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Evaluation for KAERI 6×6 Reflood Test Using TRACE Code

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1. Introduction

The Safety and Performance Analysis Code for Nuclear Power Plants (SPACE) has been developed by the Korean nuclear industries. The SPACE is a best-estimated two-phase three-field thermal-hydraulic analysis code to analyze the performance of pressurized water reactors [1] and is under a licensing review by the regulatory body. For a new code, various SET/IET assessments should be performed to identify the accuracy of code/model. Among the SETs to evaluate the effect of reflood heat transfer, the KAERI 6×6 reflood test was evaluated by the only SPACE code. The 6×6 reflood test facility (ATHER) has been constructed at KAERI to investigate quantitatively the mechanism of reflood phenomena during the reflood phase of LBLOCA and to evaluate the effect of droplet flow on core cooling during the reflood phase [2].
In this study, the ATHER test was assessed independently by the TRACE code. The objectives of this study are to identify the prediction capability of TRACE code and to utilize the prediction results for the review of SPACE code. The TRACE V5.0 patch 4 was used in this calculation [3].

2. Modeling of ATHER

The test section of ATHER consists of a simulated 6×6 rod bundle, a flow housing, 4 pairs of glasses for a visual observation and the instrumentation. Axial power shape of the heater rod is of cosine shape and the peaking factor and the heated length of the rod bundle are 1.468 and 3.810 mm, respectively, as shown in Fig. 1.

Table I. Initial Condition of Experiments

Ex. Number	EP22-50030	EP62-70030
Initial max. heater temp. (K)	772.5	972
System pressure (MPa)	0.2	0.6
Reflood time (sec)	127.4	111.6
Reflood velocity (cm/sec)	2.0	2.0
Reflood flow rate (kg/sce)	0.0739	0.0734
Reflood water temp. (K)	304.6	305.6
Total power (kW)	10.45	10.82

The test section was modeled as a PIPE component of TRACE with 20 axial volumes. The 30 heater rods were modeled as 1 heat structure and the unheated rods, the guide tube and the test section shroud were considered as the separate heat structure. The outlet that was the pressure boundary and the inlet that was the flow boundary were modeled as a BREAK and a FILL components, respectively. The initial conditions were obtained from the experimental data as shown in Table I.

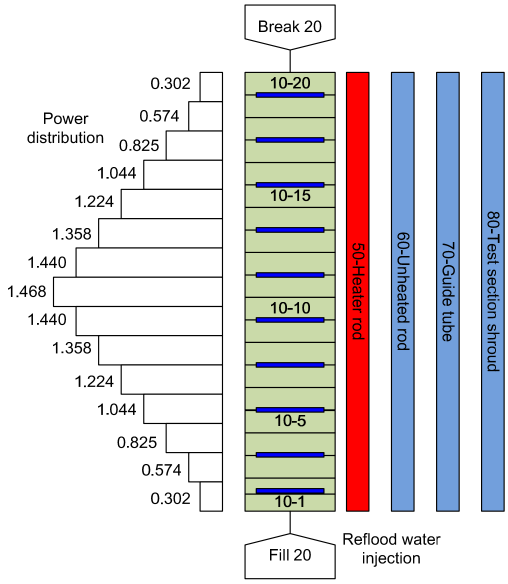

Fig. 1 TRACE Modeling of ATHER

3. Analysis Results

In the experiments, the total thermo-couples were 102 and were divided as 3 groups according to the axial direction. Table II shows the axial positions of the experimental and calculation data.

Table II. Axial Positions of Exp. and Calc. Data

Experimental data		TRACE Code	
Inst. ID	Elevation(m)	HS Cell No.	Elevation (m)
TW1-R09-3	0.48	HS50-04	0.508
TW1-R29-4	0.95	HS50-06	0.908
TW1-R29-5	1.35	HS50-08	1.308
TW1-R29-6	1.75	HS50-10	1.708
TW1-R27-4	2.08	HS50-12	2.108
TW1-R17-1	2.55	HS50-14	2.508
TW1-R17-2	2.95	HS50-16	2.908
TW1-R17-3	3.12	HS50-17	3.108

Fig. 2 shows the initial temperature distribution. The calculated initial conditions showed a good agreement to the measured values for wall temperature.

