loaded into a disposal canister [1]. Figure 1 shows the new CANDU disposal tunnel model.

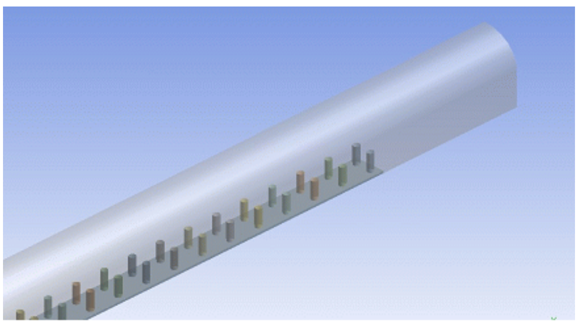

Figure 1. The new CANDU disposal tunnel

2.2 Transient Analysis for the Canisters in the Disposal tunnel.

The surface temperature of the disposal canister for the CANDU spent fuels, in the air, reaches the temperature of the thermal steady state in 20 hours [2]. In this case, the CANDU disposal canisters are in the disposal tunnel and the disposal tunnel wall temperature is fixed.

The result of the transient thermal analysis for the disposal canisters shows that the surface temperature of the canisters reaches the steady state condition in a month. Figures 2 and 3 show the transient thermal analysis model for the disposal canisters and the surface temperature of the hottest canister.

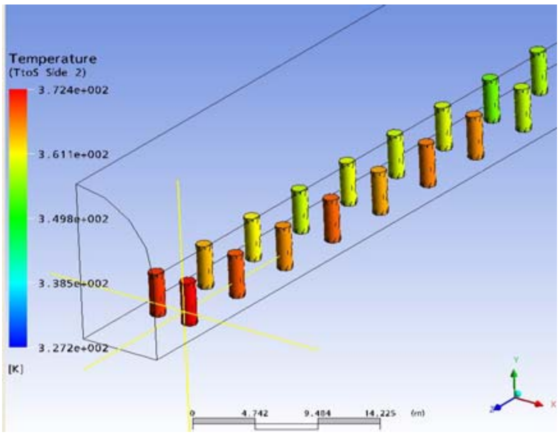

Figure 2. The transient thermal analysis model for the CANDU disposal canisters

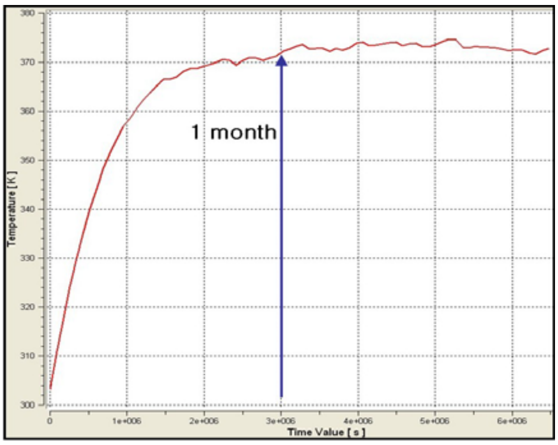

Figure 4. The surface temperature of the CANDU disposal canisters

2.3 Transient Analysis for the Disposal tunnel.

The result of the transient thermal analysis for the disposal tunnel shows that the wall temperature of the disposal tunnel is still increasing after 1 year. Figures 4 and 5 show the transient thermal analysis model for the disposal tunnel and the wall temperature at the hottest point of the disposal tunnel wall.

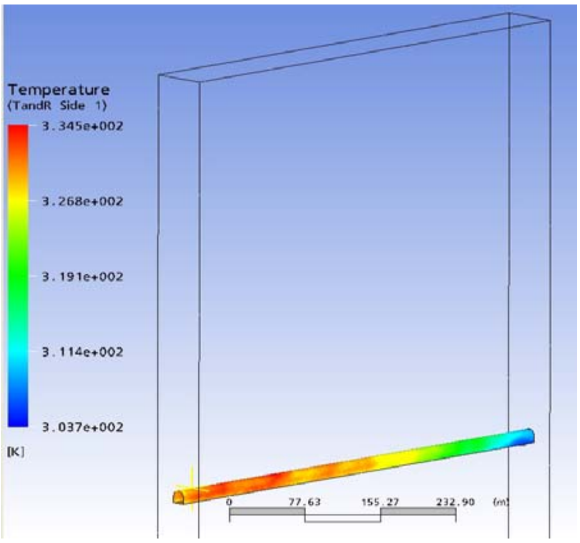

Figure 4. The transient analysis model for the CANDU disposal tunnel

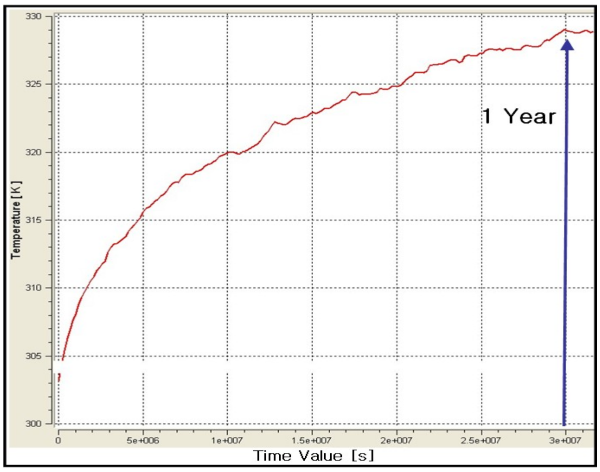

Figure 5. The wall temperature for the CANDU disposal tunnel

3. Conclusions

As for the results, the wall temperature of the disposal tunnel is changing slowly, much slower than the surface temperature of the disposal canisters. It means the wall temperature of the disposal tunnel is not decreased, according to the decay heat which is decreasing exponentially. Thus, the wall temperature of the disposal tunnel has a peak point. And it is expected that the wall temperature, in the left side of the peak point, will be lower than the steady state wall temperature and the wall temperature, in the right side of the peak point, will be higher than the steady state wall temperature.

In KERI's study, the thermal analyses were performed through 2 steps. At the first step, the steady state disposal tunnel wall temperature was defined and at the second step, the steady state disposal canister surface temperature was defined with the maximum disposal tunnel wall temperature. Thus, the results of KAERI's study are conservative enough.

REFERENCES

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[2] J. H. Cha, B. S. Youn, H. J. Choi, J. Y. Lee, S. W. Lee, and S. N. Kim, "The thermal analysis of the initial surface temperature for long-term storage canister for the CANDU spent fuels", Proceeding of the Korean Radioactive Waste Society, May, 2008.