Evaluation of TASS/SMR with steady state analysis of High Temperature/High Pressure Thermal-Hydraulic Test Facility (VISTA)

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1. Introduction

The TASS/SMR code is the revised version of the TASS code, which is the result of code development effort of KAERI since 1997, for safety analysis of NPP coolant system. Lately, it is scheduled to evaluate thermal-hydraulic phenomena during several transient periods of SMART-P with TASS/SMR. To establish the pertinence of the calculative results of TASS/SMR, there should be a process of validation and verification of TASS/SMR.

The objective of this study is validating the numerical capability and reliability of TASS/SMR with steady state analysis of VISTA (Experimental Verification by Integral Simulation of Transient and Accidents) that was designed to simulate SMART-P.

2. Modeling VISTA

2.1. General characteristics of VISTA

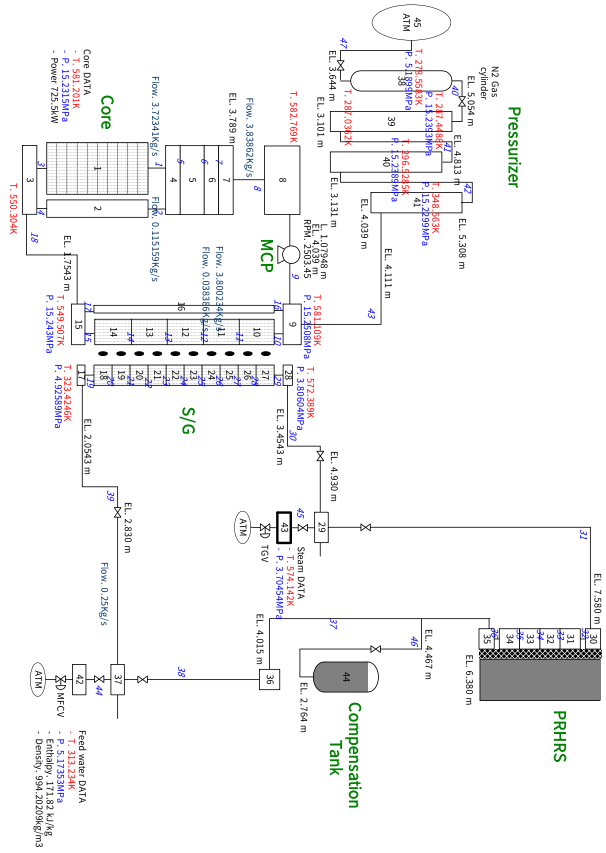

Figure 1. Modeling VISTA

The VISTA, which is operated in high temperature and high pressure conditions, is an thermal-hydraulic experimental facility of KAERI. It is designed to verify the performance and safety issues of the SMART-P (Pilot plant of the system-integrated modular advanced reactor).

- Volume ratio (VISTA : SMART-P) 1:96
- Area ratio 1:96
- Height ratio 1:1

TASS/SMR has its own neutronics and core simulation models. But, VISTA uses electronic heating rods to simulate the fuel rods, so such models are replaced with manual power input model.

To investigate on the pertinence of the TASS calculation results, several thermal-hydraulic parameters should be compared with the experimental results, such as,

- Flow rates of primary/secondary loop
- Main coolant pump head (related ΔP and loss coefficient)
- Heat balance between primary and secondary system in steam generator
- Pressure drop of secondary system in steam generator
- Pressure behavior of primary system
- Core power
- Feed water and steam flow rate (0.25kg/s)

2.2. Experimental Conditions

The overall experimental conditions can be described as following.

- Core Power: 725.5kW
- Flow rate of primary loop: 19.6m^3/hr (≈3.8386kg/s)
- Pump RPM: 2503.45rpm

At the design stage of VISTA, core power and flow rate was intended to 682.29kW and 19.2m^3/hr. But there were some changes in actual experimental condition at the implementation stage.

Especially, pressure drop of primary system was smaller than the designed value. Accordingly, experimental value of the pump rpm also got to be smaller than designed pump rpm.

