CHF for Downward-facing Flat Plates considering Pressure up to 2 bar condition, Width and Material Effects

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1. Introduction

Not just width & material effects on CHF, also pressure has an influence on the value. Several preceding studies have shown the enormous effect of pressure considering the fluid & pressure parameters' combined effects [1]. Therefore combined effects should be assessed to fully cover the effects of main parameters on the downward-facing flat plates. Based on the preceding results considering width and material effects under atmospheric condition [2,3], pressure effect was added in this study.

2. Experiment setup

In this section, test vessel, heater and test matrix for the purpose are introduced.

2.1 Test Vessel

Pressure vessel has been made with preheater located at the bottom part. Electricity was supplied to the main heaters by DC rectifier from the top part of the vessel through the copper electrodes. Detailed specifications including dimension and other installations were introduced in the preceding paper [2,3].

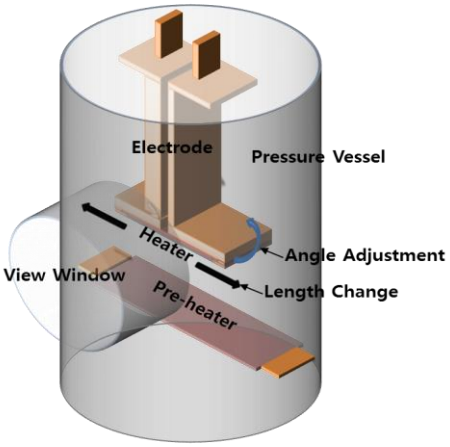

Fig. 1. Pressure vessel used in the experiments [2].

2.2 Main Heater

Initial widths (40 & 50 mm-width) have been chosen according to the observation in SBLB & SULTAN test facilities. Wider test sections have been assessed, and further wider width (60 mm-width) has been considered in the study. Furthermore, carbon steel was used, and stainless steel was considered as a reference material which is much more resistant to corrosive conditions. All the detailed information were presented in the preceding paper [2,3].

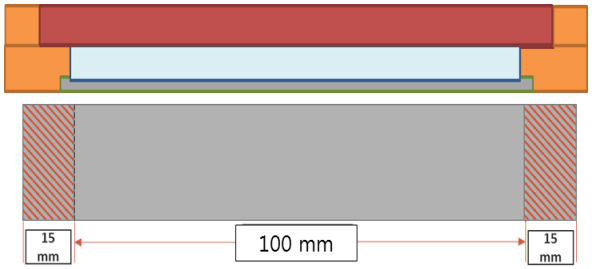

Fig. 2. Cross sectional view of the heater [2,3].

2.3 Test Matrix

In this study, three scale of width were considered for fixed length and thickness of 100 mm and 1.2 mm, respectively. For a given dimensional condition, different heater material and pressure with varying inclination angles were used.

Table I: Test Matrix

Pressure [bar]	Material	Width [mm]	Orientation [deg.]
1	SS304	40, 50, 60	0, 15, 30, 45, 60, 75, 90
	SA508		
2	SS304		15, 30, 60, 90
	SA508		
4	SS304		15, 30, 60, 90

3. Results

Wider test section continuously showed lower CHF value compared with narrow ones at least up to 2 bar condition. As pressure increased, difference in CHF value decreased in the wide test sections, especially 50 & 60 mm-width conditions.

