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A REVIEW OF DESIGN IMPROVEMENT OF SP17 MIXED FLOW TYPE STAINLESS STEEL FABRICATED PUMP USING CFD

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Abstract: SP17 mixed flow pump (Discharge 17000 L/hr at 8m head and 2800 rpm) is proprietary product of Grundfos pumps, Denmark.The VIRA Pumps Kolhapur is benchmarking this product. Study of SP17 Mixed flowpumpcarried out to reduce the problem in existing mixed flow pump by taking performance test in the testing laboratory of Vira Pumps, Kolhapur.In this test we find pump never crossed discharge of 15900 L/hr compare to original Grundfos design. Therefore it is necessary to redesign the impeller from first principle for performance enhancement for improvement in discharge.Hence study related to mixed flow pump performance is done in this paper. Effect on mixed flow pump efficiency, head, and discharge by changing parameters responsible related to it like suction diameter, width of impeller, vane profile number of vanes,inlet and outlet angles studied in this paper. Different reviews related to CFD analysis of mixed flow pump also taken into consideration.

Keywords: -Mixed flow pump, Submersible Pump.

I INTRODUCTION

A submersible pump is a device which has sealed motor coupled to the pump body. The whole assembly of pump and motor is submerged in the water. It is used to lift water from bore well.The main advantage of this type of pump is that it prevents pump cavitations, which occurs mainly due to high elevation difference between pump and the fluid surface [1].

Mixed-flow pumps function as a compromise between radial and axial-flow pumps. The fluid experiences both radial acceleration and lift and exits the impeller somewhere between 0 and 90 degrees from the axial direction. As a consequence mixed-flow pumps operate at higher pressures than axial-flow pumps while delivering higher discharges than radial-flow pumps. The exit angle of the flow dictates the pressure head-discharge characteristic in relation to radial and mixed-flow [2].

With the objective of developing a small blood pump with a levitated rotor, we propose a design scheme for an axial-type self-bearing motor. The axial type motor which is basically composed of a disc motor and an axial magnetic bearing, controls both the rotation and the axial translation of the rotor. The proposed motor is similar to the bidirectional disc motor, except for changing the magnitudes of both sides of the flux to control the axial attractive force. However, the radial and tilt directions rely on passive stability and, therefore, the rotor has poor damping which might cause damage to blood constituents. The design includes a hydrodynamic bearing for improving radial support properties. Finally, to confirm its functionality, an experimental prototype of the proposed motor has been constructed and incorporated into a mixed flow blood pump. The results indicated that the bidirectional axial type self-bearing motor had high efficiency as a small continuous flow blood pump, delivering sufficient flow rate and pressure head [3].

Computational Fluid Dynamics analysis is one of the advanced tools used in the industry. A detailed CFD analysis was done to predict the flow pattern inside the impeller which is an active pump component. From the results of CFD analysis, the velocity and pressure in the outlet of the impeller is predicted. CFD analyses are done using Ansys software. These outlet flow conditions are used to calculate the efficiency of the impeller [4].

The three-dimensional flow field of the whole flow passage of a mixed-flow pump was numerically simulated by using CFD software on the basis of Spalart-Allmaras turbulent model according to the original design of the plant. Through analysing the calculation results, the reason why the flow rate of this pump cannot reach to the design requirements was found out. After replacing the impeller, a new pump impeller was optimally designed. The numerically simulation results show that the hydraulic performance of the newly designed impeller of the mixed-flow pump were obviously improved, and the engineering requirements of the owner were satisfied [5].

The submersible pumps are used highly at the domestic and commercial level, so to increase the efficiency study of detail flow field in pump is necessary nowadays. With this regard an experimental was conducted on the mixed flow pump in pumpmanufacturing company. The head achieved by experimental result was 8.08 m. By using design parameter of existing impelleras used in experiment the geometry and cavity model of impeller was modelled in pro-e. After that CFX mesh, inlet, outletboundary conditions, hub, shroud and blade profile defined in turbo mode for CFD analysis in ANSYS 12.1. Results fromthe CFD code showed good agreement with experimental result and it was 7.45 m. So, the efficiency of pump calculated by experimental result was 53.27 % and by CFD analysis 49.6 %[6].

A subject of this paper is a numerical solution of a mixed - flow pump geometry with respect to a distribution of a static pressure in the channel of the pump. The distributions of pressure and velocity fields were obtained through experiments. The blade's design was obtained according to the pressure distribution in the impellers' channel. A comparison of different approaches is based on results of a CFD simulation in mixed - flow pump. Also information about basic performance characteristics for different blade angle distributions is presented in this contribution [7].

