

Testing of Two Different Enclosed Impellers at Same Speed

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ABSTRACT: The centrifugal pumps are to be manufactured at the different types of applications like liquids, liquid-solid mixtures etc. at different parameters like density of flowing fluid, concentration of liquid and solid, solid material properties and different environmental conditions. After manufacturing, testing is done on test to checking that manufactured pump whether achieves our goal or not. After testing the performance is predicted considering the head ratio or performance ratio. This paper deals with testing of the two enclosed impellers which is designed to the pumping river sand application. Both impellers are same conditions of flow rate $0.06\text{m}^3/\text{sec}$, density 1247 kg/m^3 , and pump speed 2000 rpm. There are changes in the design of the impeller as like inlet diameter, inlet angles, and outlet angle. The testing is done on the flowing fluid as water and then predicted for the solid-liquid mixture.

KEYWORDS: Enclosed impeller, centrifugal pump, river sand

I. INTRODUCTION

The pump receives the kinematic energy from the rotating impeller passes the fluid from inlet to outlet at high pressure. The centrifugal pumps are used to different applications and different locations. The sizes of the pumps are also getting bigger and bigger for the increasing capacity and also head of the pump. When pump is designed and manufactured for the particular applications it is always not possible to check that pump is whether achieves our goal or not, on that particular location or particular application. Hence there is testing of pump is done at shop floor or possible locations on possible factors. And then that performance is predicted for the particular applications.

Here test is done on the shop floor and the flowing fluid as water, after that the performance parameters are predicted with the sand slurry applications. Here the test is done on two impellers. After testing results are analysed.

For the performance test here used the procedure given as per the IS: 9137-1978, bureau of Indian standard [1], they given what are the guarantees and purpose of the tests. Also give the testing arrangement is done for the proper fluid selection. There is also given the procedure for the measurement of rate of flow, head, speed of rotation and power input. Here use of the IS: 13538-1993 bureau of Indian standard [2] for the mounting of the pressure gauges from the distance of pump inlet and outlet, also used the formulas for the measurement of the total head of pump. After testing the performance is predicted for the sand slurry applications for these simple relations are given by the cheng H.P. and S.P.Yun [5] are used.

II. RELATED WORK

Centrifugal pump testing is very important to checking the designed pump is whether the meet our goal or not. It is simple to test, water centrifugal pumps. But for the checking performance of the sand – slurry pumping, it is always not possible to check the on field or doing test rig as per application. Hence there is used the relations of the head and efficiency to the parameters of the flowing fluid. Here are tested the two impellers. The impeller having the change in dimensions. Fig.1 shows the methodology used to test the impeller. Following give the steps of the testing of impellers

- Firstly the study of the two different impeller the actual photographs and the dimensions are studied.
- After study arrangement of the test is done

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- Then the test is taken with the 1st impeller and results are calculated for the flow rate, head and efficiency.
- Same procedure is done with the 2nd impeller and results are calculated.
- After testing both results analysed and predicted for the sand- slurry application

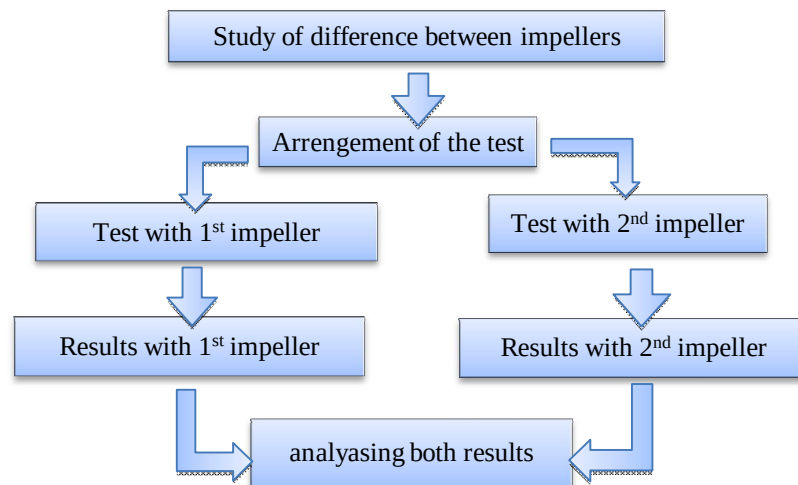


Fig.1: Methodology

III. STUDY OF TWO DIFFERENT IMPELLERS

For the study of the both impeller there are actual photograph show in the Fig.2 and Fig.3 and the dimensions are shown below in table1 and table 2. In 1st impeller and 2nd impeller there are measure changes in the impeller inlet diameter, impeller inlet angles and the impeller outlet angles.



