Advanced Materials Research Vols. 614-615 (2013) pp 586-591
© (2013) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMR.614-615.586

Design and Development of Low Subsonic Wind Tunnel for Turning Diffuser Application

Normayati Nordin[1,a], Zainal Ambri Abdul Karim[2,b], Safiah Othman[1,c] and Vijay R. Raghavan[3,d]

[1]Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia

[2]Department of Mechanical Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia

[3]OYL R&D Centre Sdn. Bhd., Taman Perindustrian Bukit Rahman Putra, 47000 Sungai Buloh, Selangor, Malaysia

[a]mayati@uthm.edu.my, [b]ambri@petronas.com.my, [c]safiah@uthm.edu.my, [d]vijay@oyl.com.my

Keywords: low subsonic wind tunnel, settling chamber, screens, contraction cone, turning diffuser

Abstract. In practice, it is basically difficult even with controlled measurement environment to acquire a steady, uniform and fully developed flow. The flow entering diffuser was severely distorted despite a sufficient hydrodynamic entrance length already introduced. This was mainly due to the imperfect joining of duct and the abrupt change of the inlet cross-section applied. In this study, several basic features of a low subsonic wind tunnel, *i.e.* a centrifugal blower with 3-phase inverter, a settling chamber, screens and a contraction cone, are designed and developed for a turning diffuser application in order to improve the flow quality. The flow profiles are examined using Pitot static probe at five measurement points within the range of inflow Reynolds number, Re_{in}= 5.786E+04-1.775E+05. The steady, uniform and fully developed turbulent flow profiles with an average deviation with theory of about 3.5% are obtained. This proves that a good flow quality could be produced by means of incorporating some basic features of a low subsonic wind tunnel to the system.

Introduction

It is not easy to obtain a steady, uniform and fully developed flow in reality. Although by introducing a sufficient hydrodynamic entrance length of $4.4D_hRe^{1/6}<L_{h,turb} < 50D_h$ [1, 2], the flow has still been found severely distorted in the last reported works [3,4]. There was a large deviation of up to 34.1% recorded between the numerical and experimental results [4]. This was mainly due to the assumption made in the simulation that the inlet velocity was fully developed and uniform. However, in actual fact, the inlet velocity was considerably disrupted due to the abrupt change introduced to the diffuser inlet and the imperfect joining of duct [4]. This has to be improved otherwise the reliability and accuracy of the work shall be in doubt. In this study, several improvements to the existing test rig are proposed mainly by designing, developing and incorporating several basic features of a low subsonic wind tunnel such as a centrifugal blower, a settling chamber, screens and a contraction cone to the system. The flow that is expected to be more uniform and perfectly developed is then measured using Pitot static probe by traverse at five points and compared to the theories within the range of inflow Reynolds number, Re_{in}=5.786E+04 - 1.775E+05.

Conceptual Design of Low Subsonic Wind Tunnel Features

Low subsonic wind tunnel is characterised as a tunnel with a test section cross-sectional area of less than about 0.5 m^2 and freestream velocities of less than about 40 m/s [5]. It is expected that a good flow quality can be produced by incorporating well-designed wind tunnel features. Consisting of