From the CFD analysis, the velocity and pressure in the outlet of the impeller isoutlet flow conditions are used to calculate the efficiency for the existing impeller by using the empirical relations. In the first case outlet angle is increase, and second caseinlet angle is decrease obtain from the CFD analysis, it iscause to improve efficiency. Thought that the calculation results bythe flow in the impeller of a mixed flow pump on the premise that the turbulent model and boundary to the actual situations. Change the outlet angle the head of the impeller is improved. Finally, from CFD analysis thecalculated efficiency of the impeller with optimum vaneHead created by this analysis would be higher [8].

By changing the outlet angle and the No. of blade of impeller the head of the impeller is improved to 86.75m. From this analysis it is understood that the changes in theinlet blade angle and No. of blade change the head of the impeller. From the CFD analysis the head of the impeller with optimum blade angles is calculated as 76.46m. Thus, head of the mixed flow impeller is improved by 10.29md by changing the inlet and outlet blade angles and No. of blade [9].

In this paper, the analysis will be done of the existing impeller along with the modified impeller by changing its inlet and outlet blade angle [10].

The CAD models of the mixed flow impeller with optimum inlet and outlet angles are modelled using CAD modelling software Catia-V5R19. To find the relationship between the vane angles and the impeller performance the optimum vane angle is achieved step by step. Three CAD models are modelled with the vane angles between existing and optimum values. These models are analysed individually to find the performance of the impeller. In the first case, outlet angle is increased by 5°. From the outlet flow conditions, obtained from the CFD analysis, it is evident that the reduced outlet recirculation and flow separation cause the improved efficiency. By changing the outlet angle the efficiency of the impeller is improved to 59%. In the second case inlet angle is decreased by 10%. The efficiency of the impeller in this case is 61%. From this analysis it is understood that the changes in the inlet vane angle did not change the efficiency of the impeller as much as the changes in outlet angle. From the CFD analysis the efficiency of the impeller with optimum vane angles is calculated as 65%. Thus, efficiency of the mixed flow impeller is improved by 18.18% by changing the inlet and outlet vane angles[11].

II CALCULATION

SP17 Mixed flow pump (Discharge 17000 L/hr at 8m head and 2800rpm Speed)

$$N_S = \frac{N \times Q^{1/2}}{H^{3/4}}$$

Here, $N = \text{rpm}$

$$Q = \text{gpm}$$
$$H = \text{ft}$$

Calculations:

$$N_S = \frac{2800 \times (74.85)^{0.5}}{(26.24)^{0.75}}$$

N_S =2089.4 $(\text{rpm} - \text{gpm}^{1/2}/\text{ft}^{3/4})$

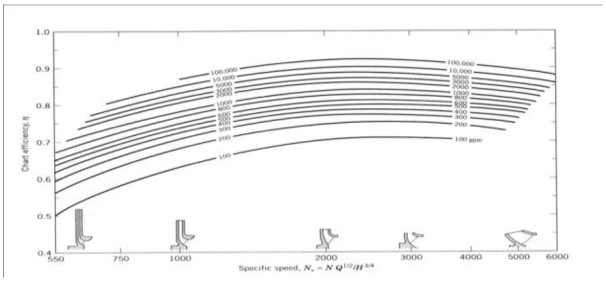

Figure 1.Chart of efficiency of pump versus specific speed.

Hence our pump model comes under mixed flow type pump

III PROBLEM DEFINITION AND IDENTIFICATION

Pump never crossed discharge of 15900 L/hr compare to original Grundfos design. Vira Pumps having many competitors in Europe and African marketso suffered huge loss due to this problem. Since 2011-12 the company's importers are diverting their demand from heavy and bulky casted pumps to the lighter weight stainless steel fabricated pump.Therefore it is necessary to redesign the impeller for performance enhancement for improvement in discharge.

IV SCOPE

Study carried out to reduce the problem in existing mixed flow pump by taking performance test in the testing laboratory of Vira Pumps, Kolhapur.Studyand analysis of different parameters of mixed flow pump and to suggest design optimization.

V,CONCLUSION

Development of new mixed flow pumps impeller is possible by doing design modifications. We can increase its efficiency, head, and discharge. It can be done by changing parameters responsible related to it like suction diameter, width of impeller, vane profile number of vanes,inlet and outlet angles.

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