Assessment of MARS-KS V1.5 with FLECHT-SEASET Test No. 31504

Min Ki Cho*, Andong Shin, Aeju Cheong, Yongwon Choi
Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong-gu, Daejeon 34142, Republic of Korea
**Corresponding author: mkcho@kins.re.kr*

1. Introduction

MARS-KS has implemented two kind of reflood model; the basic model and the KNF reflood model with optional grid model. However usage of grid model was prohibited by input processing procedure error until MARS-KS V1.4, User problem (USER-60) was submitted. Related error is corrected with distributing MARS-KS V1.5. In this study, assessment of MARS-KS reflood model is conducted with FLECHT-SEASET test.

2. Test facility and input model

In this section, the facility of FLECHT-SEASET and the input model for MARS-KS are described. For the validation purpose, three kind of input model is utilized with different reflood models; (1) general reflood model, (2) KNF reflood model and (3) KNF reflood model with grid model.

The KNF reflood model [1] could be activated with option 40 of card 1 which is developmental option card. Grid model of KNF reflood model consists of three sub-models which are the single-phase heat transfer enhancement model, the grid rewet model and the droplet breakup model. [2] The grid model for the KNF reflood model could be activated with card 430.

2.1 FLECHT-SEASET test facility

Several types of test had conducted with FLECHT-SEASET (Full-Length Emergency Core Heat Transfer – Separate Effects and System Effects Test) such as Steam Generator Separate Effect Tests, Flow Blockage Tests, and 161-Rod Unblocked Bundle Tests including the forced reflood tests. [3], [4]

The forced reflood test intended to simulate a full length Westinghouse 17 x 17 rod bundle with electrically heated rod. Within cylindrical housing with a diameter of 0.194 m and 3.89 m height, the 161 heated rods with 12 ft. (3.66m) heating length and the 16 thimble rods are located. The rods having a diameter of 9.5 mm are arranged with a 12.6 mm pitch. The power is distributed axially in cosine profile. The reflood coolant is injected consistently into the lower plenum of test section and the heated fluid flows to the entrained water separation tank and the carry-over liquid tank via upper plenum of test section.

Test number 31504 is chosen for this study. Test section was pressurized to 0.28 MPa. Reflood flow of 51℃ was injected in 24.6 mm/sec.

2.2 MARS-KS Input Model

The test section of the facility is simplified to 49 vertical hydraulic volumes with PIPE component and the inlet/outlet boundary conditions are assigned with two TMDPVOL, TMDPJUN and SNGLJUN components while the outlet boundary is set to be saturation steam at system pressure.

Total 5 heat structure components are modelled and each component stands for the heated rod, thimble rod, the housing, the fillers and the failed rods. The rods are modeled with 49 vertical cells and 7 radial cells. Each initial conditions of hydraulic components and heat structure components is entered by input model.

For the grid model of KNF reflood model, six grid spacers are applied in the input model. The specific grid configuration is shown in Table 1.

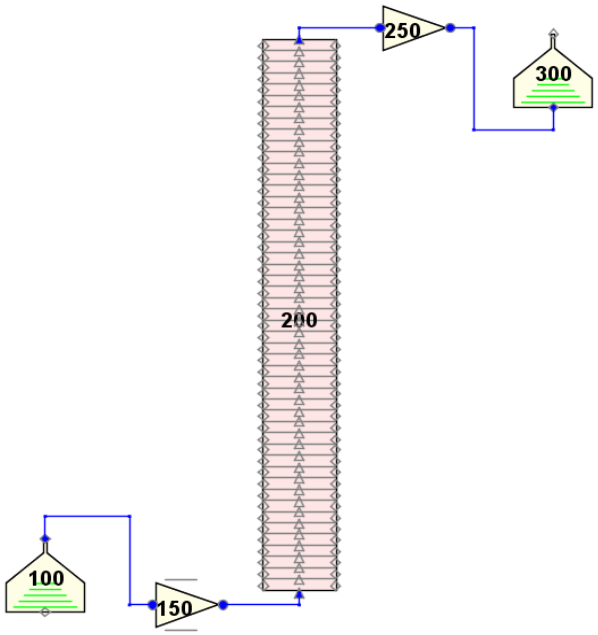
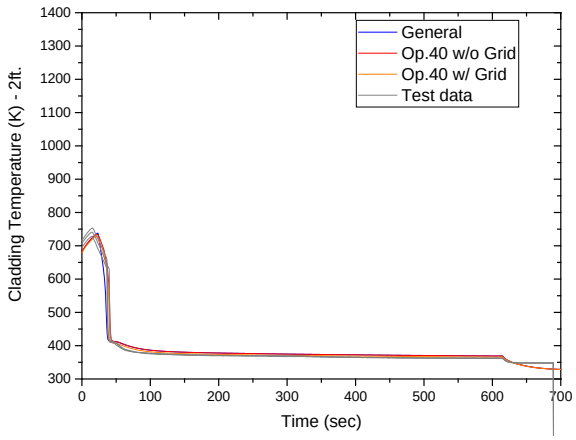


