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Design, Development and Performance Testing of Horizontal Split Case Pump

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ABSTRACT

Centrifugal pump is a hydrodynamic machine, in which rotating impeller continuously transmits mechanical work from the driving machine to fluid. The kinetic energy is converted into potential pressure energy, that are commonly out of the scope of human discernment. Alongthese lines, current instrumentation for estimatingvibration on pivoting and responding hardware makes it conceivable to distinguish creatingissues that are outside the scope of human faculties of touch and hearing. that are commonly out of the scope of human discernment. Alongthese lines, current instrumentation for estimatingvibration on pivoting and responding hardware makes it conceivable to distinguish creatingissues that are outside the scope of human faculties of touch and hearing. Need of Design of Pump. Before a pump is selected it is necessary to determine the head (H) and discharge (Q) required by the system. that are commonly out of the scope of human discernment. Alongthese lines, current instrumentation for estimatingvibration on pivoting and responding hardware makes it conceivable to distinguish creatingissues that are outside the scope of human faculties of touch and hearing. that are commonly out of the scope of human discernment. Alongthese lines, current instrumentation for estimatingvibration on pivoting and responding hardware makes it conceivable to distinguish creatingissues that are outside the scope of human faculties of touch and hearing. Now a day in most of the water service applications duty point requirements are between 150 m to 275 m head and 1000 m3/hr to 2500 m3/hr discharge. A centrifugal pump can operate at a combination of head and discharge.

Keywords : Centrifugal Pump, Computational Fluid Dynamics, Manufacturing and Testing.

I. INTRODUCTION

He various types of pumps like multistage pump, Vertical Turbine (VT) pump, mixed flow (MF) pump can be offered for present required duty of high head and discharge.

The Horizontal Split case pumps are more suitable for water supply scheme projects because of following reasons:

1) Simple in design as compare to multistage pump and Vertical turbine pump.
2) Less rotating components and easy to assemble.
3) Less cost of production.
4) Easy for maintenance.

As designed pump is used for water service applications, periodic maintenance is required to check the wear out parts like casing wear ring, impeller wear ring, shaft sleeves. In such case horizontal split case pumps are more suitable. For the horizontal split case pump there is no need to remove the suction and delivery piping, only by removing the top casing we can easily check the internal parts for wear out. The availability of horizontal split case

pump in Indo Pump is up to 190 m head for given discharge 2100 m3/hr but as mentioned in pump operating point current requirement of head is 218 m.Guidelines For Manuscript Preparation
Special | Picture (with “float over text” unchecked).

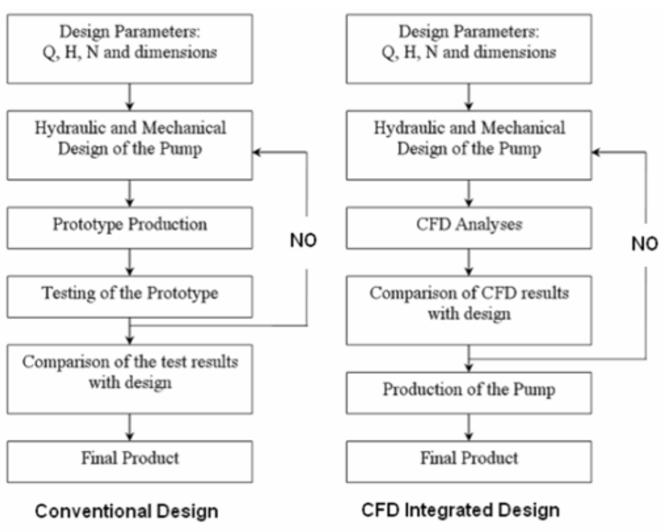
Problem Statement:

Developed the new pump for water supply.
Discharge Q = 2100 m3/hr = 4623.011 GPM
Head H = 218 m = 715.2209 ft,
Speed N= 1490 rpm

Objective:

1) To design the volute type casing and impeller of centrifugal pump for required range of discharge and head.
2) Validating Result with respect to CFD result and Experimental Result.
3) Design Validation.
4) Efficiency Validation.

