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Improving the Efficiency of 4" Submersible Pump Usingc.F.D Analysis

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ABSTRACT - *"Harson Pumps and Motors" a company that manufactures high quality submersible pumps of various sizes and capacity. This project deals with the modification in the existing design of radial flow impeller made out of plastic material in many cases may be called rotor. By modifying the design of impeller either by changing the blade angle or by changing the width we could achieve a considerable increase in the output discharge which will be shown in the further work. Ansys software is used to analyze the performance of pump and the equivalent output of the new impeller design and use Pro-e for the design of impeller. After modeling the impeller we will calculate the equivalent theoretical efficiency so as to prove that the impeller that is designed newly is of better design than the previous one. The sole objective of this project is to increase the efficiency of the submersible pump by increasing the net output discharge. The pump in which we are modifying the design of impeller is 4" submersible pump.*

Key Words - *Submersible Pump&Impeller*

I . INTRODUCTION

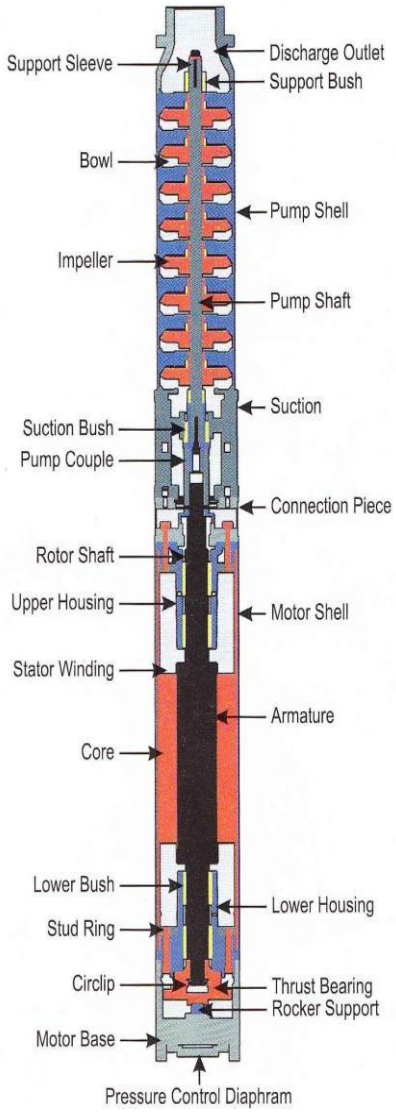
Before entering into the project details a short introduction about how this project was undertaken. I have approached the company Harson Pumps 'and they asked me whether I could help them in increasing the pump's discharge capability. Agreeing upon their request I studied pump and concluded that impeller re-design would be the ideal choice to improve pumps performance. In the
phase-1 we concentrated on studying the various submersible pumps in detail, manufactured in industry and collected all relevant data. Also we studied the related software Catia for the purpose of modeling, hyper mesh 11.0 for the purpose of meshing the impeller and casing and fluent 14.0 for the purpose of analysis of pump discharge. In the Phase-2 we had done the theoretical calculation with the standard design procedure from the book ―Centrifugal Pump Design‖ authored by John

Tuzson' and analysis using the above mentioned software to prove that the new design has a better efficiency than the existing one.

II. STUDY OF PUMP & IMPELLER

A submersible pump (or electric submersible pump (ESP)) is a device which has a completely sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and the fluid surface. Submersible pumps push fluid to the surface as opposed to jet pumps having to pull fluids. Submersibles are more efficient than jet pumps.

Submersible pumps are installed completely underwater, including the motor. The pump consists of an electric motor and pump combined in a single unit. Typically the pump will be shaped like a long cylinder so that it can fit down inside of a well casing. Although most submersible pumps are designed to be installed in a well, many can also be laid on their side on the bottom of a lake or stream.



III. 4" SUBMERSIBLE PUMP

- These Pumps are multistage centrifugal pumps with radial or mixed flow Noryl impellers which operate beneath the surface of water, suitable for 4" borewell and above.
- The prime mover motors are wet type, water lubricated, water cooled and rewinding. The stator is wound with special water proof synthetic film insulated winding wires. These pumps are the best substitute for low efficient compressor pumps and jet pumps. This is used in bungalows, Houses, Residential, Complexes, irrigation of fields, Industrial and rural water supply.

