Validation of the Fuel Heat Transfer Model of the TASS/SMR code with Experimental Data

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1. Introduction

For the safety evaluation of, the SMART (System-integrated Modular Advanced ReacTor) [1], which is the integral reactor under development in the Korea Atomic Energy Research Institute (KAERI), the TASS/SMR [2] (Transient And Setpoint Simulation/System-integrated Modular Reactor) code is used as a safety analysis method.

The TASS/SMR code is a one dimensional, thermal-hydraulic system analysis code in which the drift flux model, the point kinetics model, and the specific component models for the integral reactor are contained.

One of the component models is the fuel heat transfer model. The role of this model is to calculate the heat flux at the fuel rod surface and the radial temperature distribution of the fuel rod.

The fuel heat transfer model of the TASS/SMR code is one of the most important models in the capability of safety analysis. Therefore, an appropriate validation of the fuel heat transfer model is required in both an analytical and experimental way.

In this paper, some of the experimental validation works of the fuel heat transfer model is presented.

2. Experimental Validation of the Fuel Heat Transfer Model

2.1 Overview of the THTF Experiment

For the validation of the fuel heat transfer model, simulations of a film boiling experiment were performed and compared with the experimental data. The selected experimental data are the THTF test 3.07.9B, the steady state experiment [3], and 3.06.6B, the transient experiment [4].

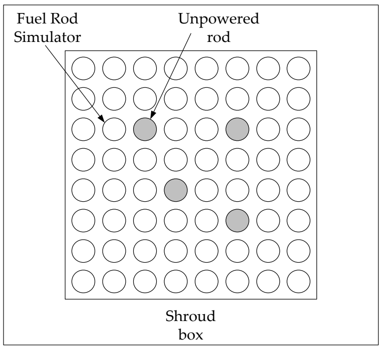

Fig. 1. Cross sectional view of the THTF FRS, 8×8 rod bundles

THTF is a non-nuclear pressurized water loop. The test section of Fig. 1 consists of 64 full length rods (Fuel Rod Simulator: FRS) arranged in an 8 × 8 bundles.

The experimental (or initial) conditions are listed in Table 1.

Table 1. Experimental conditions of the THTF test for the validation of the fuel heat transfer model

Cases	Mass flux (kg/m^2s)	Heat flux (kW/m^2)	Pressure (MPa)
3.07.9B	705	914	12.76
3.06.6B(I.C)	964	347	14.9
SMART	1010	394	15

2.2 Simulation of the Experiments with TASS/SMR

The selected cases are simulated with the TASS/SMR code for the modeling depicted in Fig. 2.

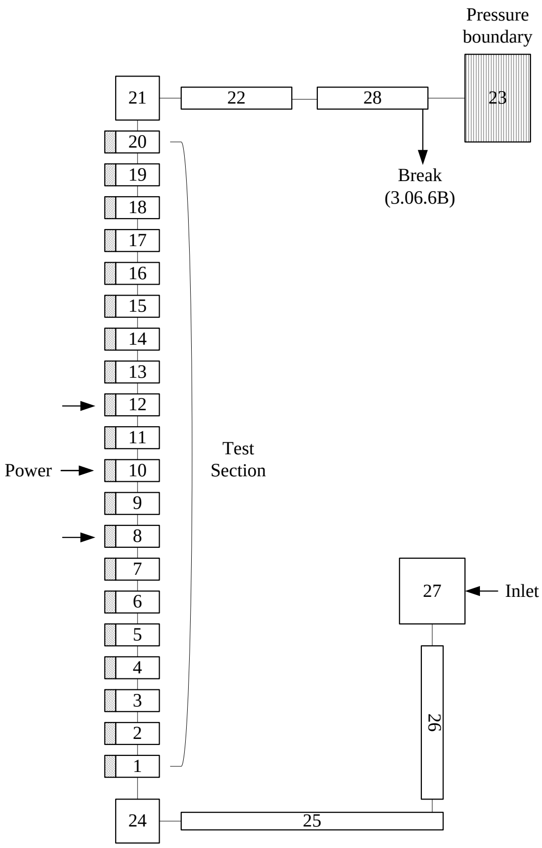

Fig. 2. TASS/SMR modeling of the THTF FRS for the fuel heat transfer model validation

While in the 3.07.9B, the heat and mass flux is constant, and the steady state condition of the fluid and

FRS is recorded in the 3.06.6B. The transient is initiated by breaking the outlet disk assembly with a breaking size of $3.135 \times 10^{-4} m^2$. After breaking the disk, the pump is tripped and the bundle power has some excursing, decaying, and cut-off behavior. It is modeled as Fig. 3 in the simulation.