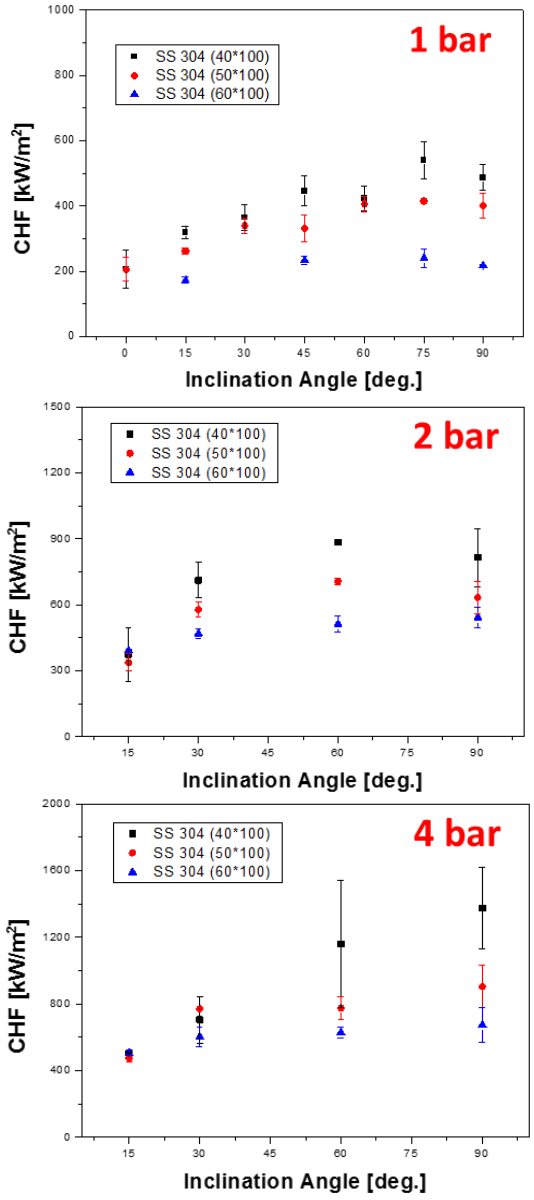

Fig. 3. Width effects for reference material (SS304).

When material effects are considered, test sections showed somehow different trend depending on the width scale. For the narrowest one (40 mm-width), carbon steel steadily showed enhanced results compared with reference material, but the increment decreased for 2 bar condition. For the 50 mm-width case, the enhancement was smaller than the 40 mm-width case under atmospheric condition, and carbon steel showed even slightly lower value compared with the reference material for 2 bar condition. In comparison, for the widest heater, 60 mm-width case, it showed almost similar or slightly different CHF value for low pressure conditions, but started to show enhanced results as pressure increased further.

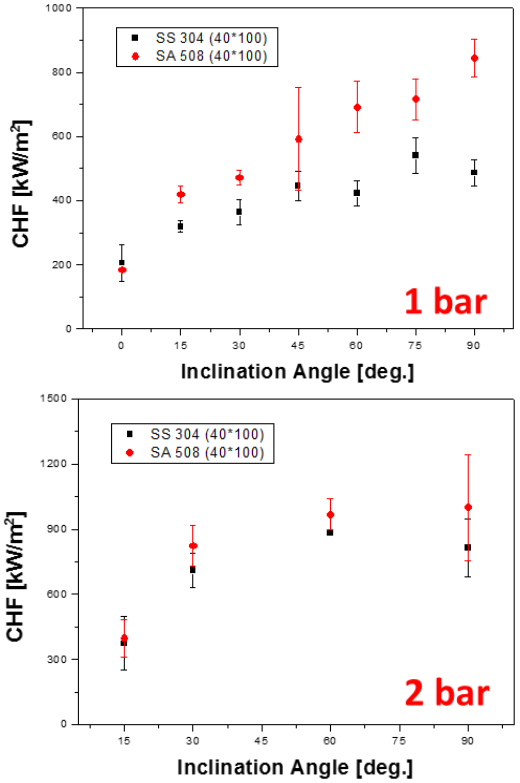

Fig. 4. Material and pressure effects (40 mm-width).