II. METHODS AND MATERIAL



III. DESIGN SUMMERY

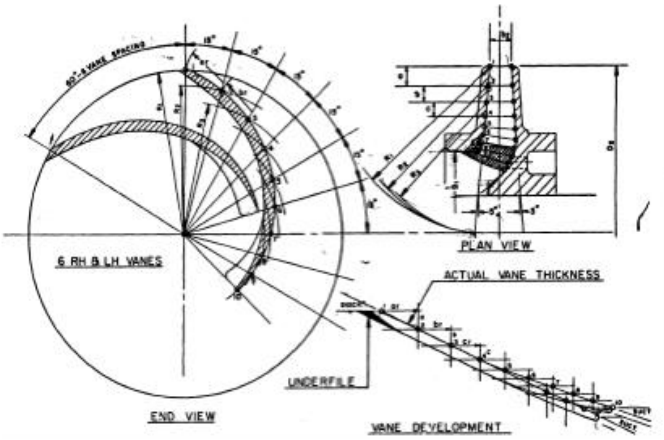


Figure 3-1. Impeller Layout

Step 1: Calculation of pump specific speed.:- 732.5(USunit)
Step 2: Selection of vane number and discharge angle.:- 230
Step 3: Calculate impeller diameter.:- 820mm
Step4: Calculate impeller width b2:- 4.57m/s
Step 5: Determine eye diameter.:- 300mm
Step 6: Determine shaft diameter under impeller eye.:- 2 in.
Step 7: Estimate impeller eye area. :-52184.58mm2d.

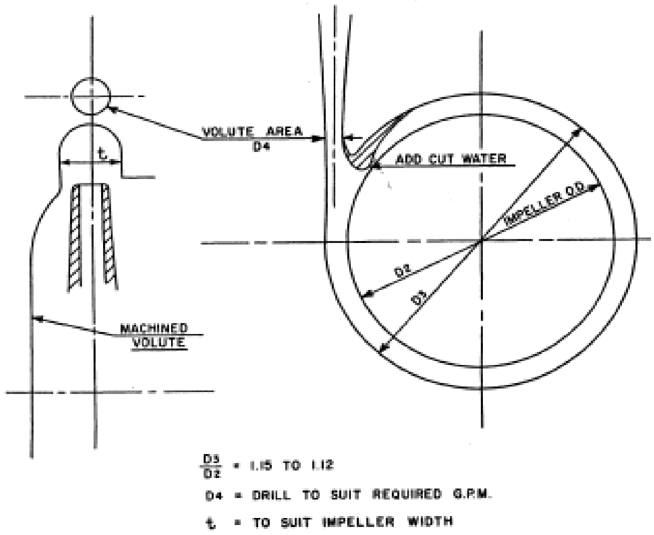


Figure 3-2. Typical layout for circular volute pump.

