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DESIGN AND DEVELOPING THE EFFICIENCY OF CENTRIFUGAL PUMP

[1]R.Arivazhagan, [2]P.Krishnan, [2]M.Madhan, [2]K.Mohanrajj, [2]Y.Nallasivam

[1]Assistant Professor, [2]UG Scholars, Department of Mechanical Engineering, Kongunadu college of Engineering and Technology, Trichy.

ABSTRACT

The Paper mills in which various GSM paper are manufactured. The manufactured paper is being used for newsprint and printout sheets. These papers are manufactured from the various pulp materials such as softwood pulp, hardwood pulp and imported pulp. The major production of the paper comes from softwood pulp. This softwood pulp is transferred for softwood storage tank which is located near the pulp mill to the paper machine. Due to improper maintenance and poor pump design the performance and productivity of the paper machine is seen to be affected. This project deals with the increase of productivity and performance of the paper machine by modifying the pump design and parameters such as the impeller diameter, vane angles, pressure head, vane width and pipeline layout. Thus the efficiency and flow rate of the pump get increased as the result productivity rate and economic benefits for the company is obtained.

INTRODUCTION

A centrifugal pump which is widely used throughout industry is a typical turbo-machinery that converts external mechanical energy into pressure and kinetic energy of fluid. It consists of an impeller and volute casing. An impeller is a mechanical device that supplies mechanical energy to fluid and is a key component of any centrifugal pump. Therefore, up to now, many studies have focused intensively on impellers. Fluid that obtains energy from an impeller is discharged through a volute casing, so the characteristics of the volute casing are an important factor if the goal is to discharge fluid with less energy loss.

Centrifugal pumps handle high flow rates, provide smooth, non-pulsating delivery, and regulate the flow rate over a wide range without damaging the pump. Centrifugal pumps have few moving parts, and the wear caused by normal operation is minimal. They are also compact and easily disassembled for maintenance. The design of efficient pumping system depends on relationships between fluid flow rate, piping layout, control methodology, and

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Pump selection. Before a centrifugal pump is selected, its application must be clearly understood.

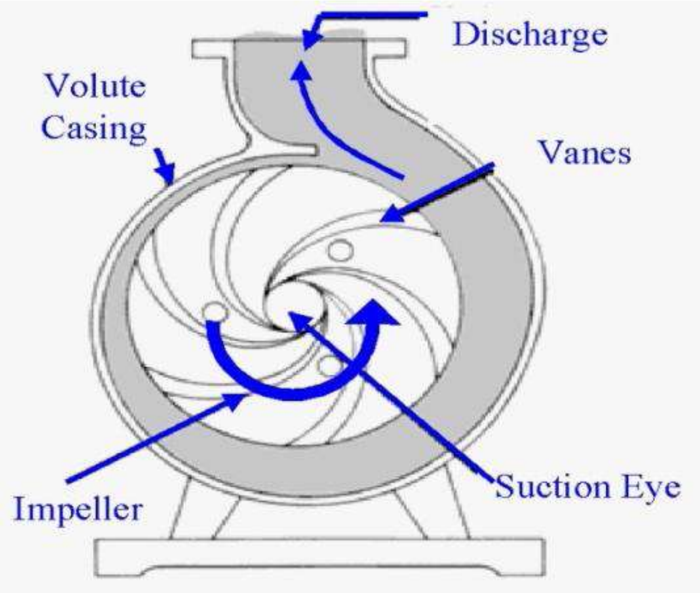

Figure 1 Centrifugal pump

Due to rotation of impeller the fluid from inner radius moves towards the outer radius during this, suction is created at the eye of the impeller. Therefore, continuous lifting of fluid from sump to the pump is carried out and kinetic energy is converted into pressure energy and head is developed from the fluid coming out from delivery pipe.

The Principle of centrifugal pumps

A centrifugal pump is a rotodynamic pump that uses a rotating impeller to increase the pressure of a fluid. The fluid enters the pump near the rotating axis, streaming into the rotating impeller. The impeller consists of a rotating disc with several vanes attached. The vanes normally slope backwards, away from the direction of rotation. When the fluid enters the impeller at a certain velocity due to the suction system, it is captured by the rotating impeller vanes. The fluid is accelerated by pulse transmission while following the curvature of the impeller vanes from the impeller centre (eye) outwards. It reaches its maximum velocity at the impeller's outer diameter and leaves the impeller into a diffuser or volute chamber.

A centrifugal pump is not positive acting it will not pump the same volume always. The greater the depth of the water, the lesser is the flow from the pump. Also, when it pumps

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against increasing pressure, the less it will pump. For these reasons it is important to select a centrifugal pump that is designed to do a particular job.

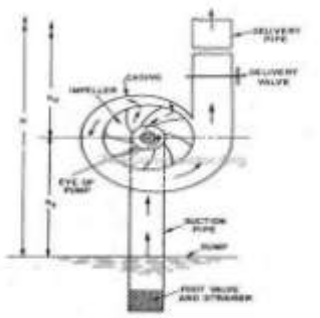
Pump generates the same head of liquid whatever the density of the liquid being pumped. The actual contours of the hydraulic passages of the impeller and the casing are extremely important, in order to attain the highest possible.