Fig.2: 1st impeller



Fig.3: 2nd impeller

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Parameters	Value
Impeller inlet diameter	130 mm
Impeller outlet diameter	225 mm
Inlet angle at shroud	9°
Inlet angle at centre streamline	14°
Inlet angle at hub	27°
Outlet vane angle	9°
Impeller outlet width	80 mm
Number of blades	2

Table 1: dimensions for impeller 1

Parameters	Value
Impeller inlet diameter	170 mm
Impeller outlet diameter	227 mm
Inlet angle at shroud	13°
Inlet angle at centre streamline	19°
Inlet angle at hub	32°
Outlet angle	20°
Impeller outlet width	60 mm
Number of blades	3

Table 2: dimensions for impeller 2

IV.ARRANGEMENT OF THE TEST

Testing of the centrifugal pump the arrangement is done like the shown below fig.3. There is engine shaft is coupled with the centrifugal pump. Pump inlet connect with pipe of 100mm diameter for the sucking the water from the tank 2 and discharge port is connects pipe of same 100 mm diameter for the measurement of the flow rate of the discharge fluid water which collect at tank 2. For the measurement of total head the suction pressure gauge mounted on the inlet pipe and positive pressure gauge is mounted on the discharge pipe.

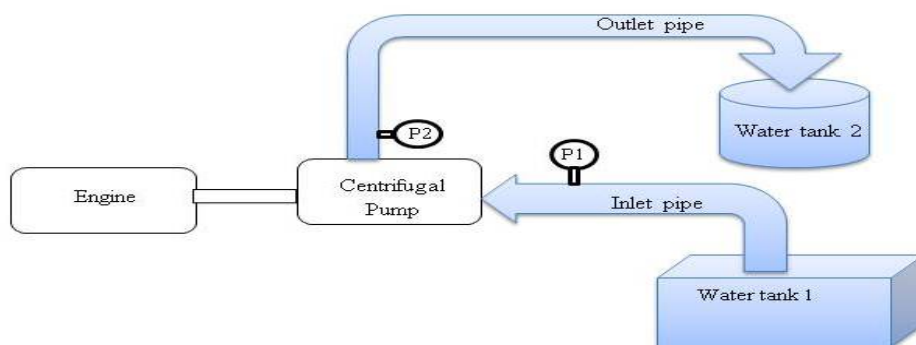


Fig.3: Arrangement of the test [4]

Requirement for the test [1, 2]

- Pressure gauges P1- vacuum pressure gauge
P2 – positive pressure gauge
- Tachometer – speed measurement
- Stop watch – time for filling water tank 2
- Tank

Known parameters

Flowing fluid – water – density (ρ) = 1000 kg/m³

Engine power at 2000 rpm = 23.7 h.p

Inlet pipe size = 100 mm

Outlet pipe size = 100 mm

Tank 2 capacity = 200 ltr.

Gauge distance = 0.45 m.

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V. TEST WITH 1ST IMPELLER

Start the engine and check the pump speed with digital tachometer and when it comes at 2000 rpm check the all parameters which are required to further calculations for the checking the total dynamic head and efficiency of the pump.

$$P_1 = 200 \text{ mm hg} = 2.72 \text{ m}$$

$$P_2 = 1.4 \text{ kg/cm}^2 = 14 \text{ m}$$

$$\text{Flow rate} = 200 \text{ ltr./3.9 sec} = 51.28 \text{ l/s} = 0.0513 \text{ m}^3/\text{s}$$

