Experimental Investigation of Heat Transfer in Absorber with Small Diameter Tube

Thanh Tong Phan+ · Choon-Geun Moon++ · Jae-Dol Kim+++ · Jung-In Yoon++++

Abstract : The effect of tube diameter on heat transfer characteristics of absorber in absorption chiller/heater using LiBr solution as a working fluid has been investigated by experimental study to develop a high performance and compact absorber. A system includes a tube absorber, a generator, solution distribution system and cooling water system was set up. The diameter of the heat exchanger tube inside absorber was changed from 15.88mm to 12.7mm and 9.52mm. The experimental results show that the heat transfer coefficient, Nusselt number and heat flux increase as solution flow rate and cooling water flow rate increase. The heat transfer performance increases as tube diameter decreases. Among three different tube diameters, the smallest tube diameter 9.52mm has highest heat transfer performance. A comparison of the heat transfer coefficient obtained by the present study with those of previous experimental results showed good overall agreement.

Key words : Tube absorber, Absorption chiller/heater, Lithium Bromide aqueous solution, Heat transfer performance.

1. Introduction

An absorber is an important component in an absorption chiller system. The size of the absorber can be reduced by using the small diameter tubes to replace conventional diameter tube. Most of previous studies were conducted on absorber which made by conventional diameter tube[1, 2]. The aim of this work is to investigate the enhancement of the heat transfer performance in tube absorber, which made by small tube diameter, working with LiBr solution. A system includes a tube absorber, a generator, solution distribution system and cooling water piping system was set up. Three different tube diameters 15.88mm, 12.7mm and 9.52mm were installed inside absorber to evaluate the effect of tube diameter to heat transfer performance of absorber with variation of solution and cooling water flow rates.

2. Experimental apparatus and method

Fig. 1 shows a schematic diagram of experimental apparatus. Table 1 shows the experimental conditions.

3. Experimental results and discussions

3.1 Effect of solution flow rate

The heat transfer coefficient increases as solution flow rate increases and tube diameter decreases as shown in fig. 2. Therefore, the Nusselt number and heat flux also increase as shown in fig. 3 and 4, respectively. In comparing with previous studies, the heat transfer coefficient of this study agrees well with studies of Kyung et al. [1] and Furukawa et al. [2].

3.2 Effect of cooling water flow rate

The heat transfer coefficient and Nusselt number increase with cooling water flow rate as shown in fig. 5 and 6, respectively. It causes the heat flux increases as shown in fig. 7. The cooling water flow rate effect significantly to heat transfer coefficient at the low flow rate, the increase of heat flux becomes slowly when cooling water flow rate increases over 10L/min.

4. Conclusions

The heat transfer performance increases as solution and cooling water flow rates increase. In the case of effect of cooling water flow rate on heat performance, it is noted that the cooling water flow rate effect significantly to heat performance at the low cooling water flow rate.

The heat transfer performance increases as tube diameter decreases. Among three different tube diameters, the smallest tube diameter 9.52mm has highest heat transfer performance.

Acknowledgements

The authors gratefully acknowledge the support from Dong-hwa Air-conditioning Co., Ltd.

References

[1] I. S. Kyung, K. E. Herold, "Performance of horizontal smooth tube absorber with and without 2-ethyl-hexanol", Transaction of the ASME, Journal of Heat Transfer, Vol. 124, pp. 177-183, 2002.

[2] M. Furukawa, N. Sasaki, T. Kaneko, T. Nosetani, "Enhanced heat transfer tubes for absorber of absorption chiller/heater", Transactions of the JAR, Vol. 10, No. 2, pp. 219-226, 1993.

+ Graduate School, Department of Refrigeration and Air-conditioning Engineering, Pukyong National University.
++ Postdoctoral Researcher, University of Auckland, NEW ZEALAND.
+++ Department of Environment and Equipment Engineering, Tongmyong University.
++++ Corresponding Author (School of Mechanical Engineering, Pukyong National University).
E-mail: yoonji@pknu.ac.kr, Tel : 051)620-1506

Table 1 Experimental conditions

Parameters		Conditions
Pressure of absorber [mmHg]		7
LiBr solution	Inlet temperature [℃]	47
	Inlet concentration [wt%]	61
	Flow rate [kg/ms]	0.014 - 0.032
Cooling water	Inlet temperature [℃]	32
	Flow rate [L/min]	6 - 14

