

EFFECT OF SWIRL ON
FLOW THROUGH ANNULAR DIFFUSERS

by

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CERTIFICATE

This is to certify that the thesis entitled
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in part or full, to any university for any degree or
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ABSTRACT

Annular diffusers are likely to operate with varying amounts of swirl at the inlet. The work described in the thesis is concerned mainly with an experimental investigation of subsonic turbulent swirling flows through annular diffusers having diverging hub and casing boundaries. The test facility was designed so as to permit different levels of inlet-swirl. The static pressure distributions and the axial and tangential velocity profiles were measured with the help of a three-hole cobra probe suitably mounted at different cross-sections along the diffuser length. The characteristic quantities such as the diffuser performance parameters, the effective area fraction and blockage, and the boundary layer integral parameters were then computed from the experimental observations. The behaviour of these parameters has been discussed to establish the effect of swirl. The presence of inlet-swirl was found to increase the overall static-pressure recovery. A substantial increase in the pressure recovery occurred over the initial stages of diffusion and the gain was maintained thereafter. An improvement in the level of effectiveness was more significant for the stalled diffusers than that for the well-behaved diffusers. Introduction of swirl was found to substantially reduce the chances of separation at the casing and to shift the stall from the casing to the hub for the stalled diffusers.

The mainstream velocity profiles were examined on the basis of the power-law model, the Ross model, the logarithmic law-of-the-wall and the Coles law-of-the-wake. The existence of the near-wall region similarity was demonstrated and the skin friction values were estimated by the use of the Clauser technique. Likewise, the cross-stream profiles were analysed using the Magor profiles, the Johnston polar plots and the Coles wake function for three-dimensional turbulent boundary-layer flows. The experimental data was found to be well-represented by the Magor cross-flow model. The velocity distribution normal to the limiting wall-stream direction could be approximated by a quarter-sine wave function.

The GENMIX-4 version of the basic Patankar-Spalding Parabolic Programme for two-dimensional flows was adopted to predict the development of flow in respect of the longitudinal and tangential components of velocity and the pressure distribution. The turbulence terms in the governing equations were modelled by employing the mixing-length hypothesis suitably modified to account for the effect of swirl. The computed results were found to be in as good an agreement with the experimental results as warranted by the accuracy of the measurements.

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