3D Design

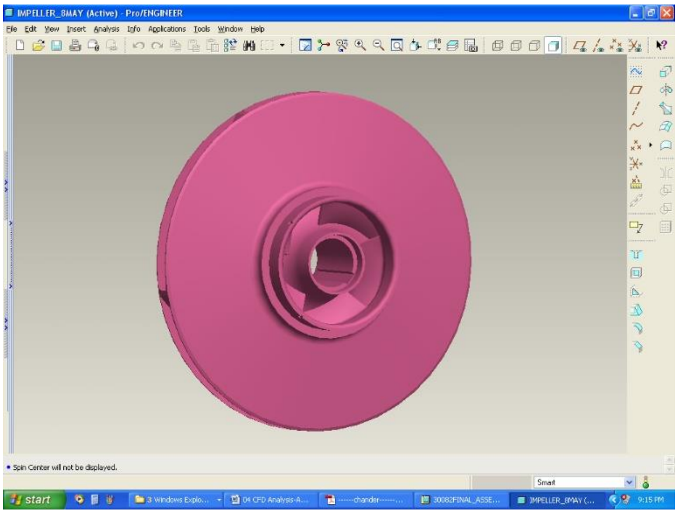


Figure 3.3 Impeller

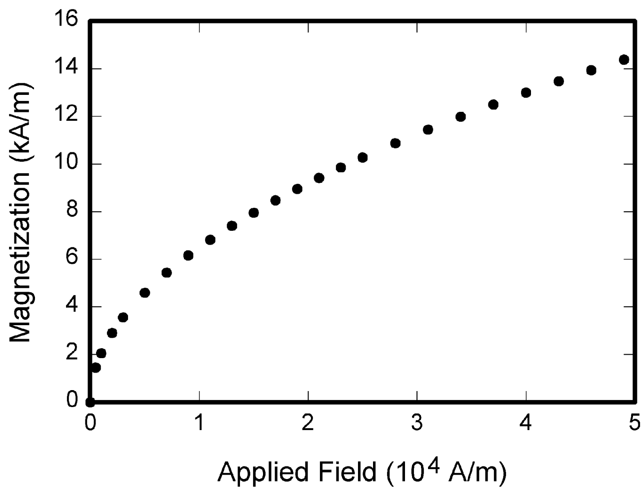
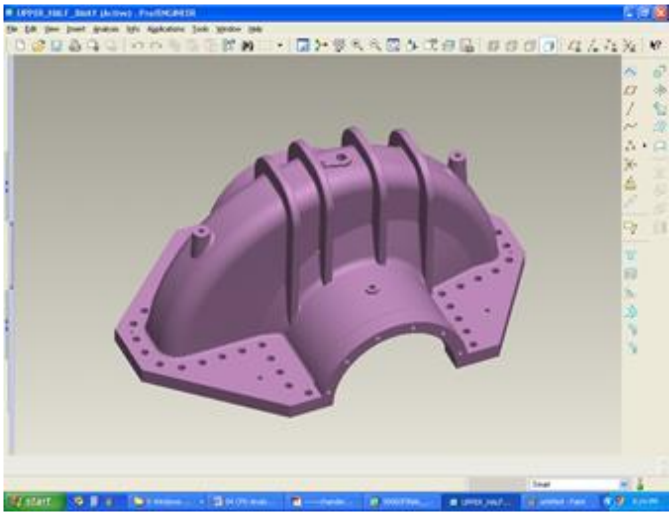


Figure 3.4 Magnetization as A Function of Applied Field. Note That “Fig.” Is Abbreviated. There Is A Period After the Figure Number, Followed by Two Spaces. It Is Good Practice to Explain the Significance of The Figure in The Caption



3.4.CFD Results

There are several considerations in the casing design process that apply to all volute types. These are as follows:

- The most important variable in casing design is the throat area. This area together with the impeller geometry at the periphery establishes the pump capacity at the best efficiency point. The throat area should be sized to accommodate the capacity at which the utmost efficiency is required, using Figure 3.8. Where several impellers in the same casing are to be considered, the throat area should be sized for the standard impeller and increased by 10% to maintain the efficiency of the high capacity impeller.
- Since significant energy conversion takes place in the diffusion chamber, the design of this element should be done with extreme care.
- The volute should be designed to maintain constant velocity in the volute sections.
- The overall shape of the volute sections should be as shown in Figures 3.2.The use of these figure will save the designer time and introduce consistency into the design process.
- The volute spiral from the cutwater to the throat should be a streamlined curve defined by no more than three radii.

IV. MANUFACTURING OF PUMP.

Patterns are made for the hydraulic parts like pump casing, impeller etc which have critical shape and also for other parts like bearing housing, Stuffing box which cannot be manufactured from the bar material or by means of fabrication. The method of production of cast parts involves pattern making, casting, machining and quality inspection. We will review this process with the example of pump casing manufacturing.