Results with 1st impeller

- o Flow rate(q) = 0.0513 m³/sec
- o Total dynamic head (h) = suction gauge reading + delivery gauge reading + gauge distance + velocity
Here the suction and delivery pipes same in size hence velocity is 0.
Total dynamic head = 2.72 m + 14 m + 0.45 m = 17.2 m
- o Efficiency of the pump = $\frac{P_{\text{output}}}{P_{\text{input}}}$

$$P_{\text{output}} = \frac{\rho * q * h}{75} = 12 \text{ h.p}$$

$$P_{\text{input}} = \text{engine output} = 22.7 \text{ h.p}$$

$$\eta_p = 52.8 \%$$

VI. TEST WITH 2ND IMPELLER

Start the engine and check the pump speed with digital tachometer and when it comes at 2000 rpm check the all parameters which are required to further calculations for the checking the total dynamic head and efficiency of the pump.[3]

$$P_1 = 280 \text{ mm hg} = 3.8 \text{ m}$$

$$P_2 = 1.8 \text{ kg/cm}^2 = 18 \text{ m}$$

$$\text{Flow rate} = 200 \text{ ltr./ 4 sec} = 50 \text{ l/s} = 0.050 \text{ m}^3/\text{s}$$

Results with 2nd impeller

- o Flow rate(q)=0.050 m³/sec
- o Total dynamic head (h) = suction gauge reading + delivery gauge reading + gauge distance + velocity
Here the suction and delivery pipes same in size hence velocity is 0.
Total dynamic head = 3.8m + 18 m + 0.45m = 22.25 m
- o Efficiency of the pump = $\frac{P_{\text{output}}}{P_{\text{input}}}$

$$P_{\text{output}} = \frac{\rho * q * h}{75} = \frac{1000 * 0.050 * 22.25}{75} = 14.8 \text{ h.p}$$

$$P_{\text{input}} = \text{engine output} = 22.7 \text{ h.p}$$

$$\eta_p = 65\%$$

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VII. ANALYSING THE BOTH RESULTS

Results are to be modified for the sand and water mixture and correction in head and efficiency [5, 6]

Sand % in mixture 40% (by volume)

Sand % in mixture 52% (by weight) = C_w

Density of sand = 1600 kg/m^3

Density of water = 1000 kg/m^3

Specific gravity of sand = $1.6 = S$

Average diameter of the sand = $1 \text{ mm} = d_{50}$

$$\text{HR (Head Ratio)} = 1 - 0.0385 * (S - 1) * \left(1 + \frac{4}{S}\right) * C_w * \ln\left(\frac{d_{50}}{0.0277}\right)$$

$$= 0.85$$

HR = ER (Efficiency Ratio)

Hence

For the 1st impeller

Total Head when sand is present = $0.85 * 17.2 = 14.6 \text{ m}$

Efficiency when sand is present = $0.85 * 52.8 = 45 \%$

Flow rate = $0.0513 \text{ m}^3/\text{sec}$ having 40% sand $0.0205 \text{ m}^3/\text{sec}$. Sand pumped $73.8 \text{ m}^3/\text{hr}$. (26 brass/hr.)

For the 2nd impeller

Total Head when sand is present = $0.85 * 22.25 = 18.9 \text{ m}$

Efficiency when sand is present = $0.85 * 65 = 55.2 \%$

Flow rate = $0.050 \text{ m}^3/\text{sec}$ having 40% sand $0.02 \text{ m}^3/\text{sec}$ = $72 \text{ m}^3/\text{hr}$. sand pumped 115200 kg/hr . (25.4 brass/hr.)

VIII. CONCLUSION

The aim of the present investigation is to compare the results of two impellers having same outlet diameter and change in the blade design, and width of impeller. The important observations are summarized below.

1. Testing with the 1st impeller show result that the flow rate $0.0513 \text{ m}^3/\text{s}$, Total head 17.2 M and efficiency 52.8%.
2. Testing with the 2nd impeller show result that the flow rate $0.0476 \text{ m}^3/\text{s}$, Total head 22.25 M and efficiency 65%.
3. Results are modified for the sand –water mixture by considering head ratio and efficiency ratio then 1st impeller results are total head 14.6 M, efficiency 45%, pumping sand of 26 brass/hr.
4. 2nd impeller for the sand-water mixture results are total head 18.9M, efficiency 55.2%, pumping sand of 25.4brass/hr.
5. There is 2nd impeller's total head and efficiency is increased by 4.3 meter and 10% than 1st impeller

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