ANALYSIS OF FLOW THROUGH VOLUTE CASINGS OF CENTRIFUGAL MACHINES

by

RAMASHISH YADAV
Mechanical Engineering Department

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

to the

Indian Institute of Technology, Delhi

November 1977

To

my parents

CERTIFICATE

This is to certify that the thesis entitled ''Analysis of Flow Through Volute Casings of Centrifugal Machines'' being submitted by Ramashish Yadav for the award of the degree of 'Doctor of Philosophy' to the Indian Institute of Technology, Delhi is a record of bonafide research work he has done during November 1974 to November 1977 under my supervision. The results obtained in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Dated: 30.11.77

S.M. Yahya.

(Dr. S.M. Yahya)
Professor of Mechanical Engg.,
Indian Institute of Technology,
Delhi, Hauz Khas,
New Delhi - 110029.

ACKNOWLEDGEMENTS

The author wishes to express his profound gratitude to Prof. S.M. Yahya, his supervisor, for the able guidance and constant encouragement provided throughout his Ph.D. programme.

Sincere thanks are due to Professor Y. Matsuoka of Kinki University, Japan for useful suggestions. The author is grateful to the Ministry of Education, Government of India for providing the financial support under the Q.I.P. scheme and to the Principal, M.N.R. Engineering College, Allahabad for sanctioning study leave for this research programme.

The author wishes to thank his friends and well wishers who helped directly and indirectly during his Ph.D. programme. Sincere thanks are due to Dr. D.P. Aggrawal, Lecturer, Mechanical Engineering Department, I.I.T. Delhi for useful discussions.

Thanks are due to the staff of Computer Centre, Turbomachiery and Heat Engines Laboratories and Boiler House for the facility and help provided during this programme. Appreciation are due to Mr. N.R. Sharma of I.D.D.C. for the greatest help in fabrication of the test rig and to Mr. Man Mohan of Turbomachinery Laboratory for the help during the experimentation. Appreciation are also due to Mr. V.P. Gulati for nice typing of the manuscript.

Last but not the least, the heartiest thanks are due to my wife, Mira Yadav for her encouragement and also to my sons Sanjay and Rajay for being neglected from my side during this research programme.

New Delhi-110029 R. Yadav

Date: 28.11. 1977

ABSTRACT

The present work was undertaken to study theoretically and experimentally the internal flow behaviour in volute casings of centrifugal blowers and compressors with standard swirling flow free from jets and wakes at its inlet for wide range of throat length to volute inlet diameter ratio, tongue position , swirl angle and Reynolds number.

In theoretical part of the work, one dimensional flow model taking into account friction and mixing was formulated and solved for pressure distribution along the volutes. For prediction of velocity profiles in volutes, two dimensional ideal flow model had been formulated and the resulting equations were solved by singularity method. The well known free-vortex analysis was also used just to compare experimental findings of velocity profiles.

In the experimental part of the work, a new method for testing the volutes was developed. Present test rig consists of an air supply unit, swirl generator and the volute casing. The air was fed to the volutes by a centrifugal blower (driven at 3000 rpm by 30 H.P. A.C. motor) through a transition piece, a setting chamber and a swirl generator. The swirl generator used works on the principle of free vortex flow. It consisted of 24 number of nozzle

blades. The volute was designed using the principle of constant mean velocity and was fabricated from devdar sleeper and commercial plywood. Such six volutes were fabricated

The tests on the volutes were conducted at six Reynolds numbers (ranging from 3.75×10^5 to 13.125×10^5) and five inlet swirl angles (ranging from 10° to 35°) in each of six volutes. Measurements of stagnation pressure, static pressure and flow direction were carried out along axial, radial and tangential directions with the help of 3 hole calibrated probe. Wall static pressure along radial and tangential direction were also measured with the help of wall tappings.

The volute performance was studied by plotting velocity, swirl angle, static pressure, total pressure distributions, pressure recovery and total pressure loss coefficients for various inlet flow conditions in all the six volutes.

Comparison of experimental findings and theoretical predictions shows good correspondence.

=oo=

CONTENTS

Contents (contd) PAGE

Contents (Contd) PAGE

Contents (Contd). PAGE

Contents (Contd) PAGE

Contents (Contd) PAGE

Contents (Contd) PAGE

Contents (Contd)

=oo=