Design Development of SMART ECC Water Asymmetric Two-phase choking test facility

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1. Introduction

SMART pressurized water reactor type is different from the existing integral NSSS commercial pressurized water reactor system which is equipped with the main features. In addition RCS piping is removed and the feature of the SBLOCA is a major design break accident. The TASS / SMR code is analyzed SMART SBLOCA. In order to verify analysis code, SMART analysis for verification of conservatism is promoting using data for experiments with Integral Effect Test and Separate Effect. In this paper, the design feature of the SWAT (SMART ECC Water Asymmetric Two-phase choking test facility) is described. SWAT is linearly reduced to a 1/5 ratio while the geometrical shape is conserved. In major shape of SMART ECC injection performance test, distortions which caused by gravitational effects are minimized. Because both the emergency core cooling water injection nozzle height and the break nozzle height match the RCP Suction Nozzle height in test section of the main forms. The main part of the test section is SG-side upper down-comer. The boundary conditions are saturated steam and water flow condition and drain flow rate to control the collapsed water level in the down-comer.

2. Design Features of SWAT

2.1 Scaling Ratio

In order to preserve the flow characteristics, the SMART design is linearly reduced with a scaling ratio of 1/5 and the flow geometry was design to be conserved. Table 1 shows a summary of the scaling relations adapted in the SWAT facility with respect to the SMART reactor.

Table I: Summary of Scaling of SWAT

Parameters	Symbol	Parameter Ratio	SMART ECC
Length Scale	l_{oR}		1/5
Diameter Scale	d_{oR}		1/5
Length	l_{oR}	l_{oR}	1/5
Diameter	d_{oR}	d_{oR}	1/5
Area	a_{oR}	d_{oR}^2	0.040
Volume	v_{oR}	$l_{oR}\, d_{oR}^2$	0.008
Core DT	$\triangle T_{oR}$	1	1.000
Velocity	u_{oR}	$l_{oR}^{1/2}$	0.447
Time	t_R	$l_{oR}^{1/2}$	0.447
Power/Volume	q_R'''	$l_{oR}^{-1/2}$	2.236
Heat flux	q_R''	$l_{oR}^{-1/2}$	2.236
Core power	q_R	$d_{oR}^2\, l_{oR}^{1/2}$	0.018
Flow rate	m'_R	$d_{oR}^2\, l_{oR}^{1/2}$	0.018
Pressure drop	P_R	l_{oR}	0.200
Break Area	a_{oR}^{break}	$d_{oR}^2\, l_{oR}^{1/2}$	0.018

2.2 System Design

In order to preserve the flow characteristics, the SMART design is linearly reduced with a scaling ratio of 1/5. An overall assembling of the test facilities is demonstrated in Fig.1. SMART ECC performance device consists of main test section, safe injection system saturated steam and saturated water supply system and recirculation water supply systems and break simulation system. Main test section of the external structure respectively installed 3 safety injection nozzles (90 °, 180 °, 270 °) and break the nozzle (0 °). Main test of the internal structure installed by 4 saturated steam and saturated water supply nozzle (45 °, 135 °, 225 °, and 315 °). Safety injection system consists of a safe supply vessel, the safety injection pump, the safety injection nozzles, and associated piping and valves etc. Safety injection supply vessel is supplied with cooling water temperature of 20 ℃ and demi-water temperature raise to a temperature of 50 ℃. Break simulation system is consist of break nozzle, water - steam separation vessel and measuring containers. Break nozzle can be mounted on a pipe rupture in the Smooth-Entrance Long Nozzle Type the L / d> 12 and L> 100mm's. In saturated steam and saturated water supply system, saturated steam and saturated water at the top of the test section is installed is injected through injection nozzles.

SMART Safety Injection System Safety Injection Performance was designed to apply the modified linear scaling method. Device as a basis for setting design criteria TASS / SMR code for the analysis using the SMART Reactor were used. In the experimental device, the shape between the pressurizer of upper core support structures and upper support structures does not simulate. The steam generator's annular regions are simulated including coolant pump. Coolant Pump is simulated as inlet shape of simple columnar. In order to simulate the conditions of saturated vapor and saturated flow to supply in 4 coolant circulation pump, separate saturated steam and saturated water supply tank is installed. The flow from the supply vessel has been simplified to be injected directly.

