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# Rewetting of the vertical hot surface in a 6x6 rod bundle during the reflood phase PART III: Single Channel Analysis by MARS Vessel

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## 1. Introduction

A 6x6 vertical reflood test has been performed by KAERI to inspect the rewetting mechanism and evaluate the reflood simulation capability of the MARS code. The MARS code, which was developed by integration of the one-dimensional RELAP5/MOD3 code and the multi-dimensional COBRA-TF code, has been improved to perform a subchannel analysis of light water reactors[1]. The test section consists of a 6x6 rod bundle array, a flow housing, 4 pairs of borosilicate glasses for a visual observation and measurement instruments[2]. Based on the subchannel analysis capability of MARS code, a 6x6 reflood test case has been modeled and calculated by using MARS3.1. The test section has been modeled as a single channel and 3 sorts of rods. The differences between single channel simulation and the experimental results are discussed.

## 2. MARS Vessel Modeling

MARS simulation of reflood test has been performed as two steps manner. First, the steady state calculation conducted to obtain a condition that all variables remain constant, for example, the rod temperature and steam flow rate. Next, the reflood calculation was done by the transient calculation manner with the steady state restart data outputs. In the previous study [2], the heating rod temperature was the control parameter of the heating power at the condition of the constant postulated steam flow rate during the steady state calculation. The location of the rod temperature measurement is 3.351 m apart from the bottom of the rods. But in the simulation calculation for experimental cases, the steady state rod heating power was set to the measured steady state power and the inlet steam flow rate is PID controlled.

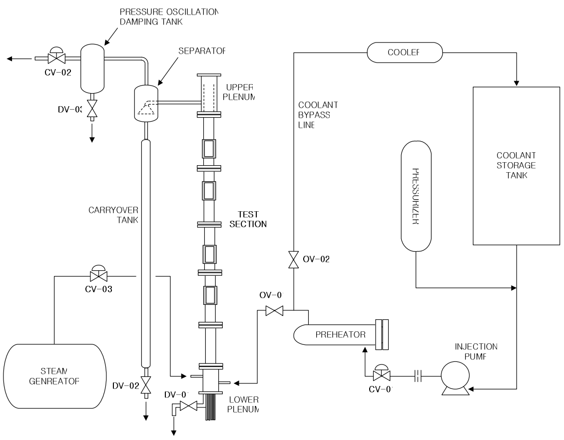


**Figure 1**. Schematic diagram of ATHER

**Figure 1** shows a schematic diagram of the 6x6 reflood test facility, ATHER. **Figure 2** shows the corresponding nodalization schemematics of the Vessel Module of MARS3.1. The 1-D nodalization is used to model the instrument and steam-water circulation loop except the test section[2]. The test section is modeled by single channel of MARS Vessel module. The 30 heating rods in 6x6 rod bundle are modeled as a single heating rod. The single channel is thermally connected to the ambient air with room temperature via 1-D heat structure. In the **Figure 2**, the average power density is 2.625 kW/m.

**Figure 3** shows the channel cross section view. The unheating rods locate at the two apposite corners of the test section, and unheating tube is at the center of test channel. In the MARS model, the geometrical information of the whole rods are neglected, but only the total thermal power and heat transfer area has consistently been conserved.

