Helium-water loop tests with PCHE for GAMMA validations

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1. Introduction

The GAMMA code was developed for the system analysis of High Temperature Gas Cooled Reactors (HTGRs) [1]. At KAIST, the GAMMA-T code has been developed through coupling GAMMA code with SANA which was developed for the simulations of turbo-machinery performance [2,3]. Low Reynolds number model for turbulent simulations was also implemented [4]. The air ingress scenario such as the guillotine break of the main co-axial pipe was investigated by using GAMMA [5].

In this study, GAMMA calculations for helium-water tests were performed for the validation of the GAMMA code. Experimental data were obtained from a helium-water facility. Detailed input values for GAMMA was provided from experimental conditions.

2. Methodology

In this section, we describe methodology for the He-water experiments and GAMMA.

2.1 Helium-Water tests

The test facility for helium-water tests is shown in Fig.1. The primary side is a closed helium loop, while the secondary side is an open water loop. Pressure and temperature at the inlet and outlet of each component were measured. We acquired steady state data for helium-water tests [6]. We also considered several transient states for GAMMA validation. According to the control of the mass flow rate in the secondary side, transient scenarios (10 kg/min → 32 kg/min, 32 kg/min→ 10 kg/ min) were obtained.

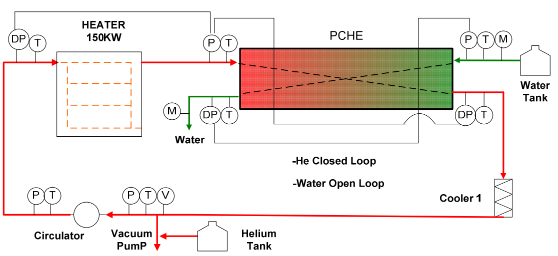

Fig.1. Helium-Water test loop

2.2 Node construction for GAMMA

Node construction was necessary for the calculation of the GAMMA code. Main components such as a circulator, a heater, a PCHE, and a cooler were described as a fluid block. The pipe was located between two main components. External junctions were between the two fluid blocks. Geometry information and initial boundary conditions were provided from experimental data. We investigated steady state and two transient scenarios using GAMMA code.

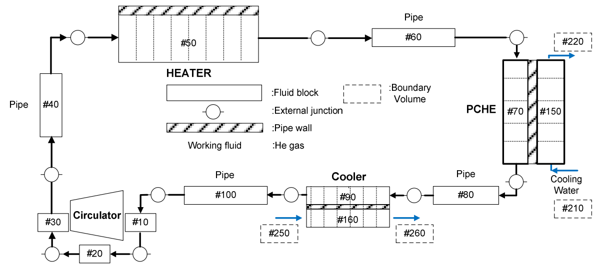

Fig.2. Node construction for GAMMA code

3. Results

For a steady state, numerical solutions were obtained using GAMMA. They are compared with experimental data, as shown in Table 1. GAMMA has good agreement with experimental data.

Table I: Data comparison between experiments and GAMMA calculations for steady state

	Experiments	GAMMA
Mass flow rate (kg/s)	(He) 0.02635 kg/s	0.02608 kg/s (-1.025%)
	(water) 0.188 kg/s	0.188 kg/s (0%)
PCHE inlet temperature	168.92℃	170.93℃ (+2.01℃)
PCHE outlet temperature	24.94℃	24.93℃ (-0.01℃)
Circulator inlet temperature	24.38℃	24.92℃ (+0.54℃)

Transient data for transient state (10 kg/min→32 kg/min, 32 kg/min→10 kg/min) were obtained from experiments, as shown Fig.2.

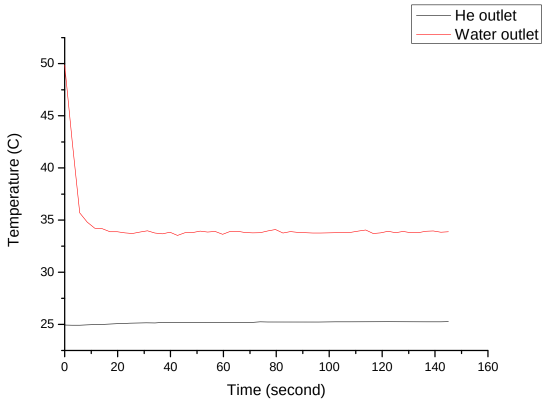

Fig.2-(a). Transient data for transient state (water 10 kg/min-> 32 kg/min)

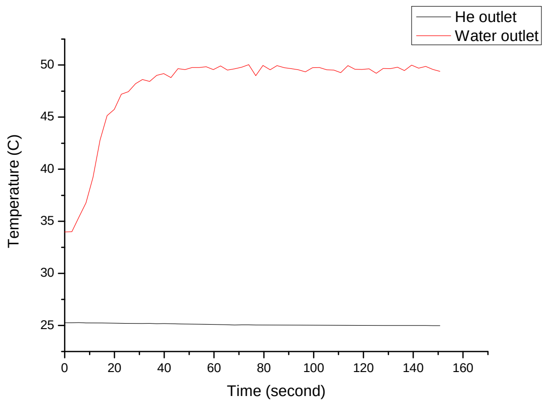

Fig.2-(b). Transient data for transient state (water 32 kg/min-> 10 kg/min)

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