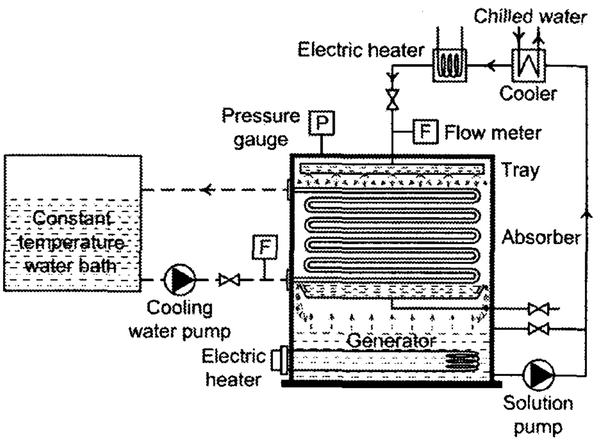

Fig. 1 Schematic diagram of experimental apparatus

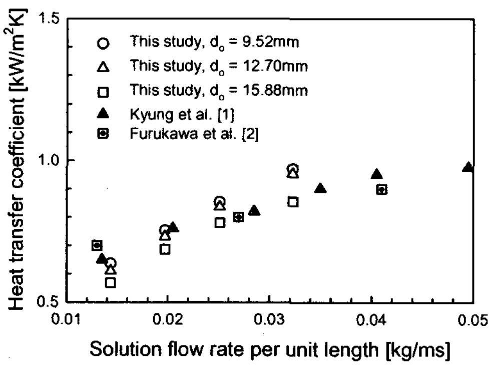

Fig. 2 Effect of solution flow rate on heat transfer coefficient

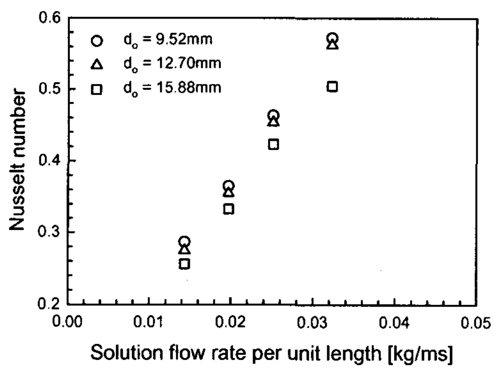

Fig. 3 Effect of solution flow rate on Nusselt number

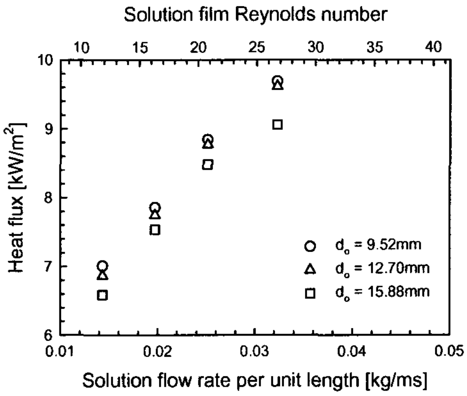

Fig. 4 Effect of solution flow rate on heat flux

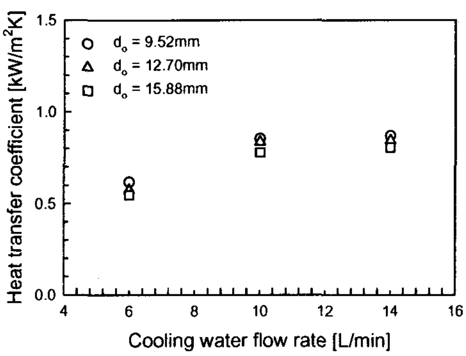

Fig. 5 Effect of cooling water flow rate on heat transfer coefficient

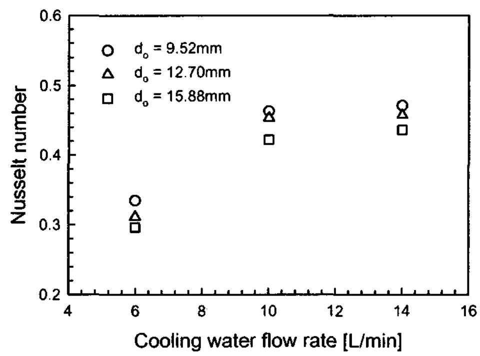

Fig. 6 Effect of cooling water flow rate on Nusselt number

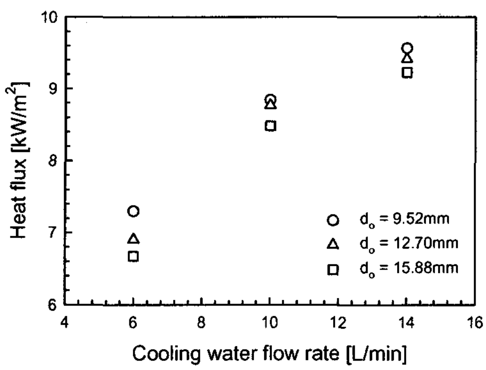

Fig. 7 Effect of cooling water flow rate on heat flux