Preliminary sizing of the Sodium Thermal-Hydraulic Experimental Facility

Hyeong-Yeon Lee, Jae-Han Lee, Tae-Ho Lee, Yong-Bum Lee
KAERI, Dukjindong, Yuseong, Deajeon,305-353, Korea, hylee@kaeri.re.kr

1. Introduction

The STEF(Sodium Thermal-Hydraulic Experimental Facility) is a passive decay heat removal circuit test facility for simulating thermal hydraulic behavior of the Korean demonstration fast reactor under development by KAERI(Korea Atomic Energy Research Institute). The KALIMER-600[1] is a prototype fast reactor whose conceptual design was finished in early 2007. Since the capacity of the demonstration Korean fast reactor has not been yet determined, the preliminary design of the STEF was based on the KALIMER-600. In this paper, the overall preliminary design features of the STEF are introduced, and issues in mechanical design and fabrication of the experimental test facility are described.

2. Preliminary design of the STEF

The design features of the KALIMER-600 are shown in Fig. 1, which shows it has two loop systems consisting of 4 IHXs, 2 pumps, 2 DHXs and 2 steam generators.

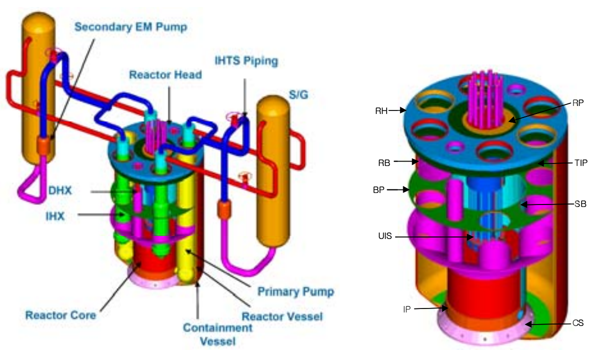


Fig. 1 Schematic of the KALIMER-600

The three dimensional images of the STEF are shown in Fig. 2. Basically it has the same number of the primary components inside the reactor vessel but due to the numerous heaters over 300 ones to be installed at the location of the reactor core make the reactor vessel bottom quite different from that of the KALIMER-600.

The preliminary STEF design has been carried out based on a scaled-down length of 1/5 for length, 1/125 for volume from the primary heat transport system and the PDRC(Passive Decay Heat Removal Circuit) loop of the KALIMER-600.

Table 1 shows the dimensions of reactor vessel (RV) of STEF along with those of the KALIMER-600.

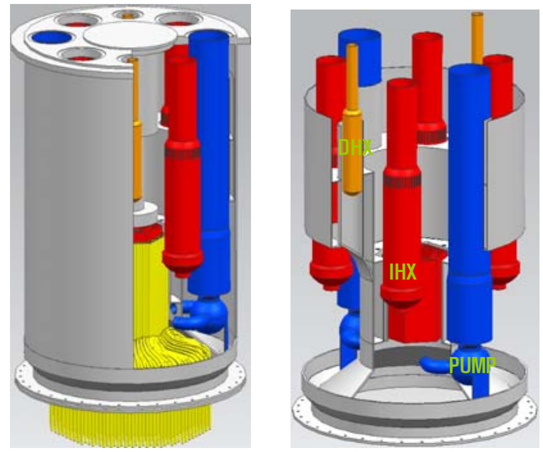


Fig.2 Image of the reactor systems of the STEF

Table 1. Comparison of reactor vessels

	OD (m)	Height (m)
KALIMER-600	11.41	18.50
STEF	2.38	3.81
Scale	1/4.80	1/4.86

The outside diameter of the STEF is larger than 1/5 because of the RV bottom shape shown in Fig. 3 and the height is also longer than 1/5 because of the different shape of the heater assembly from the reactor core[2].

As a whole, a preliminary sizing of the reactor vessel, reactor internals, reactor head assembly, and primary components supported on reactor head carried out and the outcome of the preliminary mechanical sizing of the STEF is shown in Fig. 2.

In design of the STEF, it is important how to join the reactor vessel bottom plate to RV shell. Since the RV contains sodium, maintaining leak tightness throughout the test is of prime importance. Two joining methods are shown in Fig. 3 and the 'flange + welding' method is preferred due to better leak tightness and simple fabrications.