Pump casing: It is cast and main hydraulic part of the pump. Patterns are manufactured in Aluminum using CNC machine.Casting of same is taken out from the foundry in ASTM A216/ 216M WCB steel material. Casting is then taken to the machine shop where the pump casing is machined completely. During machining Drilling, facing, tapping and boring operations are carried out.Then the component is checked by Quality control department as per drawing given by design.

A.Pump Assembly-

Pump assembly includes proper locating and fixing of 78 components. Pump assembly procedure involves sub assembly of the rotating unit and then fixing the rotating unit in the bottom casing. After fixing the rotating unit in the bottom casing top is fixed with the help of nuts and studs. Detailed procedure is described below.

B. Rotating unit sub-assembly:

1 Lightly smear the shaft (1800001) with clean good quality grease or light oil.

2 For direction of rotation refer GA (General Arrangement) drawing.

MODULE	DIM. 'A'	DIM. 'B'
1E	479	477
2E	579	577
3E	654	652
150/48-2	574	572
200/58-2	699	697
300/82	699	699

TABLE I
UNITS FOR MAGNETIC PROPERTIES

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI [a]
Φ	magnetic flux	1 Mx$\rightarrow$ 10^{-8}Wb = 10^{-8} V·s
B	magnetic flux density, magnetic induction	1 G $\rightarrow$ 10^{-4} T = 10^{-4}Wb/m^2
H	magnetic field strength	1 Oe$\rightarrow$ $10^3/(4\pi)$ A/m
m	magnetic moment	1 erg/G = 1 emu $\rightarrow$ 10^{-3} A·m^2 = 10^{-3} J/T
M	magnetization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow$ 10^3 A/m
$4\pi M$	magnetization	1 G $\rightarrow$ $10^3/(4\pi)$ A/m
σ	specific magnetization	1 erg/(G·g) = 1 emu/g $\rightarrow$ 1 A·m^2/kg
j	magnetic dipole moment	1 erg/G = 1 emu $\rightarrow$ $4\pi\times 10^{-10}$Wb·m
J	magnetic polarization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow$ $4\pi\times 10^{-4}$ T
χ,κ	susceptibility	1 $\rightarrow$ 4π
χ_ρ	mass susceptibility	1 cm^3/g $\rightarrow$ $4\pi\times 10^{-3}$ m^3/kg
μ	permeability	1 $\rightarrow$ $4\pi\times 10^{-7}$ H/m = $4\pi\times 10^{-7}$Wb/(A·m)
μ_r	relative permeability	$\mu\rightarrow\mu_r$
w, W	energy density	1 erg/cm^3$\rightarrow$ 10^{-1} J/m^3
N, D	demagnetizing factor	1 $\rightarrow$ $1/(4\pi)$

\Vertical lines are optional in tables. Statements that serve as captions for the entire table do not need footnote letters.
[a]Gaussian units are the same as cg emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

3 Screw the shaft sleeve onto the shaft (1800001) to the marked position. Turn the sleeve to the nearest slot to align with the keyway.

4 Place impeller key (3200001) into keyway and lock the shaft sleeve.

5 Check the impeller (1590001) for correct direction rotation and slide onto shaft (1800001).

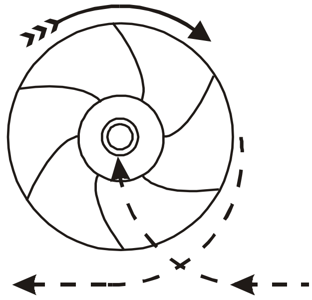


Figure 4.1 : Impeller Direction of Rotation

B. Finalassembly of Pump:

5. Screw opposite side shaft sleeve (Adjusting sleeve) onto shaft (1800001) to retain the impeller (1590001) against the locked shaft sleeve.
6. Slide the casing wear rings (1900001) onto the impeller (1590001).