BASIC COMPONENTS

The basic components of all submersible pumps are:

1. The impeller
2. The casing
3. The sealing arrangement
4. The bearing assembly
5. The drive

IMPELLER

The rotating part of a centrifugal pump is called an impeller. It consists of a series of backward curved vanes. The impeller is mounted on a shaft which is connected to the shaft of an electric motor. An impeller is a

rotor inside a tube or conduit used to increase (or decrease in case of turbines) the pressure and flow of a fluid.

TYPES OF IMPELLER

EXISTING CONCEPT

The main objective of this project is to improve the pump's efficiency by changing various parameters of impeller. So by using the reverse engineering process various dimensions of the impeller are obtained.
Asper the Existing concept,
The Exit blade angle, which is denoted by the letter (β2) is **53.4º.**

PROPOSED CONCEPT

Theoretical calculation were made several types by changing various parameters of the impeller in order to achieve the increase in output efficiency.
Finally it is achieved by changing the Exit Blade Angle (β2) to **72.5º.**

METHODOLOGY FOR MODEL PREPARATION

Reverse Engineering

- Reverse engineering is the process of discovering the technological principles of a device, object, or system through analysis of its structure, function, and operation.
- It often involves taking something (a mechanical device, electronic component, computer program, or biological, chemical, or organic matter) apart and analyzing its workings in detail to be used in maintenance, or to try to make a new device or program that does the same thing without using or simply duplicating (without understanding) the original.

Dimensions Extracted by Reverse Engineering

a. Inlet blade angle (β1) = 17.19º
b. Exit blade angle (β2) = 53.4º
c. Radius
i. D = 9.35mm, R = 9.675
ii. D1 = 41.18mm R1 = 20.59mm
iii. D2 = 54.36mm R2 = 27.18mm
iv. D3 = 72.68mm R3 = 36.37mm
d. Radius of Curvature
i. RC1 = 12.974mm
ii. RC2 = 32.83mm
iii. RC3 =76.013mm.
e. Width of the impeller (B) = 4.30mm (0.0043m)
f. Outer diameter of the impeller = 72.74mm

INTRODUCTION TO HYPERMESH & ANSYS FLUENT

Meshing

Mesh generation is one of the most critical aspects of engineering simulation. Too many cells may result in long solver runs, and too few may lead to inaccurate results. Hyper Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible. Hyper Meshing technology has been built on the strengths of stand-alone, class- leading meshing tools. The strongest aspects of these separate tools have been brought together in a single environment to produce some of the most powerful meshing available.

Fluent

ANSYS Fluent software contains the broad physical modeling capabilities needed to model flow, turbulence, heat transfer, and reactions for industrial applications ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to oil platforms, from blood flow to semiconductor manufacturing, and from clean room design to wastewater treatment plants. Special models that give the software the ability to model in-cylinder combustion, aero- acoustics, turbo-machinery, and multiphase systems have served to broaden its reach.

RESULT

- It is evident from the results that there is improvement in the efficiency value in both the methods, theoretical and analysis, adopted. The improvement in theoretical value is completely governed by the exit blade angle of the impeller.
- There is 3% approximately improvement through theoretical calculation. Also by analysis method using fluent the pump discharge capacity is calculated and the results of the analysis shows the improvement in the discharge value.
- The discharge value of the existing impeller model is 0.60045 Kg/s (0.81215 l/s) and that of the new impeller model is 0.65267 kg/s (0.88278 l/s).
- Both the results in favour of the re-design impeller it is therefore recommended to the company to go for production based on the newly designed model of impeller.

V. CONCLUSION

The modeling of the impeller is one critical parameter that should be the prime concern when considering the efficiency of the pump. Submersible pumps are used in clear water, sewage water and also in seas. Considering all these factors we need to model an impeller in a more practical way to suit to all these conditions. Not only is the angle of the blade that determines the output but also the height of the blade in a closed type radial flow impeller a parameter to be kept in mind. However there also other parameters but they have a minor impact on the pump efficiency. The software used are Pro-e and Ansys for modeling and analysis respectively. After completing the modeling and analysis the theoretical value of the pump efficiency is also calculated considering all the parameters.

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