FLOW INVESTIGATIONS IN THE VOLUTE CASINGS OF INWARD FLOW RADIAL TURBINES

by

TRILOKI NATH

Mechanical Engineering Department

Submitted
in fulfilment of the requirements of
the Degree of Doctor of Philosophy

to the

Indian Institute of Technology, Delhi

June 1980

CERTIFICATE

This is to certify that the thesis entitled "Flow Investigations in the Volute Casings of Inward Flow Radial Turbines" being submitted by Mr. Triloki Nath 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 my guidance and has fulfilled the requirements for the submission of this thesis, which 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

Dated: 26.6.80

Dr. S. M. Yahya
Professor
Mechanical Engineering Department
Indian Institute of Technology
Delhi-110016

ACKNOWLEDGEMENTS

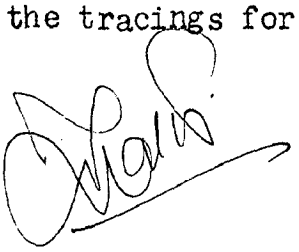
The author wishes to express his sincere gratitude to his supervisor, Professor S.M. Yahya, for his valuable help and guidance in completing the present research program. .

Thanks are also due to the staff of the Turbomachinery and Steam laboratories for the facility and help provided during this program. The staff of the Mechanical Engineering Workshop and carpentary shop of IDDC carried out the fabrication work in efficient manner. The author acknowledges their assistance.

Author is thankful to the Ministry of Education, Government of India for providing the financial support under Q.I.P. Scheme and to the Principal, M.N.R. Engineering College, Allahabad for sanctioning study leave for this research program.

I am very much indebted to my friends and well wishers who helped directly and indirectly during my Ph.D. program and family for their encouragement.

Thanks are also due to Mr. B.L. Tuli for the excellent typing and to Mr. P.R. Gauba for preparing the tracings for the thesis.



I.I.T. Delhi
Dated 5.6.1980

TRILOKI NATH

ABSTRACT

This thesis reports theoretical and experimental investigations of the flow in the volute casings of inward flow radial turbines.

In theoretical investigations, the static pressure distribution along the radial direction for different angular positions of the volute has been predicted by one dimensional theory. Theory neglects the effect of radial velocity and acceleration. To predict the flow more accurately a two dimensional theory has been developed with the help of conformal transformation. It gives the absolute velocity distribution along the radial direction for any section of the volute. This theory also predicts the static pressure distribution along the curved wall.

For experimental investigations, a test rig for testing a number of volutes was developed. It consisted of mainly an air supply unit, volute casing and the settling chamber. The exit of the volute casing was connected to the suction of a larger blower through a flexible joint which reduces vibrations from blower to the casing. A settling chamber was fitted at the inlet of the volute to obtain standardised flow. The centrifugal blower was driven by a 30 K.W., A.C. motor.

Each volute had two parts. One part had the curved wall of the desired dimensions and geometry and other part was

a plain plank having streamline body at the centre to make the flow streamlined in the volute. One of the volutes was fitted with 12 uncambered blades to see the effect of nozzles on upstream flow.

Experiments were conducted on each of the five volutes and all the experiments were performed at the design point velocity of 11 m/s at volute inlet. A 3-hole probe was used to measure the flow angle, static pressure and total pressure along the radial direction and around the volute at different axial points. Wall static pressure along radial and along the curved wall were measured with the help of wall tappings.

Different flow parameters like flow angle, angular momentum, absolute velocity, tangential velocity, radial velocity, static pressure and total pressure distribution along the radial direction at different angular positions of the volute were plotted with and without settling chamber. All the above said parameters were also plotted around the volute at different points along the span. Effect of tongue positions and nozzles on loss coefficient were also reported in some of the graphs. Variation of loss coefficient with inlet velocity and area ratio were plotted.

Comparison of theoretical predictions with experimental results show good correspondence.

Experimental results suggest that a volute without nozzle blades can safely be used where weight and cost is of prime importance.

CONTENTS