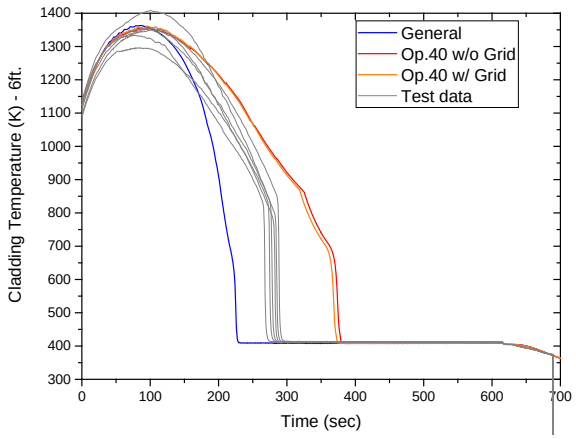
Fig. 1. MARS-KS input model for FLECHT-SEASET tests: 49 cells in axial direction for test section

Table 1. Grid configuration

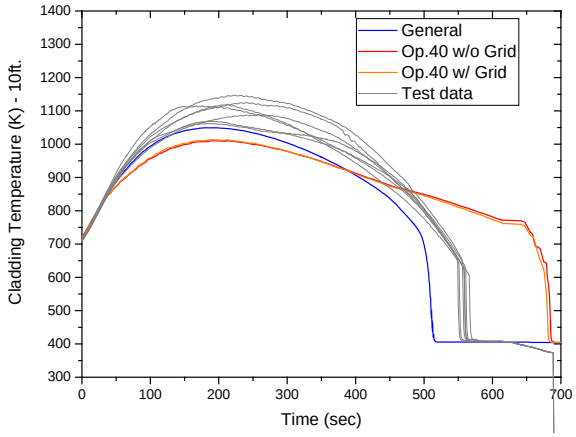
Category	Value
Number of grid	6
Fuel rod pitch	1.25984e-2 m
Fuel rod diameter	9.5e-3 m
Material density	7651.6 kg/m^3
Thickness	3.81e-4 m
Height	4.445e-2 m
Flow blockage ratio	0.2952
Number of related fuel rods	161



(a) Cladding temperature at 2 feet location



(b) Cladding temperature at 6 feet location



(c) Cladding temperature at 10 feet location

Fig. 2. MARS-KS calculation results for FLECHT-SEASET test 31504

3. Calculation results

Entire calculation is conducted successfully in MARS-KS V1.5 with SNAP environment. The maximum time step and the minimum time step are assigned as each 1.e-2 sec and 1.e-8 sec. The cladding temperatures of test result and calculation results are shown in Fig. 2.

Every cladding temperature results of each models well matched at 2 feet location. However, there shows model characteristics at higher position. General MARS-KS reflood model result shows early quenching time while both KNF reflood model results show delayed quenching time at 6 feet location and 10 feet location. Discrepancy exists about peak cladding temperature at 10 feet location with general model and KNF model while grid model has minor effect on PCT.

4. Conclusions

The grid model availability is verified with KNF reflood model in MARS-KS V1.5. The result of using KNF reflood model shows delayed quenching time for overall position and locally low cladding temperature in comparison to general reflood model. The delayed quenching time of KNF reflood model could be increased by means of using the grid model for FLECHT-SEASET test No.31504. More assessment works with various reflood tests or sensitivity studies are necessary for the satisfactory validation of the grid model and KNF reflood model.

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