Heat Transfer Research of Magnetic Fluid in a Hele-Shaw Cell of Different Aspect Ratios

蔡睿唐、溫志湧

E-mail: 9509824@mail.dyu.edu.tw

ABSTRACT

The Rayleigh-Benard instability, occurring in the nature convection of magnetic fluid in a Hele-Shaw cell with different aspect ratios, heated from below with an imposition of an even vertical magnetic field was studied experimentally.. An automatic data acquisition system was set-up, along with a high-accuracy resistance heater and K-type thermolcouples for assuring the constant-temperature boundary conditions on the top and bottom walls of the Hele-Shaw cell. The results of the research show that the unsteady flow fields can be visualized with liquid crystal, thermography and magnetic fields of different strengths can enhance the Rayleigh- Benard instabilities for Hele-Shaw cell flows with different aspect ratios. The critical magnetic Rayleigh Numbers, Ramc, for different aspect ratios are found. We also discovered that the value of Dh has a relatively influence to Ra value.

Keywords : Magnetic Fluid, Natural Convection, Hele Shaw Cell , Aspect ratios, Rayleigh-Benard Convection Instability, Liquid Crystal Thermography,magnetic fluid

Table of Contents

REFERENCES

1.蘇品書編撰,“超微粒子材料技術”,復漢出版社, pp. 59-106, 1988. 2..Berkovsky, B.M. Magnetic Fluids Engineering Applications (Oxford Univ. Press, New York) pp. 214, 1993. 3.Berkovsky, B.M. Magnetic Fluids Engineering Applications (Oxford Univ. Press, New York) pp. 214, 1993. 4.Sihiliomis, M. I.,“Magnetic Fluids’’ Soviet Physics—Advances in Physical Science, Vol. 17, No.2, pp.153 -169, 1974. 5.Stiles, P. J., and Kagan,M.“Thermocovective Instability of a Ferrofluid in a Strong Magnetic Field”Journal of Collid and Interface Science, Vol.134, No.2, pp.435-488, 1990. 6.Blennerhassett, P. J., Lin, and Stiles, P. J.,“Heat Transfer Through Strongly Magnetized Ferrofluids”Proceedings of the Royal Society of London, Series A: Mathematical and Physical Science, Vol.433, No.1887 ,pp. 165-177, 1990. 7.Finlayson, B.A.,“Convective Instability of Ferromagnetic Fluids”Journal of Fluid Mech., Vol.40, Pt. 4, pp.753-767, 1970. 8.Schwab, L, Magnetic B?聲ard Convection, Doctoral Dissertation, University of Munich, Germany, 1989. 9.Schwab, L., Hildebrandt, U., Stierstadt, K.,“Magnetic B?聲ard Convection”Journal of Magnetism and Magnetic Material, Vol.39, pp. 113-114, 1983. 10.Schwab, L., Stierstadt, K.,“Field-Induced Wavevector-Selection by Magnetic B?聲ard Convection,”Journal of Magnetism and Magnetic Material, Vol.65, pp. 315-316, 1987. 11., K., Yamada, M.,“Thermal Convecton in a Horizontal Layer of Magnetic Fluids”Journal of the Physical Society of Japan, Vol. 51, No. 9, pp. 3042-3048, 1982. 12.Yamaguchi, H., Kobori, I., Uehata, Y., Shimada, K.,“Natural Convection of Magnetic Fluid in a Rectangular Box”Journal of Magnetism and Magnetic Material, Vol. 201, No 1-3, pp. 264-267, 1999. 13.Yamaguchi, H., Kobori, I., Uehata .,“Heat Transfer in Natural Convection of Magnetic Fluids”Journal of Thermophysics and Heat Transfer, Vol.13, No 4, pp.501-507, 1999. 14.松本正,角田市良,“液晶之基礎與運用’’劉瑞祥譯, pp.1-197,1996. 15.Lehmann .O , Z. Physik. Chem. 18,p 273 ,1889. 16.Friedel .G. Ann. Physique, 18:p273, 1922 17.Arp, H. C., & Van Sant, C. T., AJ, 63, 341, 1958. 18.Ireand ,P.T., Jones, T.V.,“The Response Time of a Surface Thermometer Employing Encapsulated Thermo-chromic Liquid Crystals”19.J. Phys . E : Sci. Instrum ,Vol. 20,No.10, pp.1195-1199,1987. 20.Moffat, R.J.,“Experimental Heat Transfer”Keynote Paper, KN11, Proc. 9th Int.Heat Transfer Conf., Jerusalem, Vol. 1.,pp 882-890,1990. 21.Camci, C., Kim, K., Hippensteele, S.A.“A New Capturing Technique for the Quantitative Interpretation of Liquid Crystal Images Used in Convective Heat Transfer Studies,”Journal of 22.Turbomachinery,Vol.114,pp.765- 775, 1992, AMSE paper 91-GT-122,pp1-13.1991 23.Wen,C.Y., Chen, C. Y, Yang, S. F.,“Flow

Visualization of Natural Convection of Magnetic Fluid in a Rectangular Hele-Shaw Cell ” Journal of Magnetism and Magnetic Matericals, Vol . 252C, pp.296-298,2002. 24.Wen,C.Y, W.-P.Su, “ Natural convection of magnetic fluid in a rectangular Hele-Shaw cell ” Journal of Magnetism and Magnetic Matericals, Vol . 289, pp.299-302,2005. 25.Tan,C.,Homsy,G., “ Stability of Miscible Displacements in Porous Media: Radial source flow ” Phys. Fluid 30, pp.1239-1245,1987.