The Performance Test Procedure for the Mechanical Sodium Pump installed in STELLA-1

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1. Introduction

STELLA-1 (***S***odium in***T***egral ***E***ffect test ***L***oop for safety simu***L***ation and ***A***ssessment) is a large-scale separate effect test facility for demonstrating the thermal-hydraulic performances of major components such as a Sodium-to-Sodium heat exchanger (DHX), Sodium-to-Air heat exchanger (AHX) of the decay heat removal system, and mechanical sodium pump of the primary heat transport system, which are important to ensure the safety of the sodium-cooled fast reactor (SFR).

A mechanical sodium pump, the test component, was scaled down to preserve the major thermal-hydraulic phenomena according to the related similarity criteria using the corresponding prototype pump of the 600 MWe demonstration SFR (DSFR).

The vertical submersible prototypic pump had a rated flow rate of 17,415 m^3/h, a rated pressure head of 62.9 m, and a rated rotational speed of 433 rpm, and the model pump was scaled down while keeping the same specific speed. The model pump had a rated flow rate of 510 m^3/h, a rated pressure head of 50.3 m, and a rated rotational speed of 2,140 rpm [1].

The present paper describes the performance test procedures for the mechanical sodium pump installed in STELLA-1.

2. The Performance Test Procedure

The purpose of the performance test of the mechanical sodium pump installed in STELLA-1 is an evaluation of the performance characteristics of the mechanical pump such as the rated operating performance, coast-down performance, and pressure head variation with various flow rates at a fixed rotational speed.

Fig. 1 STELLA-1

The specifications of STELLA-1 are as follows [2].

- Working fluid: Sodium
- Max. power: 2.5MW
- Storage of sodium: 18 tons
- Max. operating temperature: 600 ℃
- Heat exchanging rate: 1.0MWth

The mechanical sodium pump was reduced to 18.1% of the prototype pump of the demonstration sodium-cooled fast reactor and the major specifications of the mechanical pumps are follows.

Table 1 The major specifications of mechanical pumps

	Prototype	Model
Specific speed	330.3 rpm·m	330.3 rpm·m
Rated flow rate	17,415.1 m^3/h	510.3 m^3/h
Rated head	62.833 m	50.31 m
Efficiency	80 %	71.8 %
Impeller Out Dia.	1,768 mm	320 mm
Rated power of Motor	3,700 kW	110 kW

Fig. 2 Mechanical sodium pump in STELLA-1

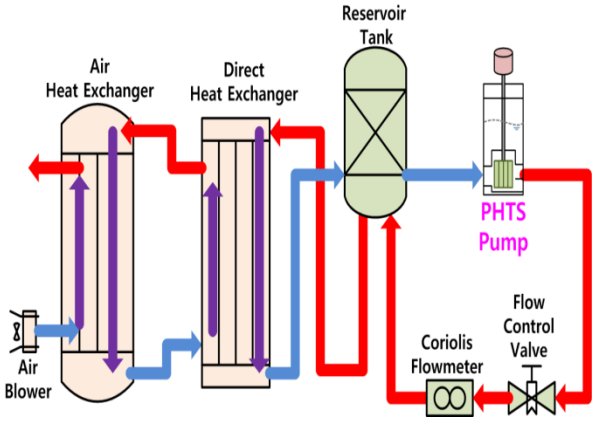

Fig. 3 System configuration of performance test of mechanical sodium pump in STELLA-1

Performance tests of the mechanical sodium pump must comply with the operation procedures because such tests use most parts of STELLA-1 at a higher operating pressure. Fig. 4 shows a schematic of the performance test procedure for a mechanical sodium pump.

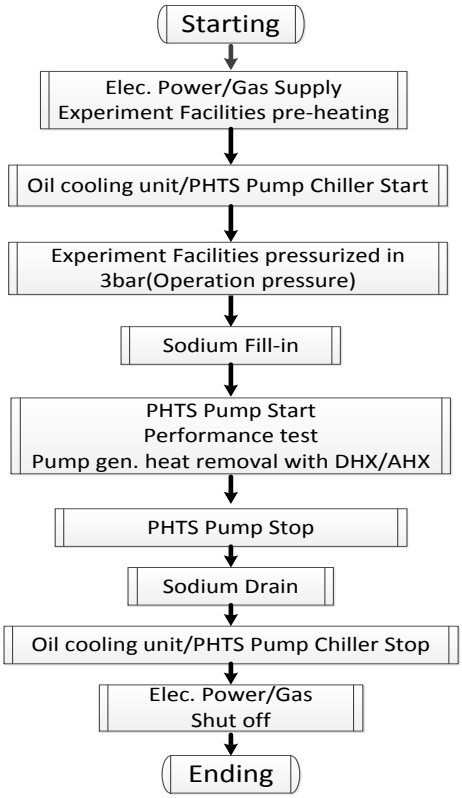

Fig. 4 Operation procedure of mechanical sodium pump in STELLA-1

We developed a graphic user interface system for a remote control of the test facility and monitoring of the status of the performance tests, and a screenshot of the computer monitor is shown in Fig. 5.

The performance test of the mechanical pump in a sodium environment was conducted with a test matrix for a comparison with the existing performance test of the mechanical pump, which has already been performed in a water environment. Table 2 shows the test matrix of the performance test of the mechanical sodium pump.

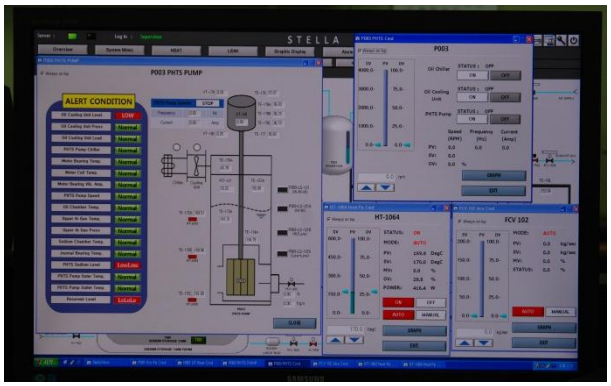

Fig. 5 System monitoring and control screen

Table 2 The test matrix of the performance test for the mechanical pump installed in STELLA-1

N/N_R / Q/Q_R	25%	35%	55%	65%	85%	100%
5%	◎	◎	◎	◎		
10%		◎				
15%	◎		◎	◎	◎	
20%		◎				◎
25%	◎		◎	◎	◎	
30%		◎				◎
35%	◎		◎	◎	◎	
40%		◎				◎
45%			◎	◎	◎	
50%		◎				◎
55%			◎	◎	◎	
60%						◎
65%			◎	◎	◎	
70%						◎
75%			◎	◎	◎	
80%						◎
85%				◎	◎	
90%						◎
95%					◎	
100%						◎
105%					◎	
110%						◎
115%					◎	
120%						◎
125%						
130%						◎
135%						
140%						◎

4. Acknowledgement

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[1] Han, Ji-Woong, et. al, Design Report of Mechanical Sodium Pump for STELLA-1, KAERI/TR-4513/2011., 2011
[2] Lee, Tae-Ho, et. al, Design Report of STELLA-1, KAERI/TR-4295/2011., 2011.