Validation of MATRA-LMR by ORNL 19-rods Fuel Assembly Experiment

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1. Introduction

MATRA-LMR is developed in Korea Atomic Energy Research Institute, KAERI, for sub-channel analysis of core in Liquid Metal Reactor, LMR. The code contains sodium properties and be able to analyze wire wrap structure.

In 2001, a validation research [1] for the MATRA-LMR code was published by KAERI. Results from the research show that the MATRA-LMR has reasonable prediction compared with other sub-channel codes for LMR, such as SABRE4 and SLTHEN.

The validation research was conducted by using ORNL 19-rods fuel assembly experiment [2] that liquid sodium flows into an assembly which has 19 rods with wire-wrap structure. Length of rods are 40 inches and the region from 16 inches to 37 inches of rods was heated. Thermo-couples are located at rods end, therefore temperature in sub-channels were obtained at channel end.

However, the validation research compared data at the channel end (40 inches from bottom) in ORNL 19-rods experiment with results at heated region end (37 inches from bottom) from MATRA-LMR. In this research, MATRA-LMR analyzes the experiment of the ORNL and the results from MATRA-LMR is validated by the experimental data.

2. Method and Results

Formation of sub-channels in the ORNL 19-rods fuel assembly experiment and wire wrap structure are shown in **Fig. 1**. Only the length from 16 inches to 37 inches is heated and 3 inches after the heated region, temperature data is obtained.

In the validation research published in 2001, location data of wire wrap in MATRA-LMR was different with the experimental apparatus and the wire-wrap location is shown in **Fig. 2**.

The validation is conducted in the same experimental condition with the validation research and an additional experimental data, ORNL Test series 2, test 2, Run 109, is also used for validation. The additional experimental data is obtained in similar condition with the data used in the validation research. The MATRA-LMR contains three pressure drop models, which are Novendstern (Nov), Chiu-Rohsenow-Todreas (CRT), and Cheng-Todreas (CT) model. In this research, CT. model shows error, so only Nov. and CRT. models are analyzed.

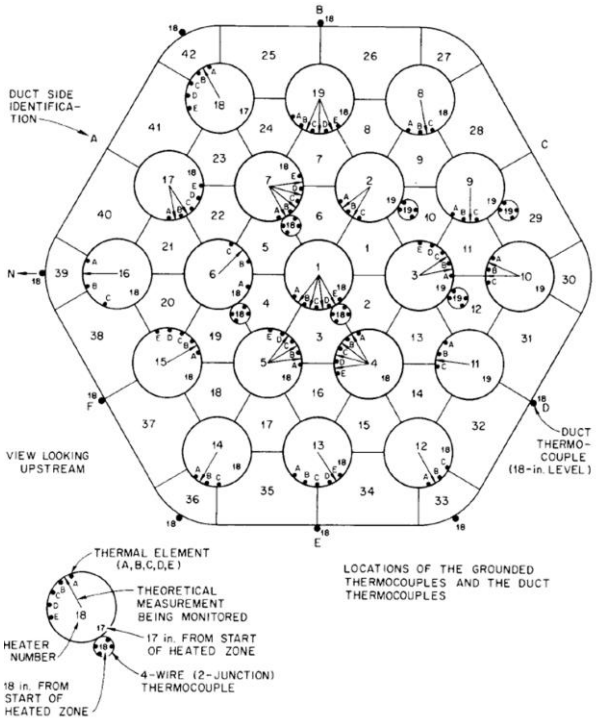

Fig. 1. Locations of sub-channels and wire-wrap structure in ORNL 19-rods fuel assembly experiment

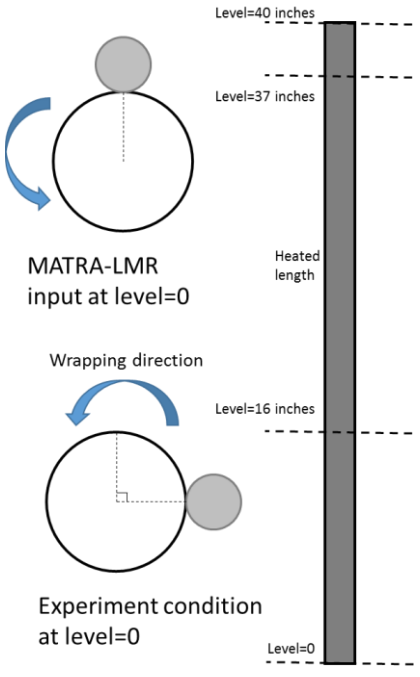

Fig. 2. Wire-wrap location in validation research and ORNL experiment.