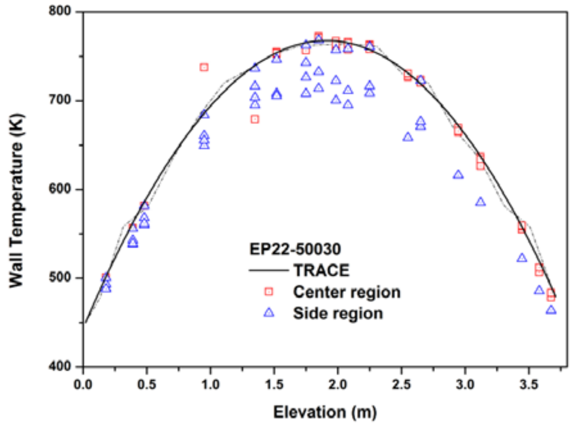

Fig. 2 Initial temperature distribution (EP22-50030)

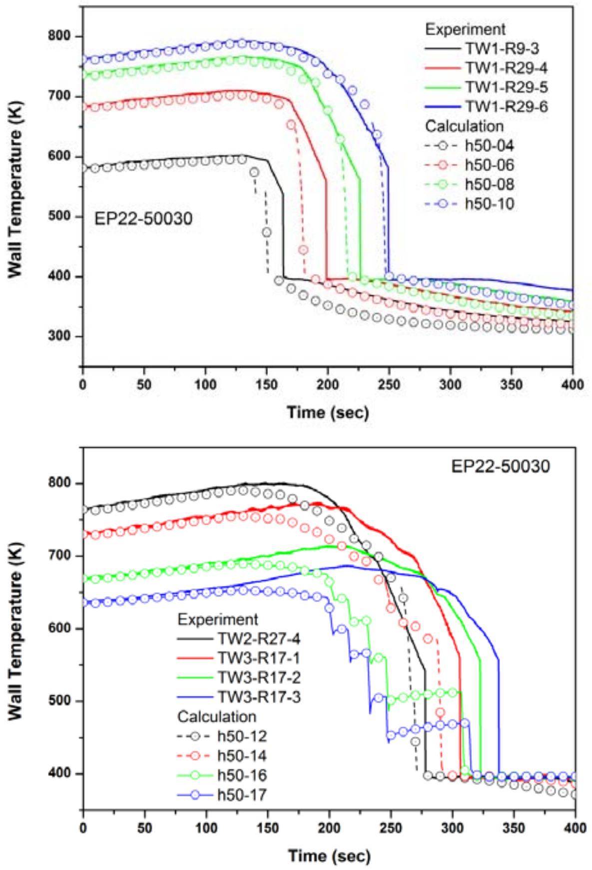

Fig. 3 Wall temperature distribution (EP22-50030)

Fig. 3 shows the predicted and measured wall temperature. For initial ~ 130 sec when the reflood water was injected, the measured wall temperature behavior agreed well to the TRACE prediction. After the reflood was started, the wall temperature showed a relatively good prediction to an elevation of ~ 2.1 m except the rapid drop of wall temperature after quenching. However, at an elevation of over ~ 2.5 m, the predicted wall temperature was lower than that of the experiment and the quenching of heated wall occurred earlier around ~ 250 sec compared to the measured data. It may be resulted from the increment of vapor heat transfer due to the high void fraction.

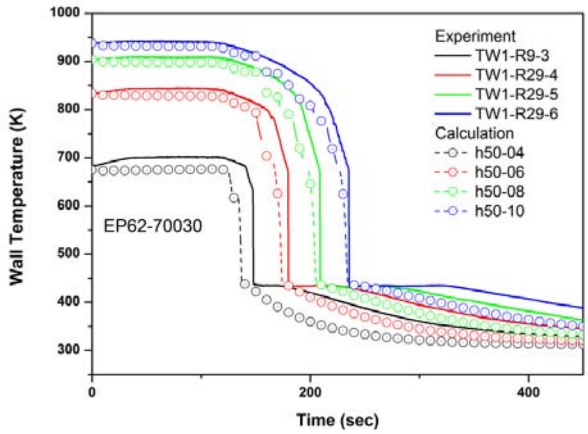

Fig. 4 Wall temperature distribution (EP62-70030)

Fig. 4 shows the wall temperature distribution for EP62-70030 experiment. The overall wall temperature behaviors were similar to those of the EP22-50030 experiment. The wall temperature were predicted well to the measured values to a middle elevation.

4. Conclusion

The calculation for the 6×6 reflood test (ATHER) was performed with the TRACE code. From the calculation results, the major behavior of the wall temperature could be predicted well. However, the further study will be needed to resolve the differences of quenching behaviors and to understand the reflood heat transfer model of TRACE code.

Acknowledgments

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