In the KALIMER-600 design, the reactor head insulation / shield plates consist of 5 plates to lower the reactor head temperature as shown in Fig. 4(a). In design of the STEF, the insulation plate with a new material of Micro-therm® which is a micro-porous insulation material of amorphous silica with application range up to 1000°C and lower thermal conductivity than still air is shown in Fig. 4(b). If this insulation material is successfully used, it is expected to be applicable to a demonstration fast reactor.

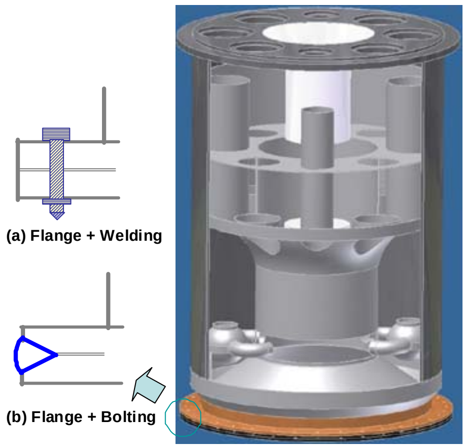
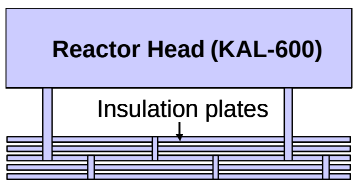
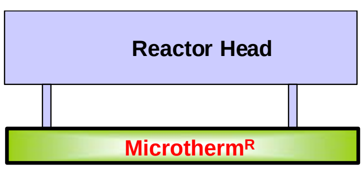


Fig. 3 Two types of reactor bottom plate joints



(a) KALIMER-600



(b) STEF

Fig. 4 Two types of reactor bottom plate joints

The sealing of cover gas through the reactor head is important because radioactive material and hot gas can flow out if leakage occurs in an actual fast reactor. In the STEF, sealing with O-ring and canopy seal is to be applied in reactor head to ensure the leak tightness, as shown in Fig. 5[3].

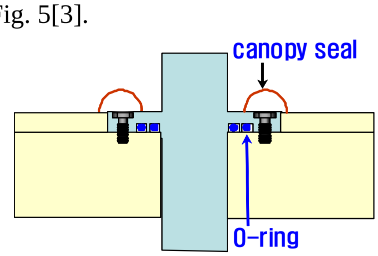


Fig. 5 Two types of reactor bottom plate joints

The 3D solid model and miniature model of the STEF is shown in Fig. 6. In design and fabrication of the STEF, the issues of joining method of the reactor bottom plate to reactor shell, reactor head insulation plate and reactor head sealing are to be addressed.

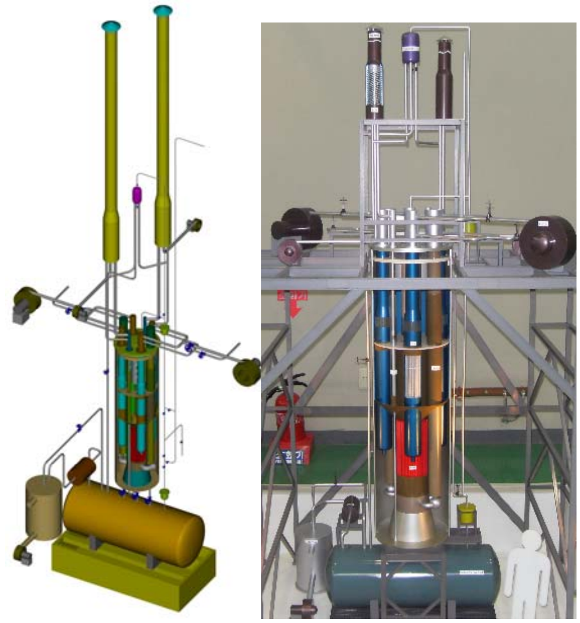


Fig. 5 The STEF model

3. Summary

A preliminary design on the STEF(Sodium Thermal-Hydraulic Experimental Facility) has been carried out with focus on the reactor vessel, reactor internals, reactor head and primary components. The issues of mechanical design and fabrications (welding of reactor bottom plate to the reactor shell, sealing of reactor head, and the insulation plates under the reactor head) are highlighted and to be addressed.

Acknowledgements

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