

研究生:	李旺朝
研究生(英文姓名):	Wang-Chao Lee
論文名稱:	電液動力(EHD)熱傳增強技術用於殼管式冷凝器性能提升之探討
英文論文名稱:	Experimental Study of EHD Enhanced Technique for The performance Promotion of Shell and Tube Condenser
指導教授:	黃博全
學位類別:	碩士
校院名稱:	國立臺北科技大學
系所名稱:	冷凍空調工程系所
學號:	91458520
學年度:	93
語文別:	中文
論文頁數:	80
關鍵詞:	電液動力；熱傳增強；EHD冷凝器
英文關鍵詞:	Electro-hydrodynamic；Enhanced heat transfer；EHD Condenser
被引用次數:	0

[摘要]

開發提升熱交換器熱傳遞效率之新技術，乃是當今環保與節能的重要課題。先進電液動力EHD (Electro-hydro-dynamic)技術，使之產生較大擾動及液體擷取現象，達到熱傳增強的效果，但所造成的壓降卻很小，甚能符合環保節能的目標。本研究以實驗的方法，對EHD技術應用於冰水主機冷凝器熱傳增強性能之可行性進行研究探討。研究方式以R-22為工質，將EHD之熱傳增強電極，將EHD技術植入冰水主機之冷凝器中，建立具EHD冷凝器雛型機系統，再以實測評估EHD之熱傳增強效果。實驗結果顯示，EHD冷凝器之冷卻能力會隨輸入電壓的增加而增加，其最佳冷卻能力為未投入EHD電壓時的104.3%，其消耗電力僅97瓦。綜言之，本研究研製之EHD冷凝器雛型機，受有限經費及時間的限制，雖性能提升不十分明顯，但實驗結果顯示，EHD技術應用於冰水主機冷凝器熱傳增強性能之可行性是可行的。

[英文摘要]

For both environmental protection and energy saving, the heat exchangers with high efficiency have become an important topic. Advanced electrohydrodynamic (EHD) technique applies in condensation, utilizes an electric field to destabilize the thermal boundary layer near the wall and liquid extraction phenomenon, and leading to substantially higher heat transfer rate at the wall without significant pressure drop. In this study, the effect of applying EHD technique to condenser of commercial chiller was investigated by experimental method. The working fluid was R-22. The EHD enhanced heat transfer tubes were installed. The experimental result showed that the cooling capacity increased. Finally, a 1.043-fold enhancement of cooling capacity, with 1.0% consumptive energy increase and 97W uncharged electrodes. In summary, despite the increase in performance observed was not as obvious as predicted, the experimental results proved that the EHD technique is a feasible application in increasing condenser performance.

[論文目次]

摘要	i
ABSTRACT	ii
誌謝	iv
目錄	v
表目錄	vii
圖目錄	viii
第一章 緒論	1
1.1 背景說明	1
1.2 文獻回顧	2
1.3 研究目的與方法	9
第二章 電液動力(EHD)熱傳增強機制原理簡介	11
2.1 EHD簡介	11

2.2 EHD理論介紹	11
2.3 EHD熱傳增強機構	14
第三章 EHD冷凝器設計與製作	19
3.1 殼管式冷凝器設計	19
3.2 EHD電極設計	23
3.2.1 EHD電極的選定	24
3.2.2 EHD電極的製作	26
3.3 EHD熱傳增強管束殼管式冷凝器設計與製作	29
3.3.1 EHD絕緣座	29
3.3.2 EHD絕緣碍子	30
3.3.3 EHD增強管束冷凝器製作組合	32
第四章 EHD殼管式冷凝器冰水主機實驗量測	37
4.1 EHD殼管式冷凝器冰水主機	37
4.2 直流高電壓供應裝置	39
4.3 EHD冷凝器冷卻能力性能檢測系統配備	41
4.3.1 冰水主機冷媒循環系統	44
4.3.2 冰水主機冷卻水循環系統	45
4.3.3 冰水主機冰水循環系統	48
4.4 實驗量測儀器設備	49
4.4 實驗方法	53
4.4.1 Thermal-Couple校正	53
4.4.2 實驗程序	54
4.4.3 實驗數據擷取與分析	56
4.4.4 實驗數據分析工具介紹	57
第五章 實驗結果分析與討論	58
5.1 EHD電場對冷凝器冷卻性能的影響	58
5.2 EHD電場對系統壓縮機消耗功率的影響	64
5.3 EHD電場對EHD電源供應設備消耗功率的影響	69
5.4 EHD電場對冷凝器入出水溫度差的影響	71
5.5 EHD電場對冷凝器出入口壓力差的影響	72
第六章 結論與建議	74
參考文獻	76
符號彙編	79

[參考文獻]