7. Install casing gasket with a light coat of commercial cup grease on both gasket surfaces. Carefully align the inner edge of the gasket with the insert 'O' rings.
8. Lower the upper half casing into place and install casing joint nuts.
9. NOTE: -When installing upper half casing, make sure that the 'O' rings are not cut or pinched and that the casing gasket is hard against the 'O' rings.
10. Insert casing joint dowels and drive them home. Tighten the joint nuts to the specified torques.

Plate 4.2 Assembled Pump

V. EXPERIMENTAL SET-UP AND ANALYSIS OF HORIZONTAL SPLIT CASE PUMP

After manufacturing, assembly and hydro testing,performance testing of pump is carried out to validate the actual performance with respect to design parameters.

1.Experimental Set Up: Performance testing of the pump is carried out at Pune. The experimental set up employed for testing the pump is with reference to the final installation conditions at site.

The performance is conducted for verifying Head, Discharge, power absorbed & efficiency. Noise level & vibration levelof the pump also recorded during performance test.

Experimental set up is as shown in figure 6.1. At site pump input pressure is -0.5kg/cm^2. To supply the water at -0.5 kg/cm^{2}pressure closed loop with pressurized water tank is used. Various parts of the set up are described below.

1. SCT300/82 Pump: Pump under performance testing whose performance validation is to be done against the design parameters
2. Prime Mover:1700 kW 1450 rpm motor employed to test the pump.
3. Suction Valve: Suction valve is used to adjust the input pressure to the pump. It is kept constant at -0.5 kg/cm^2.
4. Suction Pressure Transducer: It is used to measure the suction pressure at the suction nozzle of the pump.
5. Delivery Pressure Transducer: It is used to measure the delivery pressure at the delivery nozzle of the pump.
6. Delivery Valve: It is used to carry out the performance testing of the pump at different operating points, starting from closed valve condition to full open maximum flow condition.
7. Electronic Flow Meter: It is used to measure the discharge of the pump. Flow rate varies as the delivery valve is throttled. Flow rate is plotted on X-axis of the curve against which Head Discharge and Efficiency of the pump is measured.
8. Suction Pressure Indicator: It is the digital display meter which indicates the pressure in bar sensed by the Suction Pressure Transducer.
9. Delivery Pressure Indicator: It is the digital display meter which indicates the pressure in bar sensed by the Delivery Pressure Transducer.
10. Flow Indicator: It is the digital display meter which indicates the flow rate in m^3/hr sensed by the Electronic

Meter.

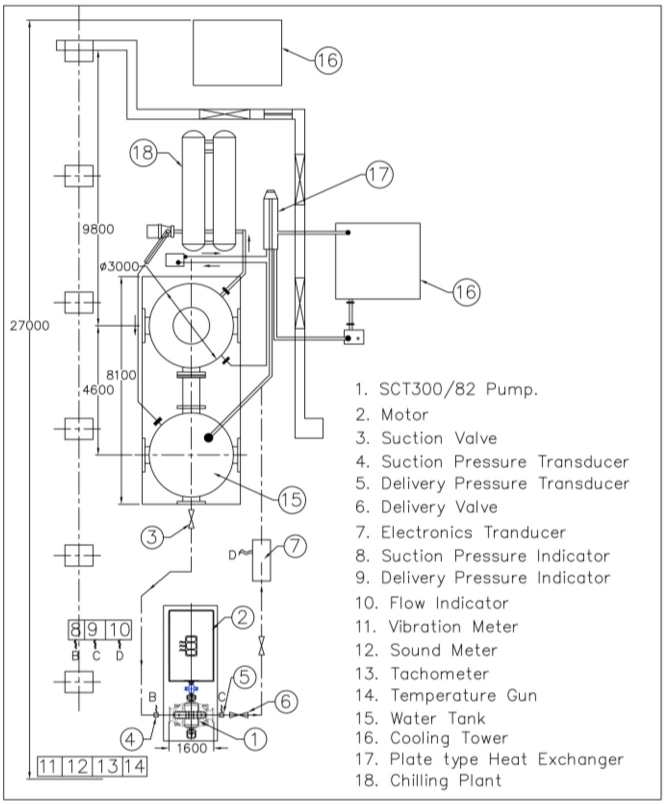


Figure 5.1 Schematic of Testing Set Up

design and analysis presented is indeed part of a new product in development at Indo Pump Limited. This shows that CAD and CAE tools are very useful in hydraulic design.