So the centrifugal force assists accelerating the fluid particles because the radius at which the particles enter is smaller than the radius at which the individual particles leave the impeller. Now the fluid's energy is converted into static pressure, assisted by the shape of the diffuser or volute chamber. The process of energy conversion in fluids mechanics follows the Bernoulli principle (eqn.1) which states that the sum of all forms of energy in a pump system is the sum of potential head energy, static pressure head energy and velocity.

$$Z_1 + \frac{V_1^2}{2g} + \frac{p_1}{\rho \times g} = Z_2 + \frac{V_2^2}{2 \times g} + \frac{p_2}{\rho \times g}$$

As a centrifugal pump increases the velocity of the fluid, it is essentially a velocity machine. After the fluid has left the impeller, it flows at a higher velocity from a small area into a region of increasing area. So the velocity is decreasing and so the pressure increases as described by Bernoulli's principle. This results in an increased pressure at the discharge side of the pump. As fluid is displaced at the discharge side of the pump, more fluid is sucked in to replace it at the suction side, causing flow.

LAYOUT OF EXISTING SYSTEM



METHODOLOGY

Based on the changing of the following parameters

- Size of the impeller
- Pipe distance
- Vane angle

PROPOSED SYSTEM

LITERATURE REVIEW

In the present study by H.Safikhani, et al[1] multi-objective optimization of centrifugal pumps is performed in three steps. In the first step, efficiency and NPSHr in a set of centrifugal pumps are numerically investigated using commercial software NUMECA. In second step modelling of above both parameters with respect to geometrical design variables is done. Finally using obtained polynomial neural networks, multi-objective genetic algorithms are used for Pareto based optimization of centrifugal pumps considering two conflicting objectives, efficiency and NPSHr. Such combining application of GMDH type neural network is very promising in discovering useful and interesting design relationships. The operation of a centrifugal pump working in direct mode and as a centripetal turbine was investigated by John S. Anagnostopoulos, et al. [2]using a commercial CFD code. The predictions of the radial load showed a minimum radial thrust near design conditions in pump mode and an increasing magnitude with flow rate in reverse mode of operation. The magnitude of the total radial load resulted lower than the maximum total load in pump mode for operating below turbine rated conditions. Thus, it can be concluded that the mechanical design of the machine and of the shaft bearings must be carefully undertaken if a usual operation in reverse mode is to be expected.

The influence of the outlet blade angle on the performance is verified with the CFD simulation by Zhou et al.[3].As the outlet blade angle increases the performance curve becomes smoother and flatter for the whole range of the flow rates. When pump operates at nominal capacity, the gain in the head is more than 6% when the outlet blade angle increases from 20 deg to 50 deg. However, the above increment of the head is recompensed

Presented over the entire flow range. It was found that the predicted results for pumps M2 and M3 were better than those for pump M1, which suggests that the efficiency of pumps M2 and M3 will also be higher than that of pump M1. Thus, future work will be focused on improving the design of pump M1. It was found that when the flow rate decreased below a certain value of the design flow rate, backflow occurred near the pressure with 4.5%decrease of the hydraulic efficiency. Moreover, at high flow rates, the increase of the outlet blade angle causes a significant improvement of the hydraulic efficiency.

The commercially available 3D Navier-Stokes code called CFX, which has a standard k-€ two-equation turbulence model, was chosen by Erik dick et al. [4] to simulate the internal flow of various types of centrifugalpumps-M1, M2, M3. The predicted results of the head-flow curves are surface of the pump impeller. That might occur because when the flow rate through the impeller decreases, the impeller passage correspondingly "narrows" itself so that continuity theory can be satisfied.

Fluent provides three calculation methods for analysis of turbo machinery flows: the Multiple Reference Frame method (MRF), the Mixing Plane method (MP) and the Sliding Mesh method (SM) by Selvarasu A.et al. [5]. In all three methods, the flow in the rotor is calculated in a rotating reference frame, while the flow in the stator is calculated in an absolute reference frame. In the MRF and MP methods steady flow equations are solved, while in the SM method, unsteady flow equations are solved. The SM method does not introduce physical approximations. From above methods it is concluded that, Steady calculation methods like the Frozen Rotor method and the Mixing Plane method cannot be used with confidence to analyze the performance of volute centrifugal pumps. Only a truly unsteady method like the Sliding Mesh technique is able to correctly reproduce this flow behaviour. The predicted performance by the Sliding Mesh method can be used with confidence. The impeller of the existing closer range pump has been modified by V.S. Kadam et al. [6] 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.

Result & conclusion:

The proposed system offers the following benefits

- The rate of flow increases
- The profit increases
- Power consumption is reduced
- Efficiency is improved
- Production of paper get high
- Friction losses decrease
- Power consumed is also maintained

From our project we have concluded that the production rate of paper increases as well as profit of company is increased to certain extent after the implementation of our project.

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