- Pressure of primary loop: 15.23 ~ 15.25MPa
- Pressure of secondary loop: 3.70 ~ 5.17MPa
- Temperature of Primary loop: 550.3 ~ 582.8K
- SG secondary pressure drop: 4.93 → 3.81MPa

Because that core power was increased to 725.5kW, there were some increase of pressure and temperature in experiments.

VISTA has no turbine, so steam flow is released to atmosphere and feed water supply system is continuously operated during experiments.

PRHRS (Passive Residual Heat Removal System) plays an important role in simulating natural circulation feature of VISTA. But in steady state experiments, PRHRS is not operated.

3. Results

3.1. Heat balance

Figure2 shows the results of heat balance between the primary and the secondary parts in steam generator calculated by TASS/SMR. Lower line is heat loss of primary system (represented in (-)), and upper dotted line is heat supply of secondary system.

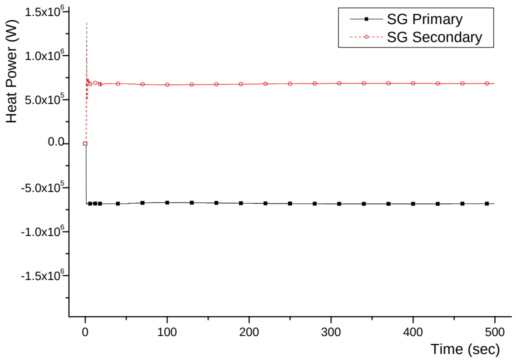

Figure 2. Heat balance of SG

3.2 Pressure drop of SG secondary

Figure 3 shows the pressure distribution of the secondary system. Two dashed lines of figure3 represent the experimental value of inlet/outlet pressure of SG secondary. Although slightly lower pressure is shown, difference of inlet/outlet pressure is extensively matched with experimental value. The pressure distribution of secondary system should be calibrated in detail by analysis of characteristics of pressure drop.

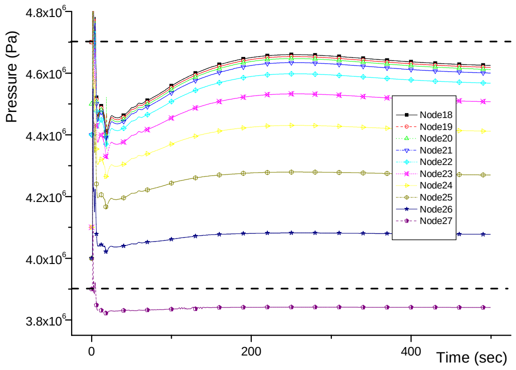

Figure 3. Pressure drop of SG secondary

3.3. Flow rate of primary loop

There is a bypass flow path (modeled by path 2 in figure1) in the VISTA core component and 3% of primary flow pass through it. In figure 4, upper line shows flow rate of core and lower dotted line shows flow rate of bypass path. Dashed lines are experimental values.

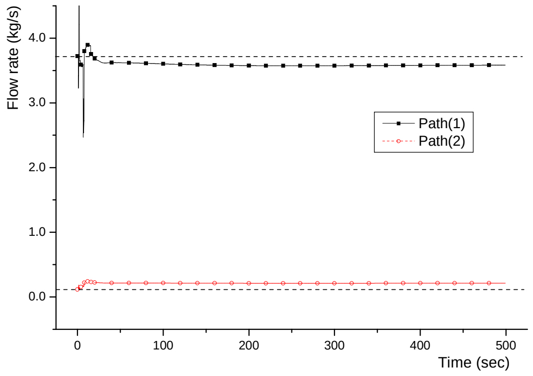

Figure 4. Flow rate of primary loop

4. Conclusions

The steady state calculation of VISTA was performed by TASS/SMR code and overall results show the similarity with the experimental data, but some discrepancies were found between the calculated results and experimental data. The range of system pressure was deviated from the experimental data and the value of flow rates mismatched by some degree.

Because that this experiment was a kind of the preliminary experiment, verification of the experimental data had not been completed. There will be another steady state experiment with more sophisticated condition and then, additional analysis will be performed by TASS/SMR.

Acknowledgement

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