Flow Boiling CHF Experiments using Nanofluid under Different Heating Rate

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1. Introduction

Studies regarding CHF enhancement using nanofluid have been conducted by many researchers. Few of them have been conducted under flow boiling condition [1-3]. In our previous work, we could not find the concentration effect of nanofluid on the flow boiling CHF [2, 3]. We concluded that the effect of nanofluid on the CHF may already be saturated at low concentration because of long boiling time (more than 15 minutes), and there may be a minimum deposition layer of nanoparticles to enhance the flow boiling CHF.

In the present study, we conducted flow boiling CHF experiments using nanofluid under different heating rate to examine the minimum deposition layer. After the flow boiling CHF experiments, the inner surfaces of the test section tube were explored by FE-SEM.

2. Experiments

2.1 Experimental Apparatus

Our flow boiling CHF experiments were conducted in a KAIST-CHF experimental loop which is shown in Fig. 1. This experimental loop consists of a CRN3-23 pump, a mass flow meter, a pre-heater to control the inlet subcooling of the working fluids, a throttling valve, a test section tube, a condenser for cooling the working fluids, and a surge tank with an overhead liquid reservoir. The test section tube was directly heated by a DC power supply which had 25 V rated output voltage and 3000 A rated output current. The working fluid in the loop was circulated by a centrifugal pump with a variable speed driver that flowed vertically upward in the test section tube. The dimensions of the test section tube and the experimental conditions are listed in Table 1. A schematic diagram of the test section is shown in Fig. 2.

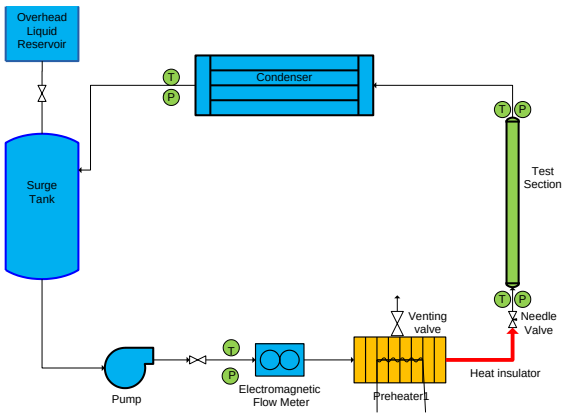

Figure 1. Schematic diagram of experimental loop

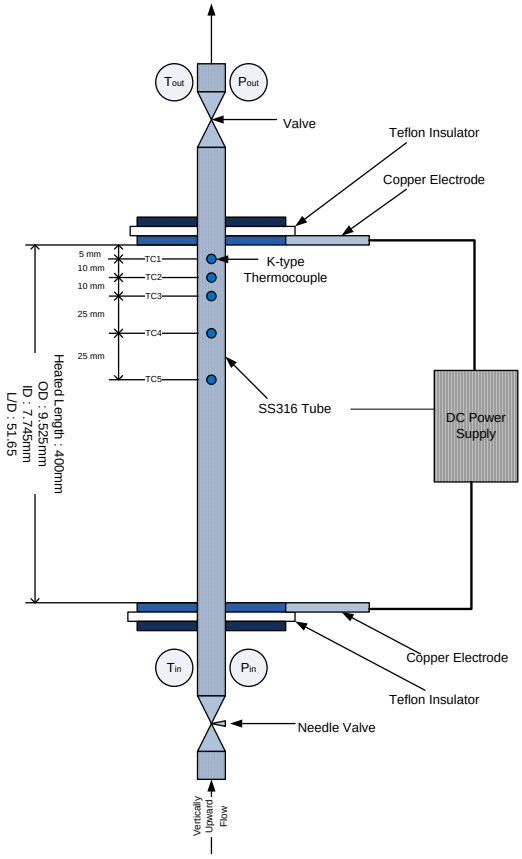

Figure 2. Schematic diagram of the test section

Table 1. Test matrix of flow boiling CHF experiments

Test Matrix		
Bare round tube		
Outer diameter		*9.525 mm*
Inner diameter		*7.745 mm*
L/D ratio		*51.65*
Heated length		*400mm*
Vertically upward flow		
Pressure		*101.3 kPa*
Mass flux		*500,1000 kg/m^{2}s*
Inlet temperature		*50 ℃*
Working fluid		
Total fluid in the loop		*50l*
DI water		
Nano Fluid	*Al_2O_3*	*10^{-4}vol%*
Boiling time		
From ONB to CHF		*3min, 1min, 30sec, 10sec*

2.2 Heating procedure

In the previous study, the heating power in the test section increased gradually by increasing the voltage of the test section, and the voltage of the test section increased stepwise with thermal equilibrium of the working fluid in the loop. Hence, the boiling time from the onset of boiling (ONB) to the CHF was more than 15 minutes. In this study, we directly heated up the test section from the ONB to the CHF without thermal equilibrium of the working fluid to examine the minimum deposition layer, and the range of the boiling time was from 3minutes to 10 seconds.

3. Results and Discussion

The CHF data will be obtained and reported on the KNS poster.

REFERENCES

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