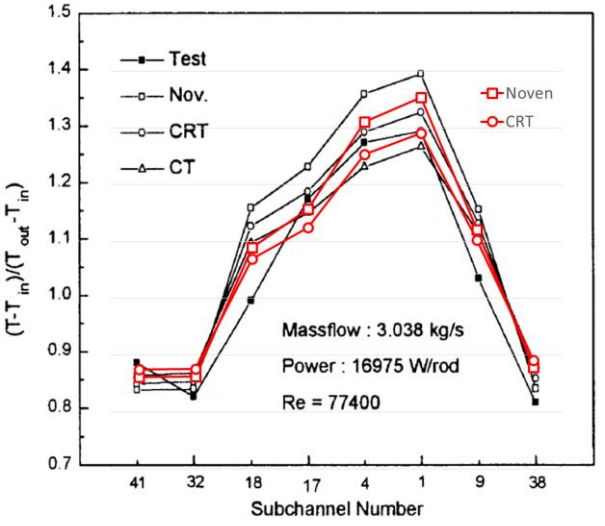

Fig. 3. Results from MATRA-LMR and experimental data at channel end in the condition of the validation publication

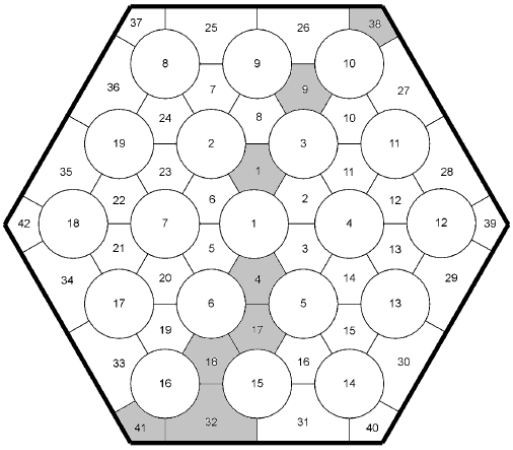

Fig. 4. Sub-channel numbering and the location where temperature is obtained in ORNL experiment (gray region)

The MATRA-LMR input is modified to fix wire-wrap location, and the results and experimental data are shown in **Fig. 3**. The sub-channel numbers and the location where temperature data is obtained are shown in **Fig. 4**. The two pressure drop models shows similar results but the CRT. model shows more smooth temperature distribution than Nov. model. The MATRA-LMR code shows similar results with the experimental data without sub-channel 18.

The results in additional experimental condition are shown in **Fig. 5**. In this case, MATRA-LMR also shows similar tendency with previous experimental case. The two pressure drop models has reliable results from MATRA-LMR, and CRT. model shows more smooth temperature distribution. Temperature of sub-channel 18 also shows much higher than experimental data.

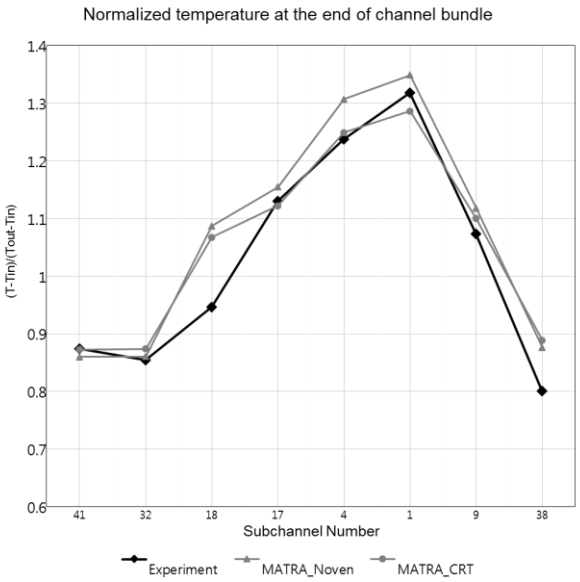

Fig. 5. Results from MATRA-LMR and experimental data at channel end in ORNL Test series 2, test 2, Run 109

3. Conclusions

From the ORNL 19-rods fuel assembly experimental data, validation of MATRA-LMR code is conducted at the channel end using two pressure drop models. The normalized temperature in sub-channels are obtained from the experiment and MATRA-LMR code and it shows good prediction. The two models show good prediction and CRT. model shows more smooth temperature distribution than Nov. model, i.e. the result by Nov. model shows more conservative result than CRT.

REFERENCES

[1] W. S. Kim, Y. G. Kim, and Y. J. Kim, A subchannel analysis code MATRA-LMR for wire wrapped LMR subassembly, Annals of Nuclear Energy, Vol. 29, pp.303-321, 2002.

[2] M. H. Fontana, R. E. MacPherson, P. A. Gnadt, L. F. Parsly, and J. L. Wantland, Temperature Distribution in the Duct Wall and at the Exit of a 19-Rod Simulated LMFBR Fuel Assembly (FFM Bundle 2A), Nuclear Technology, Vol. 24, pp.176-200, 1974