



**AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING**

**Experimental Investigation of Using Double-Volute Casing
Centrifugal Pump to Reduce Radial Thrust.**

A thesis submitted in fulfillment of the requirements of the degree of Master
of Science in Mechanical Engineering

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Preface

This dissertation is submitted for the Degree of Master of Science in Mechanical Engineering for the Faculty of Engineering of Ain shams University; Cairo.

The work described in the thesis was carried out at the department of mechanical power Engineering, Faculty of Engineering, Ain Shams University, Cairo.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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Acknowledgement

My Greatest thanks to Allah for giving me the will power and strength to make this great achievement.

I would like first to thank my supervisors Prof. **Dr. Raouf Nassif** and **Dr. Ehab Mouris** for their continuous guidance, encouragement, invaluable assistance and patience. I learned so many valuable things from them, but above all, they taught me how to be devoted to scientific research.

I wish to express my deepest appreciation and gratitude to my beloved **mother**, my beloved **father** and my **brothers** for supported me with the greatest possible care, encouragement and for their endless love through my life.

I would like to express my deepest love to my beloved wife, **Sara** for her understanding, unlimited support and incredible love.

I would like also to thank Eng. **Mohamed Matbouly**, Dr. **Hesham Matbouly** and Eng. **Mohamed Mounir El Boghdady** for their support and encouragement during pump testing and the research stages.

Special thanks to laboratory operators; Mr. Ahmed Sobhy and Mr. Sherif Abdelmoneim for their sincere support during the phases of test rig construction and preliminary runs.

Finally, but most important, I thank God almighty again on all things in my life.

Abstract:

Radial thrust in a single volute centrifugal pump, which is a result of pressure variation in the volute casing, is investigated in order to avoid failures caused by this thrust force. Two ideas are introduced to avoid or to minimize this thrust force, the first is a double volute, and the second is a triple volute. A complete centrifugal pump design was manufactured. The volute was designed such that partition vanes could be added to change the number of volutes. Experiments were performed on single, double, triple volutes centrifugal pump at 500, 800, and 900 rpm for each case.

The performances of the three pumps as seen on a non-dimensional plot, are nearly the same in the three casing types (Single, double and triple volutes). However the values of the efficiency reveal an improvement associated with the presence of the volute(s)

On the other hand, the use of multiple volutes reduced the radial thrust force. These reductions were pronounced as the departure from the BEP was increased. At shut off for instance, the radial thrusts for the double volutes and triple volutes were reduced by 55% and 70%, respectively, below the thrust of a single volute pump.

List of Nomenclatures

A_r	The leakage or clearance area	(m ²)
b_1	Passage width at inlet	(m)
b_2 or B_2	Total passage width at outlet	(m)
BEP	Best efficiency point	
B_i	Impeller width at outlet	(m)
B.P	Brake power	(watt)
C_Q	The flow coefficient	(-)
C_1	Velocity at inlet vane edge	(m/s)
C'_2	Impeller absolute outlet velocity	(m/s)
C_e	Velocity at impeller eye	(m/s)
C_{m1}	Radial inlet velocity	(m/s)
C_{m2}	Radial outlet velocity	(m/s)
C_{su}	Velocity at suction flange	(m/s)
D_1	Diameter of inlet vane edge	(m)
D_2 or D_i	Impeller outlet diameter	(m)
D_e	Impeller eye diameter	(m)
D_h	The hub diameter	(m)
D_{bb} or D_{Hb}	The impeller back hub diameter	(m)
D_{hf} or D_{Hf}	Impeller front hub diameter	(m)
D_r	The wearing ring inner diameter	(m)
D_s	Shaft diameter	(m)
D_{su}	Suction flange diameter	(m)
F_r	Radial thrust force	(N)
H	Pump's head	(m)
H_L	Head loss across the wearing ring	(m)
K or K_t	Radial thrust factor	
N_s	Specific speed	[-]
Q	Pump discharge	(m ³ /s)

QL	Amount of flow leakage	(m ³ /s)
Qt	Total discharge	(m ³ /s)
Qn	Discharge at BEP	(m ³ /s)
t	The normal vane thickness	(m)
T	Shaft torque	[N.m]
u1	Inlet vane edge tangential velocity	(m/s)
u2	Impeller peripheral velocity	(m/s)
Z	Number of vanes	
N	Pump motor speed	rpm

Greek symbols

α'_2	Angle of water leaving impeller	deg.
β_1	Impeller vane inlet angle	deg.
β_2	The outlet vane angle	deg.
ε	The contraction factor	
δs	The shaft maximum allowable shear stress	[N/m ²]
φ	Speed ratio	
ω	The angular speed	[rad/sec]
η	The pump overall efficiency	[%]
θ	Angle measured from tongue	deg

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