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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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

Ar	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	(-)
C1	Velocity at inlet vane edge	(m/s)
C'2	Impeller absolute outlet velocity	(m/s)
Ce	Velocity at impeller eye	(m/s)
Cm_1	Radial inlet velocity	(m/s)
Cm_2	Radial outlet velocity	(m/s)
Csu	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)
Dh	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)
Dr	The wearing ring inner diameter	(m)
Ds	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	
Ns	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/m²]
φ	Speed ratio	
ω	The angular speed	[rad/sec]
η	The pump overall efficiency	[%]
θ	Angle measured from tongue	deg

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