Paper 28.6

Flow measurement around a fan volute tongue using particle tracking velocimetry

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ABSTRACT

The primary function of the collecting volute of centrifugal fans and compressors is to collect the swirling flow issued from the upstream impeller and diffuser and deliver it to a single discharge duct. This can be achieved efficiently at the design flow rate only. At off-design flow rates a pressure distortion is generated around the vaneless diffuser and impeller discharge leading to reduced performance of both components. The tongue of the collecting volute acts as a single vane around which the flow is divided and directed down the discharge duct and/or forced to recirculate around the volute. At high flow rates the volute acts as a nozzle and accelerates the air velocity leading to a reduction in static pressure. This high air velocity impacts the leading edge of the tongue at a large incidence angle leading to flow separation. At low flow rates the volute decelerates the airflow leading to an increase in pressure through the volute. At these low flow rates separation or flow unsteadiness can occur from the underside of the tongue. This investigation concentrates on the measurement of the flow characteristic in the vicinity of the volute tongue. Three volute tongue designs were investigated. Volute A had a full tongue and did not allow any flow recirculation. Volute C had a reduced tongue length thereby opening the recirculation port. Finally the tongue of volute RT-60 had a rounded leading edge to make it less sensitive to off-design flow conditions. Volutes C and RT-60 showed poor performance at flow coefficients between 0.19 and 0.29. Typical flow patterns at the volute tongue of design C are shown in Fig.1 for a flow coefficient of 0.27. The flow from injection port C2 was unstable with the flow direction switching between the recirculation duct and the discharge duct.

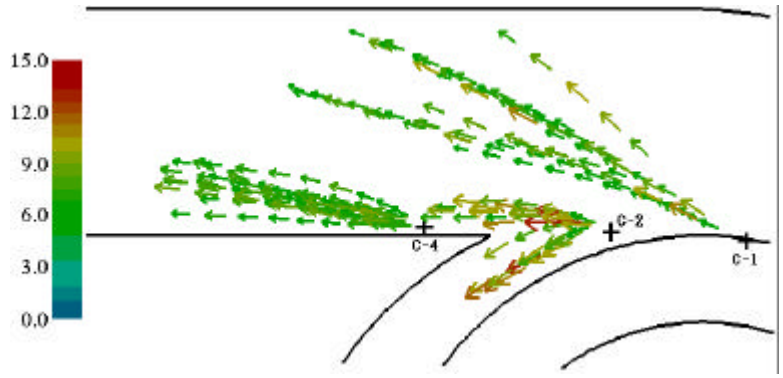

Fig.1 Velocity vectors illustrating unstable flow, Volute C, $f = 0.27$