壓電致動式合成噴流研析

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摘 要

壓電致動合成噴流產生器(Piezoelectric-Actuated Sythetic Jet Generator)因具有質量輕、效率高，且構造簡單等優點，故 常應用於主動式氣流控制。合成噴流的流場現象依特性不同可分 為發展、充分發展以及消散等三個區域，噴流運作時從週遭吸入 和噴出的空氣質量約略相同，故又稱為零質量氣流(Zero-Net - Mass- Flow)，但流場仍維持正向動量。 本研究應用熱絲式流速計量測消散區速度分佈，與配合雷射 螢光顆粒激發顯像(Laser-Particle image)方法以觀察合成噴流 動態流動現象。理論分析係基於三維，暫態，可壓縮紊流之質量 與動量守恆方程式並配合 SIMPLEC數值方法以探討合成噴流行為 特性，紊流效應將採用K-e雙方程式紊流模式另設定移動邊界 (Moving Boundary Conditions)以模擬壓電模片之高頻週期振動 。數值結果與實驗量測數據比對後，可驗證理論模型與計算軟體 正確性，並延伸應用模擬程式於合成噴流參數分析。

關鍵詞 : 複合式噴流、壓電致動器、主動式氣流控制、數值模擬

目錄

參考文獻

[1] J. E. Cater and J. Soria,“ The evolution of round zero-net-mass-flux jets, ” J. Fluid Mech. 472, 167 1997.

[2] B. L. Smith and A. Glezer,“ The formation and evolution of synthetic jets, ” Phys. Fluids 10, 2281 1998.

[3] Venkata Pavan K Madhira,“ Interaction of Synthetic Jets with Boundary Layers, ” Fluid Sciences, Department of Mechanical Engineering, UNM, Albuquerque, NM 87131, USA.

[4] Smith, B. L. and Glezer, A.“ Vectoring and Small Scale Motions Effected in Free Shear Flows Using Synthetic Jet Actuators ”, AIAA Paper 97-0213, 1997.

[5] Allen, M. G. and Glezer, A.“ Jet Vectoring Using Zero Mass Flux Control Jets ”, AFOSR Workshop at Wright Patterson AFB, 1995.

[6] Pack, L. G. and Seifert, A.“ Periodic Excitation for Jet Vectoring and Enhanced Spreading ”, AIAA Paper 99-0672, 1999.

[7] Smith, D. R., Kibens, V., Parekh, D. E. and Glezer, A.“ Thrust Vectoring with Hybrid Synthetic Jet Actuator ”, Proc. of the ASME Fluids Engineering Division Summer Meeting, Vancouver, B.C., 1997.

[8] Smith, B., L., Synthetic Jets and their Interaction with Adjacent Jets, PhD Thesis, Georgia Institute of Engineering, 143 pp., June 1999.

[9] Mallinson, S. G., J. A. Reizes, and G. Hong,“ An Experimental and Numerical Study of Synthetic Jet Flow, ” Aeronautical Journal, Vol. 105, No. 1043, pp. 41 – 49, January 2001.

[10] Rizzetta, D. P., M. R. Visbal, and M. J. Stanek,“ Numerical Investigation of Synthetic Jet Flowfields, ” AIAA Journal, Vol. 37, No. 8, pp. 919 – 927, August 1999.

[11] Lee, C. Y. and Goldstein, D. B.“ Tow Dimensional Synthetic Jet Simulation, ” AIAA Journal, Vol. 40, No. 3, pp. 510 – 516, March 2002.

[12] Mallinson, S. G., C. Y. Kwok, and J. A. Reizes,“ Numerical Simulation of Micro-fabricated Zero Mass-flux Jet Actuators, ” Sensors and Actuators A: Physical, Vol. 105, pp. 229 – 236, 2003.

[13] Wang, Y.,“ Microfluidic Technology for Integrated Thermal Management: Micromachined Synthetic Jet, ” Ph. D. thesis, Georgia Inst. Technol., Atlanta, GA, November 2003.

[14] Coe, D. J. ,“ Fabrication Technology Approaches to Micromachined Synthetic Jets ” ,Ph.D. Dissertation ,Georgia Institute of Technology,2002.

[15] Amitay, M., Honohan, A., Trautman, M., and Glezer, A.,“ Modification of the Aerodynamics Characteristics of Bluff Bodies, ” AIAA Paper 97-2004, 1997.
[16] Roos, F. W., "Synthetic-Jet Microblowing for Forebody Flow-Asymmetry Management", AIAA Paper 98-0212, 1998.
[17] Crook, A., Sadri, A. M., and Wood, N. J., "The Development and Implementation of Synthetic Jets for the Control of Separated Flow", AIAA Paper 99-3176, 1999.
[18] Van Doormaal, J. P., and Raithby, G. D.,“ Enhancements of The SIMPLE Method for Predicting Incompressible Fluid Flows, ” Numerical Heat Transfer, Vol. 7, 1984, pp. 147-163.
[19] Pilliod, J. E., and Puckett, E. G..“ Second Order Volume-of-Fluid Interface Tracking Algorithms. ” Journal Computational Physics, Vol. 188, No. 1, 2003, pp.100-122.
[20] 吳坤城,“ 改良式合成噴射氣流器有限元素模型的建立和實驗量測與驗證 ”, 大葉大學機械工程研究所碩士論文, 2002.
[21] 陳華斌,“ 壓電噴射氣流器的設計與實驗評估 ”, 大葉大學機械工程研究所碩士論文, 2003.