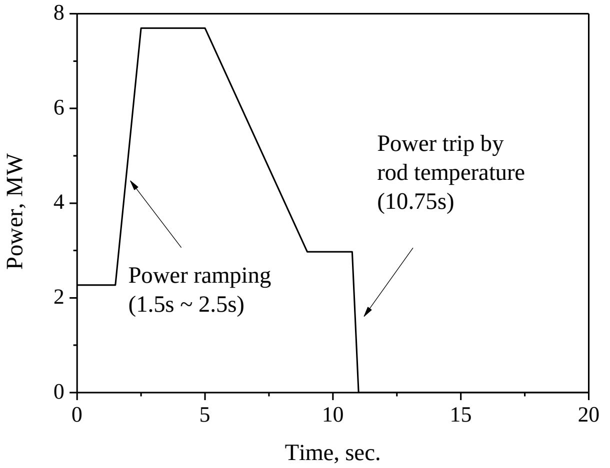

Fig. 3. Modeling of the rod bundle power of the 3.06.6B: transient film boiling experiment

2.3 Simulation results and discussions

After simulation of the THTF 3.07.9B and 3.06.6B with the TASS/SMR, the comparisons of the FRS temperature and fuel rod temperature are performed.

Fig. 4 shows the results of 3.07.9B. The FRS temperature is predicted slightly low in the upstream of CHF. The CHF position is well-predicted and the behavior downstream of the CHF shows also a similar trend with experimental data.

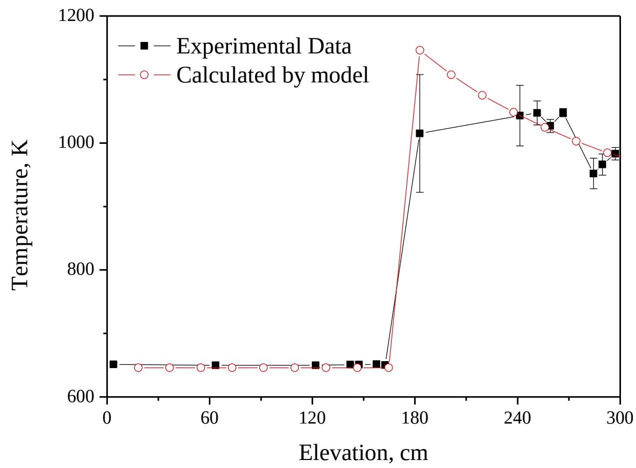

Fig. 4. Validation result: Comparison with the temperature of 3.07.9B, the steady state film boiling experimental data

The comparison result of 3.06.6B is shown in Fig. 5. The FRS temperature in the inlet of the test section is somewhat underestimated but the deviation of the experimental data is also large. In the middle region, the model predicts that the CHF takes place and that there is a high FRS temperature. At the exit of test section, a very similar trend is observed between the experiment and the calculation.

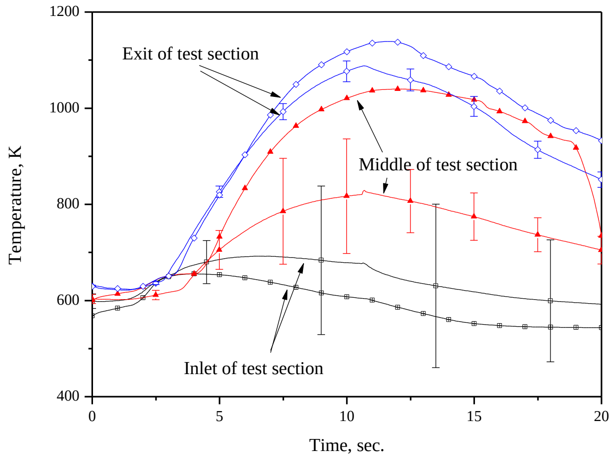

Fig. 5. Validation result: Comparison with the temperature of 3.06.6B, the transient film boiling experimental data

3. Conclusions

The validation of the fuel heat transfer model of the TASS/SMR was accomplished with the THTF film boiling experimental data.

From the comparison results, the following conclusions can be summarized:

First, for the comparison with the steady state experiment, the model shows good agreement with the data because of the well-defined thermal hydraulic conditions and power supply.

Second, for the comparison with the transient data, the difference between the calculation and the experiment was observed. This is because of partly the lack of whole system parameters and partly the conservatism of the models.

For further works, more comparison with transient data is recommended for the complete fuel heat transfer model validation.

REFERENCES

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