FLOW THROUGH WIDE ANGLE ANNULAR DIFFUSERS WITHOUT AND WITH SWIRL

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CERTIFICATE

This is to certify that the thesis entitled "Flow Through Wide Angle Annular Diffusers without And With Swirl" by RAMCHANDRA NARAYAN RAO SAPRE has been prepared under my supervision in conformity with the rules and regulations of the Indian Institute of Technology, Delhi. I further certify that the thesis has attained a standard required for a Ph.D. degree of the Institute. The research report and results presented in this thesis have not been submitted, in part or full, to any university for any degree or diploma.

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ABSTRACT

Diffusers have been the subject of extensive study over the past two decades. Amongst various types of diffusers, the least attention has been paid to annular diffusers because of the number of geometric parameters that need to be considered. In many fluid dynamical applications flow through annular diffusers is swirling in nature. The present study is an experimental investigation of subsonic turbulent swirling flows through wide angle annular diffusers having diverging hub and casing boundaries with straight walls. The objective of the investigation was to carry out precise measurements of the mean flow and the turbulence quantities in plane two-dimensional or axisymmetric turbulent boundary layer flows without swirl and with inlet and/or hub generated swirl in a series of wide angle annular diffusers. Six perspex diffusers having different geometrical characteristics were fabricated. The hubs were cast of Aluminium and thereafter machined to obtain a smooth surface. Each of the diffusers in turn were mounted and tested on the same test rig as used by Kumar (88). The longitudinal variation of the static pressure along the wall of the casing was read on a multitube manometer. The radial distribution of static pressure as well as the axial

and tangential velocity profiles were measured with the help of a three hole cobra probe which was traversed across various cross-sections along the diffuser length. The shear stress acting on the diffuser wall was measured by means of a Preston tube. It was also computed from the measured velocity profiles with the help of a Clauser plot. The turbulence intensity at the inlet to the diffuser and the distribution of turbulence intensity along the length of the diffuser were measured using a Disa constant temperature hot wire anemometer. The experimental data was processed on an ICL 2960 computer to calculate the radial distribution of the longitudinal and tangential velocity components, the swirl angle, the static pressure and the distribution of the total pressure at each axial location. The results have been presented in the form of normalised plots using the mass averaged velocity at the inlet as the reference velocity to normalise the longitudinal and tangential components of velocity. The radial distribution of static pressure along the length of the diffuser, the longitudinal variation of static pressure along the casing wall, the pressure recovery, the blockage factor, the wall shear stress, and the distribution of turbulence intensity along the diffuser length have also been presented. The measurements indicate that the pressure recovery improves on introduction of inlet swirl. Hub generated swirl results in an increase of the radial static pressure and the distribution of the longitudinal static pressure along the casing wall and hence an improvement in the pressure recovery similar to that with inlet swirl. Introduction of swirl in Group A diffusers was found to substantially reduce the possibility of separation at the casing and to shift the stall from the casing to the hub. On the other hand, even a swirl of 25° which was the maximum investigated was not sufficient to completely eliminate separation in group B diffusers although the extent of the separation zone could be reduced.

The TEACH-T computer code developed by Gosman et al (1976) for turbulent recirculating flows was modified and adopted for affecting flow predictions in conical diffusers. Predictions of the axial and tangential velocity profiles and the pressure recovery for flow through conical diffusers with and without swirl were compared with the corresponding experimental results and found to be in fair agreement. The program was further modified and updated for investigating annular diffusers with a straight hub and with diverging hub and casing walls. Theoretical predictions for these cases were compared with the corresponding experimental results and found to be in good agreement.

CONTENTS

FIGURES are all serially arranged at the end.