Introduction of Integral Test facility, OSU-MASLWR and Steady State Calculation

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1. Small integral reactor, MASLWR

The Multi-Application, Small, Light Water Reactor (MASLWR) is a natural circulation design with the reactor core and steam generator contained in a reactor vessel, located within a cylindrical containment, which is submerged in a water pool as shown in Fig. 1.

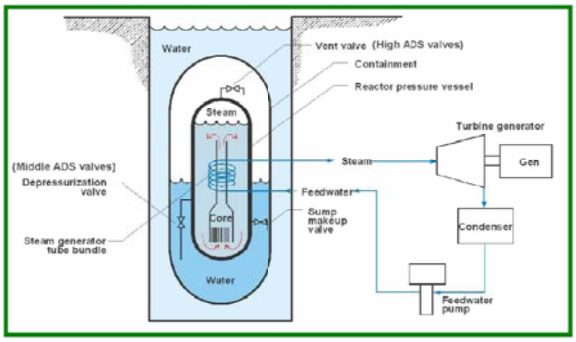

Fig. 1 Schematic diagram of the MASLWR

The core is composed of standard PWR assemblies. The steam generator is a helical coiled once-through steam generator. Coolant heated by the core flows upward through a central riser and is cooled as it flows downward through an annular space that contains the steam generators, and returns into the bottom of the core. Cold feedwater enters the steam generator tubes at the bottom and superheated steam is collected at the top. The system operates thermal power of 150 MW at a pressure of 10 MPa.
To maximize natural circulation for reactor cooling of the MALSWR, the elevation difference between the core center and steam generator center must be maximized.

2. OSU-MASLWR facility

The OSU-MASLWR facility, which is a 1/3 height scale, 1/255 volume scale integral system test facility is built at Oregon State University(OSU) to assess the performance of the MASLWR concept as shown in Fig. 2.
The OSU-MASLWR facility models all of the important design features of MASLWR. It consists of a pressure vessel that houses electric heater rods, a vertical riser, helical steam generator and a downcomer. This facility can operate at full MASLWR pressure and full temperature conditions. The purpose of the initial test series is to assess the thermal hydraulic stability of the primary loop under full power natural circulation conditions and to develop operational procedures for the MASLWR. Several preliminary design-basis accident scenarios also were simulated in the test facility.

Fig. 2 OSU-MASLWR facility

3. Steady state calculation

For a blind calculation of a natural circulation test at OSU-MASLWR Test Facility, TASS/SMR-S code has been used. TASS/SMR-S is a thermal-hydraulic system analysis code that is developed by KAERI, focused on an integral type reactor.

TASS/SMR-S code is capable of system analysis with water, steam and non-condensable gas. Specific models such as once-through helical coil steam generator model and condensate heat exchanger model have been embedded for an integral reactor.

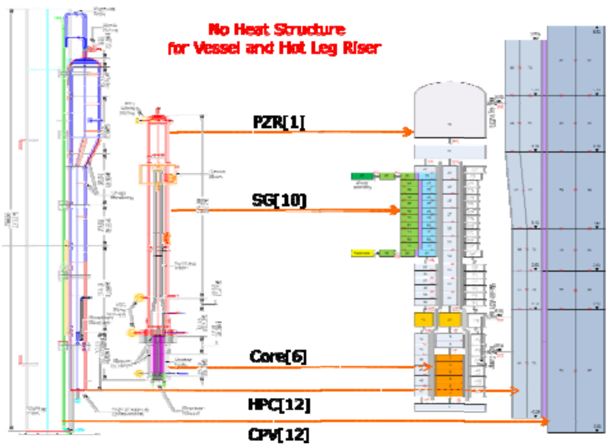

Fig. 3 OSU-MASLWR nodalization of TASS/SMR-S

The test facility is nodalized with 'Node' and 'Path' for TASS/SMR-S code. Core region is divided in 6 nodes and hot leg region is divided in 13 nodes. Plates in core (Core Flow Plate and Upper Core Plate) are considered in proper core node. The helical steam generator is described in 10 nodes, which is combined the 3different size helical coils. Feed-water flow rate and steam pressure are given as boundary condition.

TASS/SMR-S is used to establish the conditions given the required boundary conditions. The NSSS is required to deliver steam at approximately 1.38 MPa pressure and superheated by 13.9 K or 8.3 K to a turbine-generator. The primary side conditions are established by the heat rejected by the steam generator tubes, the overall heat transfer coefficient, the frictional losses, and the density differential between the core and steam generator centers. It is assumed that the reactor vessel is isolated for steady state calculation. During steady-state calculation, the reactor core operated in sub-cooled natural circulation. Table 1 and 2 show the performance characteristics of the model in steady-state operation. TASS/SMR-S code is predicted well the initial conditions as shown in Tables

Table 1 initial condition for 36 kW

Variables	MASLWR	TASS/SMR-S
Core Power*	36 kW	36 kW
Core In Temp.	N/A	558.5 K
Core Out Temp.	N/A	565.7 K
Coolant Subcooling	8.3 K	8.7 K
PZR Pressure	8.618 MPa	8.619 MPa
Steam Pressure	1.379 MPa	1.38 MPa
Steam Superheating	13.9 K	13.22 K
Primary Flow	N/A	0.92 kg/sec
Feed-water Flow*	N/A	0.01313 kg/sec
Feed-water Temp.*	N/A	293.15 K

Table 2 initial conditions for 299 kW

Variables	MASLWR	TASS/SMR-S
Core Power*	299 kW	299 kW
Core In Temp.	N/A	535.53 K
Core Out Temp.	N/A	566.10 K
Coolant Subcooling	8.33 K	8.09 K
PZR Pressure	8.618 MPa	8.618 MPa
Steam Pressure	1.379 MPa	1.379 MPa
Steam Superheating	8.33 K	8.49 K
Primary Flow	N/A	1.8814 kg/sec
Feed-water Flow *	N/A	0.10955 kg/sec

4. Future work

Thermo-hydraulic characteristics will be investigated as a function of primary mass inventory in order to determine the effect of inventory reduction on the reactor vessel natural circulation flow. Also, a blind calculation for the loss of feedwater transient with subsequent automatic depressurization system (ADS) actuation and long term cooling will be calculated by using of TASS/SMR-S code.

Acknowledgement

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REFERENCES

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