Experimental Study of the Behavior of a Symmetric Valveless Impedance Pump

許智崵、溫志湧

E-mail: 9509823@mail.dyu.edu.tw

ABSTRACT

In this study, we have conducted the experimental the behavior of a symmetric valveless impedance pump. The valveless impedance pump was constructed of two reservoirs, one elastic tube and two rigid tubes. The elastic tube of rubber was connected to rigid acrylic tubes at two ends to form asymmetry impedance. The two rigid tubes were glued to two acrylic reservoirs, respectively to observe the pressure head. An electric-mechanical actuating mechanism was used to compress the elastic tube at different positions of compression positions along its length with fixed duty cycle, different amplitudes of compression and compression frequencies. Through cumulative effects of wave propagation and reflection originating from an excitation located asymmetry along the length of the elastic tube, a pressure across the pump can be built up to drive flow. According to the results of this experiment, flow can be reversible, and the pressure head is highly dependent on the frequency, amplitude of compression, and compression location. It is shown that when the amplitude of compression reaches inside diameter of the elastic tube is observed maximum flow rate up to 86ml/min at 26Hz. Measurements show a complex non-linear behavior in response to the compression frequency.

Keywords : valveless pump, impedance, elastic tube, wave propagation

Table of Contents

REFERENCES

1 馮記恩,“實用泵浦指南”, 科技圖書股份有限公司, 1991. 2 胡家琛,“泵”, 科技圖書大庫, 2002. 3 張兆豐,“泵及其使用方法”, 臺隆書店, 1982. 4 A. Olsson, & G. Stemme,“A Valve-less Planar Fluid Pump with Two Pump Chambers”, Sensors and Actuators A., Vol. 46, pp. 549, 1995. 5 E. Stemme, & G. Stemme,“A Vales-less Diffuser/Nozzle-Based Fluid Pump”, Sensors and Actuators A., vol. 39, pp. 159, 1993. 6 G. Liebau,“Uber ein Ventilloses Pumpprinzip”, aturwissenschaften vol. 41, pp. 327, 1954. 7 H. Thomman,“A Simple Pumping Mechanism in a Valveless Tube”, Iournal of Applied Mathematics and Physis (ZAMP), vol. 29, pp. 169, 1978. 8 M. Moser, J. W. Huang, G. S. Schwarz, T. Kenner, & A. Noordergraaf,“Impedance Defined Flow Generalisation of William Harvey’s Concept of The Circulation - 370 Years Later”, International Journal of Cardiovascular Medicine and Science, Vol. 1, Nos 3/4, pp. 205, 1998. 9 E. Jung,“2-D Simulations of Valveless Pumping Using The Immersed Boundary Mothod”, New York University, 1999. 10 T. Kenner, M. Moser, I. Tanev, & K. Ono,“The Liebau-Effect or on The Optimal Use of Energy for The Circulation of Blood”, Scripta Medica(BRNO), Vol. 73(1), pp. 9, 2000. 11 C. Babbs, & E. Jung,“Valveless Pumping Explained in Terms of Reflected Pressure Waves”, 2002. 12 D. Rinderknecht, A. I. Hickerson, & M. Gharib,“A Valveless Micro Impedance Pump Driven by Electromagnetic Actuation”, Journal of Micromechanics and Microengineering, Vol. 15, pp. 861, 2005. 13 C. Y. Wen, C. H. Cheng, C. N. Jian, T. A. Nguyen, C. Y. Hsu, & Y. R. Su,“A Valveless Micro Impedance Pump Driven by PZT Actuation”, Material Science Forum, Vol. 505, pp. 127, 2005. 14 A. I. Hickerson, D. Rinderknecht, & M. Gharib,“Experimental Study of The Behavior of A Valveless Impedance Pump”, Experiments in Fluids, 2005. 15 A. I. Hickerson,“An Experimental Analysis of The Characteristic Behaciors of An Impedance Pump”, California Institute of Technology Pasadena, 2005. 16 T. A. Nguyen,“無閥式組抗幫浦的流體力學研究”,大葉大學車 輛工程研究所， 2005 17 邱顯堂,“台灣橡膠工業發展史”, 台灣區橡膠工業同業公會, 1998. 18 張文能,“高分子材料”, 國興出版社, 1984. 19 S. Takagi, & R. Saijo,“Study of a piston pump without Valves”, Bulletin of JSME, Vol. 26, pp. 831-836, 1985. 20 D. Auerbach, W. Moehring, & M. Moser,“An analytic approach to the Liebau problem of valveless pumping”, Cardiovascular Engineering: An International

Journal, Vol. 4, No. 2, pp. 201, 2004. 21 R. C. Mackay, “ The pratical pumping handbook ” , Mc Graw-Hill, New York, 2001.