Multi-Dimensional Analysis for Sodium Hot Pool using MARS-LMR in Steady State

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1. Introduction

DBEs (Design Basis Event) of KALIMER-600 (Korea Advanced Liquid Metal Reactor) were analyzed in one dimension by KAERI (Korea Atomic Energy Research Institute) [1]. KALIMER-600 is the pool type SFR (Sodium cooled Fast Reactor), thereby the sodium of primary system is prohibited movement to out of a reactor vessel. There are many contacting and including compositions in the sodium hot pool, such as IHX (Intermediate Heat eXchanger), DHX (Decay Heat eXchanger), Pump, UIS (Upper Internal Structure), and core. Moreover, the complex phenomena are occurred in sodium hot pool during steady and transient states. Therefore, the one dimensional analysis is modified to the multi-dimensional analysis through modification of sodium hot pool from one to three dimensions.

2. Multi-Dimension Modeling for Sodium hot pool

The schematic layout of KALIMER-600 is shown in Figure 1. The UIS has holes on its surface and locates in central of hot pool.

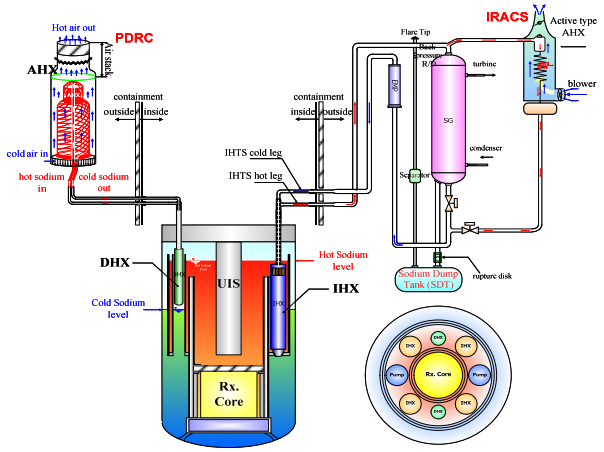

Fig 1. Layout of KALIMER-600

Figure 2 shows simplified hot pool structure for MARS-LMR input. The big cylinder based on diameter of top layer is drawn and then other layers are decreased the volume size by using volume declining function in MARS code. The three dimensions structure is divided into two parts in radius direction. The inside part is to be operated as UIS. There are many junction surfaces between inside and outside parts in radius direction. The using junction area controlling function in MARS code can decrease junction area like a hole. If the factor is one, MARS code recognizes a structure with original input geometry size, whereas if the factor is zero to one, MARS code perceives that a structure for calculation is computed and reduced by multiplication of the factor. Finally, the hot pool structure including UIS can be adopted in modified three dimensional modeling. The modeling structure has three directions, such as radius, angular, and axial direction. Numbers of nodes are two, four, and eight as shown Figure3, respectively. The nodalization for multi-dimensional analysis of KALIMER-600 is shown in Figure 3.

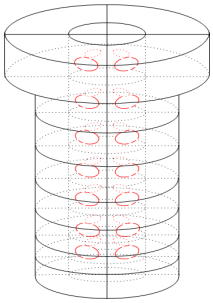

Fig 2. Hot pool structure for MARS-LMR input

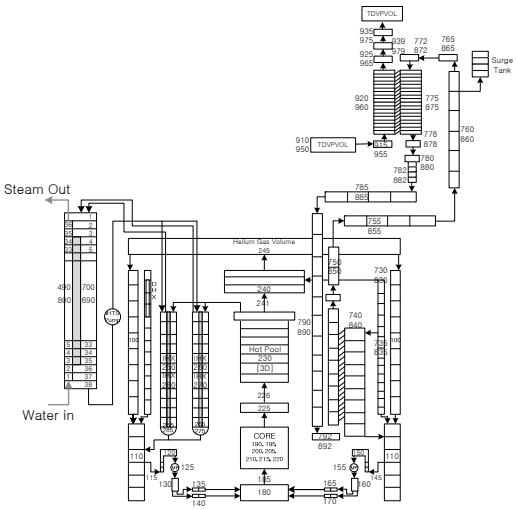

Fig. 3 Nodalization for Multi dimensional analysis

3. Result

The calculation is executed for 500 in one and multi-dimensional analysis. The power history is illustrated in Figure 4. The results of power are exact agreement in one and multi-dimensional analysis.

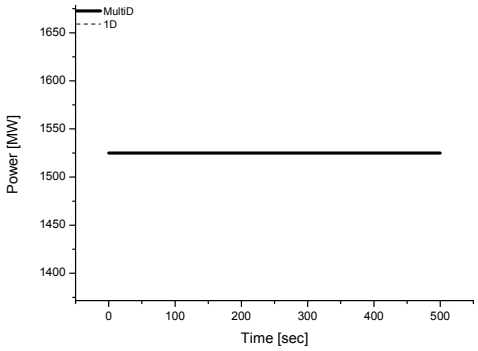

Fig. 4 Power history in one and multi-dimensional analysis

The sodium temperature of core inlet and outlet is shown in Figure 5. The core inlet and outlet are indicated component 180 and 225 in nodalization. The design parameters of core inlet and outlet are 390.0 and 545.0 ^{o}C, respectively [2]. The calculated data for core inlet and outlet temperature are 391.46 and 546.62 ^{o}C in one dimensional analysis and 390.19 and 547.12 ^{o}C in multi-dimensional analysis. There are good agreement between one and multi-dimensional analysis.

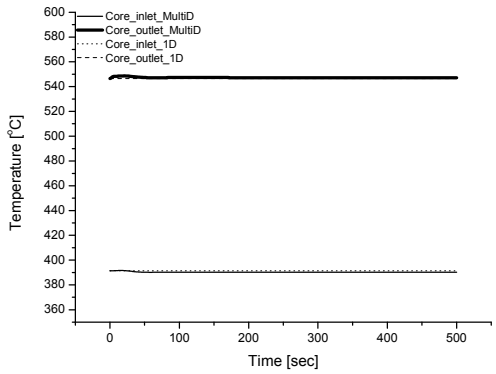

Fig. 5 Core inlet and outlet temperature

4. Conclusions

The simulated results show generally good agreement between one and multi-dimensional analysis in steady state. Moreover, the all results are satisfied design criteria for KALIMER-600. As the further works, the design basis events will be analyzed in multi-dimension, and then those results are compared and evaluated between one and multi-dimensional analysis.

5. Acknowledgement

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REFERENCES

[1] Kwi-Seok Ha, Hae-Young Jeong, Young-Min Kwon, Won-Pyo Chang, Yong-Bum Lee, and Young-IL Kim, DBE Analysis for KALIMER-600, Korea Atomic Energy Research Institute, Korean Nuclear Society, 29-30 October, 2009
[2] D.H Hahn et al., KALIMER-600 Conceptual Design Report, Korea Atomic Energy Research Institute, 2007