- [1] Velkoff, H. R., Miller, J.H., "Condensation of Vapor on a Vertical Plate with a Transverse Electrostatic Field" pp. 197-201.
- [2] Choi, H. Y., " Electrohydrodynamic Condensation Heat Transfer" , Journal of Heat Transfer, Transactions of ASME, Vol. 112, 1990, pp. 1-10.
- [3] Didkovsky, A. B., Bologa, M. K., "Vapor Film Condensation Heat Transfer and Hydrodynamics under the Influence of an Electric Field" , Vol. 24, No.5, 1981, pp. 811-819.
- [4] Yabe, A., "Active Heat Transfer Enhancement by Applying Electric Fields" , ASME / JSME Thermal Engineering Conference, Vol. 3, 1991, pp. 47-53.
- [5] Sunada, K., Yabe, A., Taketani, T., and Yoshizawa, Y., "Experimental Study of EHD Pseudo-dropwise Condensation" , ASME / JSME Thermal Engineering Conference, Vol. 3, 1991, pp. 47-53.
- [6] Lovenguth, R. F., Hanesian, D., "Boiling-Heat Transfer in the Presence of Nonuniform Direct Current Electric Fields" , Vol. 112, 1990, pp. 570-576.
- [7] Kawahira, H., Kubo, Y., Yokoyama, T., Ogata, J., "The effect of an Electric Field on Boiling Heat Transfer of Water" , Vol. 26, No.2, 1990, pp. 359-365.
- [8] Ohadi, M. M., Papar, R. A., Lag, T. L., Faani, M. A., Radermacher, R., "EHD enhancement of shell side boiler condensation" , ASHRAE Transactions, Vol.98, Part2, 1992, pp. 427-434.
- [9] Alien, P. H. G., Cooper, P., "The Potential of Electrically Enhanced Evaporators", 3rd Int. Symp. On the Large Scale Use of Electric Fields in Heat Transfer, Vol. 1, 1990, pp. 221-229.
- [10] Cooper P., "EHD Enhancement of Nucleate Boiling", J. Heat Transfer, Trans., ASME, Vol. 112, 1990, pp. 41-47.
- [11] Ohadi, M. M., Salehi, M., Dessiatoun, S., Singh, A., " EHD-Enhanced Pool Boiling of R-123 in a Parallel Plate Heat Exchanger" , Proceedings of the ASME/JSME thermal engineering joint conference, 1995, pp. 225-232.
- [12] Cooper, P., Allen, P. H. G., "The Potential of Electrically Enhanced Condensers" , Proc. 2nd Int. Symp. On the Large Scale Use of Electric Fields in Heat Transfer, Vol. 1, 1990, pp. 221-229.

293-309.

[13] Yamashida, K., Kumagai, M.M. Sekita, S., Yabe, A., Taketani, T., and Kikuchi, K., “Heat Transfer Characterization of R-134a in a Tube Bundle,” Third ASME / JSME Joint Thermal Engineering Conference, Reno, Nevada, 1991, pp. 61-67.

[14] Yabe, A., Kikuchi, K., Taketani, T., Mori, Y., Hijikata, K., “Augmentation of Condensation Heat Transfer by Electric Fields,” 7th International Heat Transfer Conference, Vol. 5, 1982, pp. 189-194.

[15] Yabe, A., Taketani, T., Kikuchi, K., Mori, Y., Hijikata, K., “Augmentation of Condensation Heat Transfer on Micro-structured Surfaces by Applying Non-uniform Electric Fields” , Heat Transfer Science and Technology, ed. B. Wang, 1998, pp. 1-11.

[16] Cheung, K., Ohada, M. M., Dessiatoun, S. V., “Boiling Heat Transfer Enhancement of R-134a in a Tube Bundle,” Enhanced Heat Transfer, Vol. 3, No.4 , 1996a, pp. 301-309.

[17] Ogata, J., Iwafuji, Y., Shimada, Y., and Yamazaki, T., “Boiling Heat Transfer Enhancement in Tube-Bundle,” Transactions, Vol. 98, Part 2, 1992, pp. 435-444.

[18] 朱高照, “The Study of Electrohydrodynamic Technique for the Performance Promotion of Direct-Expansion Air Conditioning Systems,” Master's Thesis, National Taiwan University of Science and Technology Cold and Low Temperature Technology Research Institute, Taipei, 2002.

[19] Singh, A., Ohadi, M. M., Dessiatoun, S., “EHD Enhancement of In-Tube Condensation Heat Transfer of Air in Tubes.” ASHRAE Transactions Vol. 103, 1997, pp. 1-11.

[20] J. Trommelmans, and J. Berghmans, “Influence of Electric Fields on Condensation Heat Transfer of Noncondensable Gas Mixtures,” International Heat Transfer Conference, San Francisco, C.A. U.S.A., vol. 6, 1986, pp. 2969-2972.