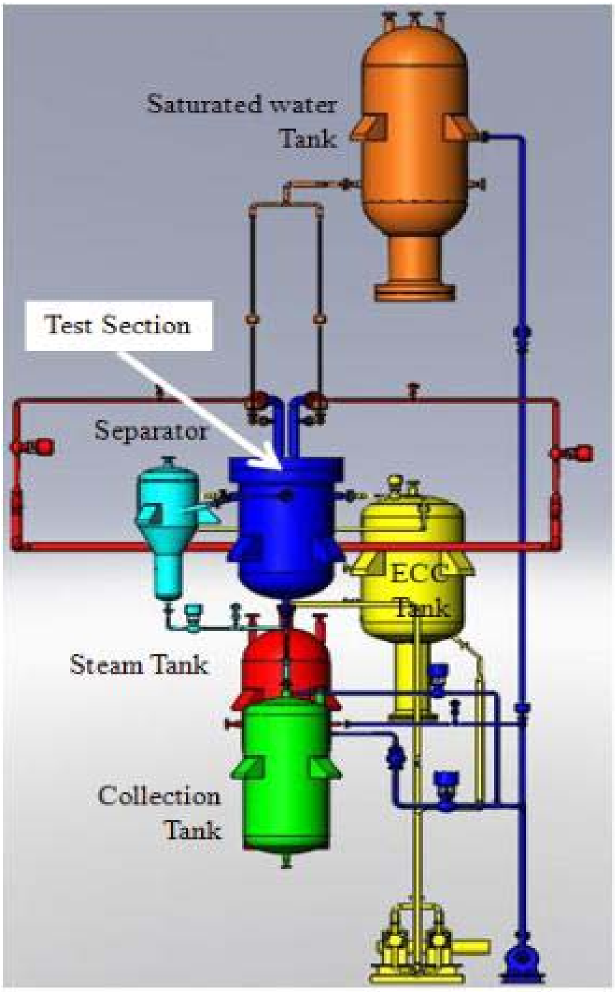

Fig.1.View of SWAT Test Facility.

2.3 Instrumentation

The loop flow, pressure, and temperature would be measured by using vortex flow meters and smart type pressure transmitters and thermocouples. In order to measure average level of the main test section 4 differential pressures are installed. In order to measure the fluid temperature in main test section, thermocouples are installed as shown in Figure 2. In order to protect during installation and to support of the thermocouple instrumentations, the 1/4 inch tubes were used. The experimental data measured by various instruments LT (level measurement), PT (pressure measurement), QV (flow measurement), TF (fluid temperature measurement), TH (heater measurement), TW (wall temperature measurement) and so on separate PC's Hard Disks are respectively stored.

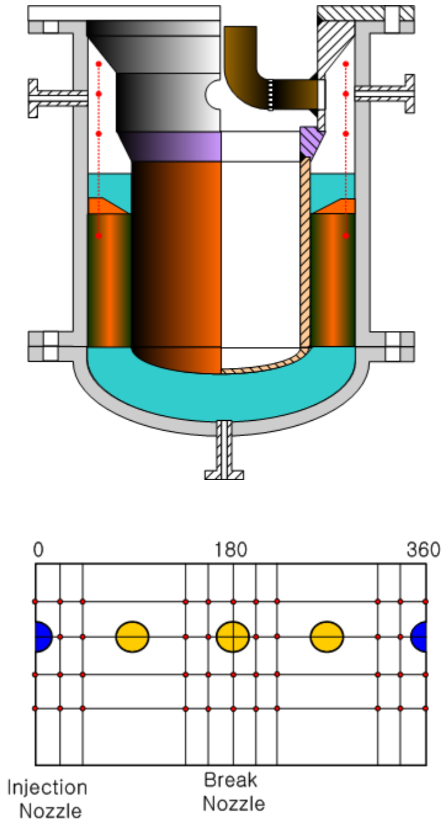

Fig.2. Alignment of the fluid thermocouples

3. Conclusions

SWAT is aimed at measuring ECC bypass in down-comer and producing the experimental data to evaluate the penetration rate in core. The design of systems is applied with a modified linear scaling method and 1/5 ratio of the linear reduction is chosen. This paper describes the overall design feature including scaling, assembling, component design and instrumentation.

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