Assessment of Core Status of TEPCO's Fukushima Daiichi Nuclear Power Plants (68) A new heat transfer model for simulating Corium-Concrete Interaction in DSA module of SAMPSON code

*Mirco Di Giuli, Marco Pellegrini and Masanori Naitoh

[1]The Institute of Applied Energy (IAE)

During a severe accident in a nuclear reactor corium may fall and spread over the concrete basemat of the reactor pit. Molten Core Concrete Interaction (MCCI) then occurs, characterized by concrete ablation. This paper discusses a new heat transfer correlation implemented in the DSA module of SAMPSON code to reproduce the ablation behavior of different type of concrete and its application to simulate CCI-2 and CCI-3 tests.

Keywords: MCCI, Siliceous concrete, Corium, Het Transfer Coefficient, Crust, SAMPSON

1. Introduction

One of the major issues raised by MCCI is how the 2D cavity ablation in an oxidic pool evolves. In case of calcareous/limestone concrete the MCCI leads to a 2D isotropic ablation, on contrary the siliceous/basaltic concrete shows an anisotropic behavior lateral ablation about 3 times axial ablation. The DSA is the debris spreading analysis module of the severe accident code SAMPSON, which models corium natural convection, heat transfer and concrete erosion in three dimension. In order to simulate the different behavior observed during CCI-2 and CCI-3 experiments [1], a new heat transfer correlation was implemented in the DSA module.

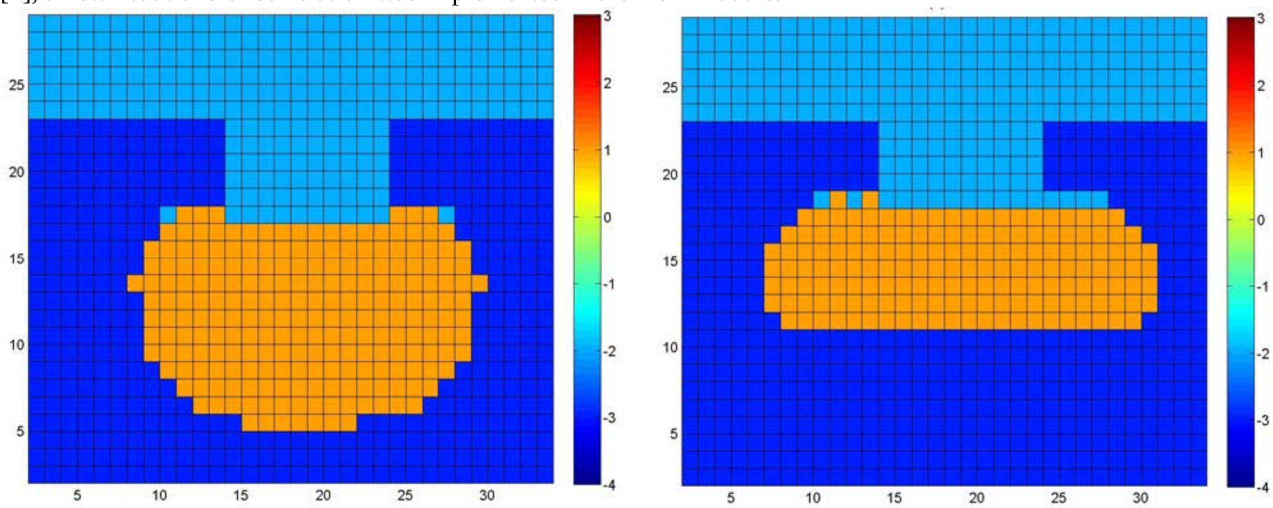

Figure 1 : CCI-2 and CCI-3 final state predicted by DSA module

2. Results and methodology

Starting from the works of Ross [2], the presence of a stable crust at the horizontal corium/concrete interface was assumed. The crust thickness has been calculated as function of the corium properties, the radius and the content of refractory gravel (silica, clinker) in the concrete. The presence of this stable crust increases the thermal resistance at the bottom corium/concrete interface and the heat flux to the vertical walls. The new heat correlation has been verified by comparison the DSA predicted results of CCI-2 and CCI-3 simulations with the test data. The preliminary results of the CCI-2 and CCI-3 calculation using DSA module showed a good agreement with the experimental data. The corium/concrete interface model can simulate the heat flux distribution along lateral and bottom interface and thus the anisotropic ablation observed in the CCI-3 test. The DSA module reproduces well, also the CCI-2 experiment ablation, confirming its capability for high-precision MCCI analysis.

3. Conclusion

Further validation of the model against different experiments are compulsory to confirm its potential. As far as reactor application the model could be used to analyze the Fukushima ex-vessel scenario, given that the basaltic concrete, which made up the Fukushima reactor cavities, should be shown the same behavior of the silica concrete.

4. Acknoledgment

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References

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