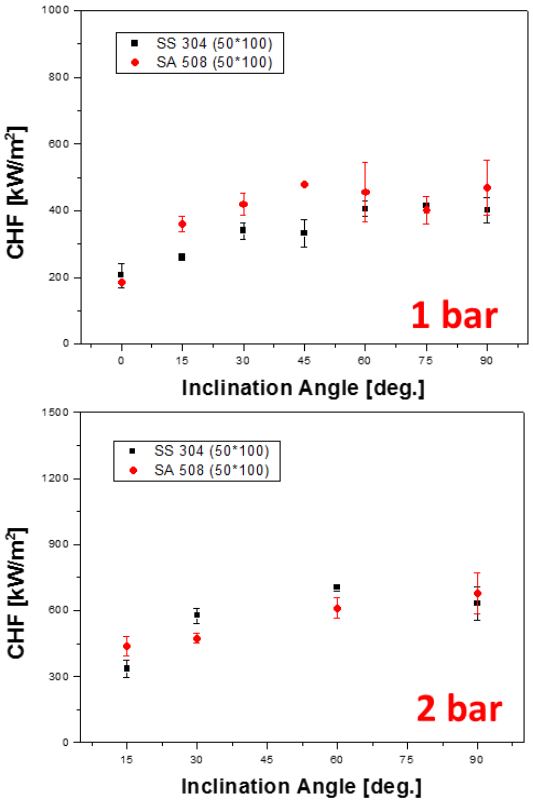

Fig. 5. Material and pressure effects (50 mm-width).

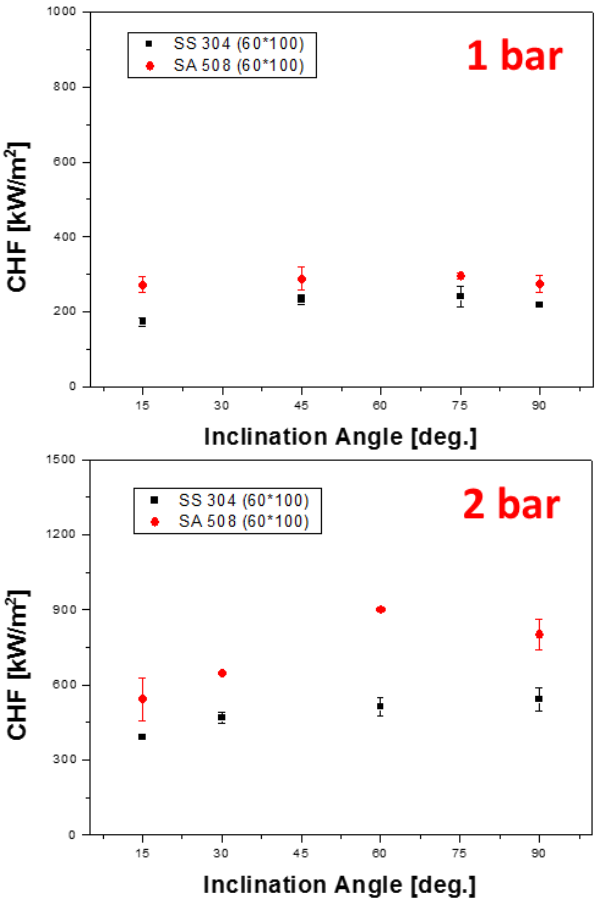

Fig. 6. Material and pressure effects (60 mm-width).

4. Conclusions

Width effect has been assessed for stainless steel under pressurized conditions. Width effect decreased as pressure increased for wide test sections. When considering material effect, some different trend was noticed depending on the width sizes. For the 40 mm-width case, enhancement decreased somehow as pressure increased up to 2 bar condition, and for the 50 mm-width case, carbon steel sometimes showed lower value compared with the reference material under 2 bar condition. For the widest case, 60 mm-width, an enhancement was started to be noticed for 2 bar condition.

REFERENCES

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[2] D. H. Kam, H. M. Park, Y. J. Choi, and Y. H. Jeong, CHF Measurement for Downward Facing SUS 304 and Carbon Steel Plates under Atmospheric and Pool Boiling Conditions, 16th International Topical Meeting on Nuclear Reactor Thermal Hydraulics(NURETH-16), Aug.30-Sept.4, 2015, Chicago, IL.

[3] D. H. Kam, H. M. Park, Y. J. Choi, and Y. H. Jeong, Critical Heat Flux Measurement for downward facing flat plates (SUS 304, SA 508) under atmospheric and pool boiling conditions, The Seventh China-Korea Workshop on Nuclear Reactor Thermal-Hydraulics(WORTH-7), Oct.14-17, 2015, Kunming, Yunnan.