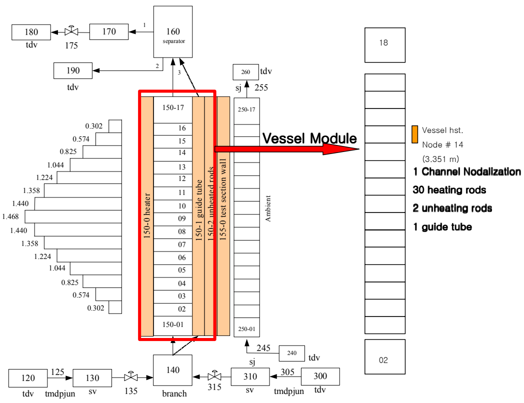


**Figure 2. Vessel module nodalization for the 6x6 reflood test section**

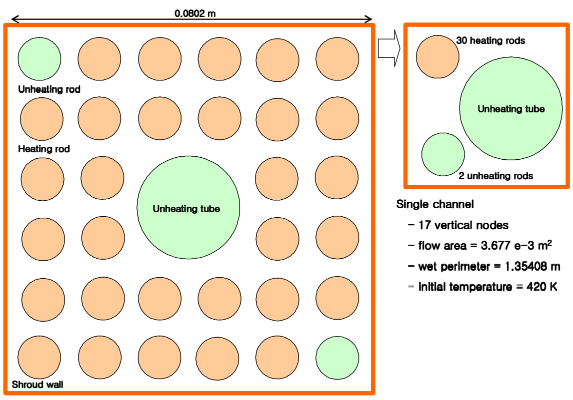


**Figure 3. Rod model of single channel cross section**

## 3. Results

### *3.1 Steady State Calculation*

During the steady state calculation, the steam has been supplied from the 120 time dependent volume component at the pressure of 0.5 MPa. The steam flow rate is PID controlled so that the rod temperature of 3.351 m height is sustained at 773.15 K. The results of the steady state calculation of both the single and multiple channels are compared. After the rod temperature at the 3.351 m height remains constant at 773.15 K, the vertical rod temperature profiles are shown in **Figure 4**. The rod temperature of MARS modeling is shown in **Figure 5**.

### *3.2 Reflood Calculation*

During the transient reflood calculation, the subcooled water has been injected at the speed of 2.0 cm/s with the temperature of 30°C from the 315 valve component. The 135 valve has been closed at that instance. The whole system pressure is still controlled by valve 175 to maintain 0.5 MPa. **Figure 6** shows the temperature drop behaviors calculated by MARS at three different elevations.

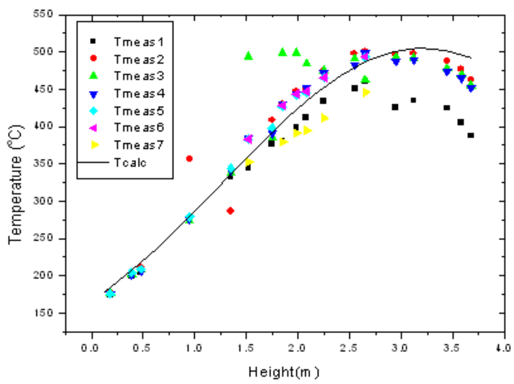


**Figure 4. Measured rod temperature profiles at steady state**

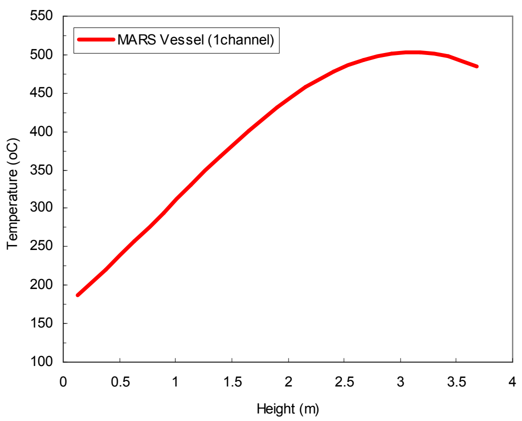


**Figure 5. Rod temperature profile calculated by MARS for steady state**

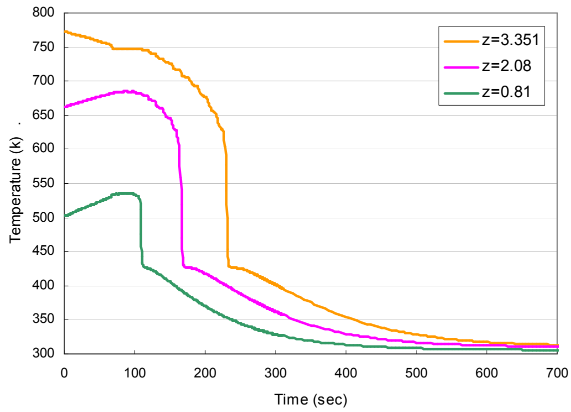


**Figure 6. Temperature drop behaviors during the reflood transient.**

## 3. Conclusion

A 6x6 rod bundle reflood test has been simulated by using MARS3.1 with the single channel vessel modeling. Comparing the result of the single channel modeling to the experimental measurements, it can be said that the single channel vessel modeling has a capability to analyze the reflood phenomena. The temperature drop at the quenching front is successfully calculated by MARS3.1. As a further work, the sensitivity analysis calculations are to be performed with the grid and spacer model of MARS Vessel.

## Acknowledgements


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## REFERENCES


[1] J.-J. Jeong, et al., Hot Channel Analysis Capability of the Best-Estimate Multi-Dimensional System Code, MARS 3.0., Nuclear Engineering and Technology, Vol. 37 No. 5, pp.469-478, October 2005

[2] K.Y.Choi, et al., Preliminary Descriptions on the 6×6 reflood test of KAERI-Part Ⅱ : System and vessel module analysis with MARS 3.0 and COBRA-TF, Proceeding of KNS meeting, 2005.