The Study of Two-Dimensional Flow Using a Vertical Soap Film Tunnel（PART I）The Design of 6-Inch Shock tube System（PAR

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ABSTRACT

This thesis is devided into two parts : Part I - "The Study of Two-Dimensional Flow Using a Vertical Soap Film Tunnel" and Part II

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- "The Design of 6-inch Shock tube System". The main goal for the first part of the thesis is to develop a novel experimental apparatus - a vertical soap film tunnel, which is driven by gravity and can generate perfect two- dimensional flows, and to conduct two two-dimensional flow experiments with this device. The first experiment was to investigate two-dimensional flow about a normal flat plate. It was aimed to understand the difference of time-averaged drag coefficients between previous experimental studies and computational results. This contradiction has been discussed for years and there is still no definite conclusion. Momentum defect method was used to obtain the drag coefficient, in which the wake velocity profiles is depicted by laser Doppler velocimetry (LDV). Flow visualization was also emphasized to help understand the unsteady nature embedded in this type of flows. The small thickness variation of the soap film results in interference patterns, thus providing an excellent means for flow visualization. The drag coefficient of a normal flat plate we obtained (Cd=2.02) is in good agreement with the mean value of the previous experimental results (Cd=2.0). The second experiment conducted in this soap film tunnel was to verify the double cascade theory in the two-dimensional turbulence. Flow visualization and the measurement of the velocity fluctuations was emphasized in the experiments. A traditional camera was used to visualize the wake behind the grid, with the interests in finding the evolution of the wake vorticies and the interactions between nearby vorticies. LDV was used to measure the velocity fluctuations in the turbulent flow field. The power spectra of the turbulent velocity fluctuations was analyzed and compared to the double cascade theory. There are three goals for the second part of this thesis : the first one emphasizes on the design of a 6-in shock tube; the second one is to build up a data acquisition system, to complement the shock tube system, and the last one is to design the test section for the Richtmyer-Meshkov experiments. The design of the shock tube was finalized and is under construction. The data acquisition system constructed under IEEE-488 protocol has also been build up and tested. The system is also able to synchronize with the schlieren optical system. The Richtmyer-Meshkov instability experiment will be the first experiment to be done in the 6-in shock tube. The design of the testsection for the Richtmyer- Meshkov instability is the preliminary work for the experiment. The design incorporates two different mechanisms to produce sinusoidal and quasi-planar interfaces, respectively.

Keywords : Soap Film Tunnel ; Two-Dimensional Flow ; Flat Plate ; Two-Dimensional Grid Turbulence ; Shock Tube ; Shock Wave

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