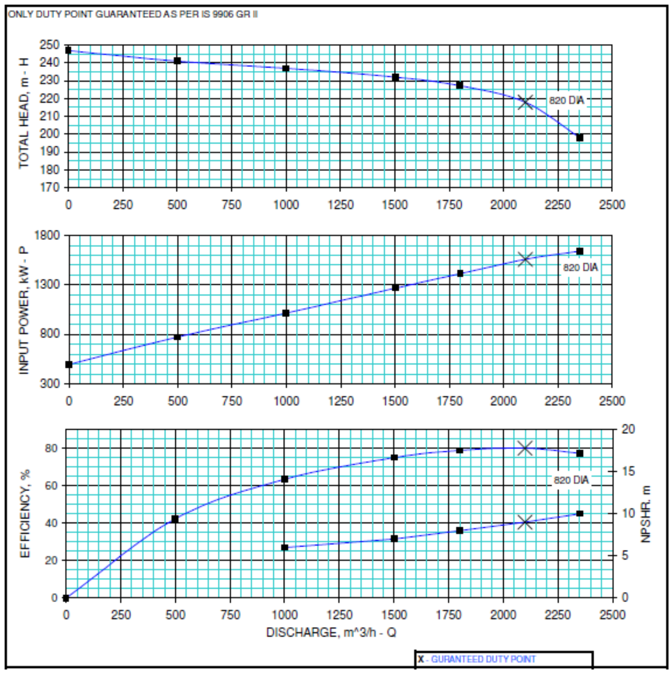


Figure 6.1. Performance result for Pump in CFD

VI. Actual Test Results and Conclusion

The impeller of the existing closer range pump has been modified by increasing the diameter to 820 mm from 770 mm to suit the higher efficiency, required head and discharge. Considering economic incentive for operating range and efficiency is gained by better understanding of the influence of the tongue. Pump with higher efficiency and greater stable operating region is designed. The CFD analysis of the pump with modified impeller diameter is carried out to check the performance and efficiency of the pump. Efficiency of the pump from CFD results is coming 82 % and by actual performance test efficiency is coming 81.37%, by which it is confirmed that CFD analysis is clearly validated. Traditional volute design is based on two-dimensional analysis, and the emphasis is on collection (Impeller) and less on the diffusion (Volute) function. However, with the use of advanced fluid modeling tools, it is possible to design a volute using three-dimensional analysis. The volute design and analysis presented is indeed part of a new product in development at Indo Pump Limited. This shows that CAD and CAE tools are very useful in hydraulic design.

VII. ACKNOWLEDGMENT

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1. Calculations and use the reported results. Although not everything need be disclosed, a paper must contain new, useable, and fully described information.

2. Papers that describe ongoing work or announce the latest technical achievement, which are suitable for presentation at a professional conference, may not be appropriate for publication.

VIII. BIOGRAPHIES

Miss. K.D. Dhande received the degree in B.E. Mechanical from M.C.O.E.R.C Nashik, Maharashtra, India in July 2012 and pursuing master degree in (Mechanical Design Engineering) in S.V.I.T Nashik, Maharashtra, India under Savitribai Phule Pune University, Pune, and Maharashtra, India.

Prof. A. D. Dongare. is an Assistant Professor in S.V.I.T Nashik, Maharashtra, India. He received the degree in B.E. Mechanical and Specialization in M.E. (Design).

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