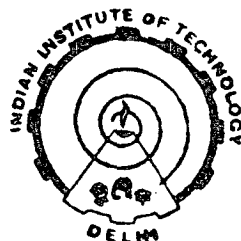


FLOW AND PERFORMANCE INVESTIGATIONS OF CENTRIFUGAL BLOWERS WITH AEROFOIL BLADED IMPELLERS

BY
JAY K. MUKHRAIYA

A THESIS SUBMITTED IN
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CERTIFICATE

This is to certify that the thesis entitled, "FLOW AND PERFORMANCE INVESTIGATIONS OF CENTRIFUGAL BLOWERS WITH AEROFOIL BLADED IMPELLERS", being submitted by Mr. J.K. Mukhraiya to the Indian Institute of Technology, Delhi, for the award of the degree of 'Doctor of Philosophy' in Mechanical Engineering is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to our knowledge has reached the requisite standard.

The results contained in this thesis have not been submitted in part or in full, to any other University or Institute for the award of any degree or diploma.

S.M. Yahya
Dr. S.M. Yahya,
Professor,

D.P. Agrawal
Dr. D.P. Agrawal,
Assistant Professor

Mechanical Engineering Department,
Indian Institute of Technology, Delhi,
Hauz Khas, New Delhi-110016.

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(J.K. MUKHRAIYA)

To my parents and teachers

ABSTRACT

Centrifugal fans and blowers are used commonly in applications ranging from household ventilation system to process industries. Their main function is to move gas or air and/or raise its pressure from a few millimeters to more than a meter of water gauge. These machines have been designed with different configurations and geometries, viz. backward curved, forward curved and radial tipped bladed impellers. The flow in a centrifugal blower is highly complex and poorly understood due to its 3-dimensional nature and geometrical parameters of the machine. This has resulted in major handicap in achieving high efficiency standard for these blowers. The performance of a blower is greatly affected by the number of blades, their shape, geometry and operating conditions. Further the diffusing elements downstream of the impeller govern the flow through the machine, its range of operation and efficiency.

Conventionally the impeller blades in a centrifugal blower are of constant thickness made out of sheet metal; as the demand for the improvement of performance and efficiency of centrifugal turbomachines increases the blades with aerofoil sections have come to be used for centrifugal impellers, since it is well known that the aerofoil sections in turbomachines can guide and control the flowing fluid with minimum losses.

The literature review reveals that the work on aerofoil bladed centrifugal blower is scanty. So far only some experiment for overall performance characteristics of backward curved aerofo

bladed centrifugal blowers have been reported. The geometry of these blowers is not optimized and the choice of number of blades is arbitrary. Detailed flow investigation and blade pressure distributions have not been reported. No attention has been given to other impeller shapes. The effects of inlet flow conditions on the performance have not been studied. The present programme of experimental investigation was undertaken to study the performance of centrifugal blowers with aerofoil bladed impellers and to carry out parametric investigations. To undertake this study a centrifugal blower test rig was developed. An aerofoil bladed radial tipped centrifugal blower was designed and fabricated to run at 2000 RPM. The impellers were dynamically balanced, and driven by a variable speed thyristor controlled D.C. motor. The most important aspect of the impeller design was the selection and design of aerofoil section. The C-4 profile section was selected because of its suitability for low tip speed blowers. A pressure transfer unit was also fabricated to measure the blade surface pressure distributions. For comparison of overall performance an impeller with backward curved blades was also fabricated.

Experiments were conducted with radial tipped impellers at different speeds ranging from 1600 to 2200 RPM and with different throttle openings. Measurements were taken to determine overall performance characteristics with different geometrical configurations, number of blades, and blockages. A 3-hole pressure probe and a hot-wire probe were traversed at the exit of the impeller to obtain velocity and turbulence level. Noise and vibration levels were also recorded at different locations

with and without inlet duct. The blade surface pressure was recorded with the help of a pressure transfer unit. The wall static pressure distributions on the casing and front wall were also recorded. To compare the overall performance, a backward curved aerofoil bladed impeller was also tested.

The data obtained from these measurements were processed on an ICL 2960 computer. The results are presented graphically in terms of overall performance characteristics, velocity distributions, blade surface pressure distribution, wall static pressure distribution, turbulence level, noise and vibration patterns and their frequency spectra. These results are discussed in detail and on the basis of these results useful conclusions are drawn.

The main conclusions of the investigation are that the radial tipped aerofoil bladed impellers give wider range of stable operation and the optimum number of aerofoil blades for radial tipped centrifugal impeller is about $2/3$ of the number of sheet metal blades. Secondly the higher pressure coefficients are obtained with radial tipped aerofoil loaded impeller, compared to backward swept aerofoil bladed impeller as is the case with sheet metal blades. It is suggested that the detailed flow investigations should be carried out for backward swept and forward swept aerofoil bladed impellers.

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