International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 08, August-2015

Optimum Design on Impeller of Mixed Flow Pump using CFD Simulation

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***Abstract*— The effects of the pump-impeller operating conditions and geometries on its performance were investigated. The analysis was carried out to study the effect of some parameter on the performance of mixed flow pump impeller. These parameters such as inlet blade angle, outlet blade angle. The impeller has been designed and built to study the effect of these parameters with the help of software for analysis. In this paper change the inlet & outlet angle of blade with increase the angle 10%, 20% and decrease the angle 10%, 20% with respect to design angles. From these all simulation was done, we should consider the best inlet & outlet angle to take the best head & efficiency of mixed flow pump.**

Keywords*— Computational Fluid Dynamics, Efficiency, Mixed Flow Pump Impeller, Head

I. INTRODUCTION

The concept of mixed-flow (MF) pumps is by no means new, having been applied to large scale liquid transfer tasks such as irrigation, flood control, dewatering and power station cooling systems for almost a century. In common with many other industrial products, their development has been steady. The advent of nuclear power stations and of significantly larger fossil fuel stations, as well as the need for large-area irrigation schemes to meet rising demands for food, has in recent years lent urgency to this trend. Because MF pumps are inherently versatile and reliable when operated within their performance envelope, increased efforts are being made to extend their range.

Impeller is an important flow passage component in a mixed-flow pump. To find out the causes of low hydraulic performance of the original pump, it is necessary to study the flow in the impeller. While the impeller of the pump is operating, the impeller will rotate, and the geometric shape of the flow passage will be distorted. The water flow in the impeller is a complicated three-dimensional turbulent flow. Therefore, observing the flow situations in the impeller through experiment not only will be a waste of time, but also will cause economic losses due to the shutdown.

In this present work design of mixed flow pump impeller was carried out and effect on head & efficiency with changing the inlet & outlet angle of impeller blade to find out the best design point of impeller.

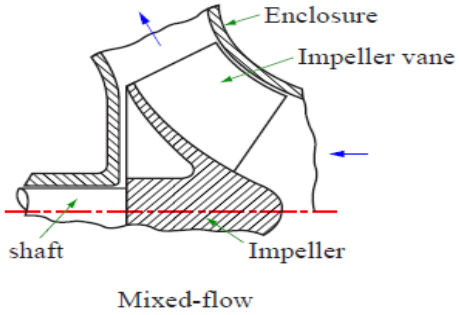

Fig. 1 mixed flow direction on impeller[2]

II. ANALYSIS OF MIXED FLOW IMPELLER

In this work detail geometry of mixed flow impeller was done in software CFTURBO. The parameter used for the design is head developed (H) = 5 m , mass flowrate (Q) = 125 kg/s & speed of rotation (N) = 1000 RPM[5].

The parameter of the impeller for the modelling of impeller is given in table I.

TABLE I DESIGN PARAMETER OF IMPELLER

Parameter	specification
mass flow rate	0.125 m³/s
Rpm	1000
Suction Head	5 m
hub dia.	30.7 mm
thickness leading edge	3.6 mm
Intel blade angle	22.7°
suction dia.	168 mm
impeller dia.	254 mm
outlet width	33.7
number of blade	6
thickness trailing edge	4.2 mm
Outlet blade angle	45.5°

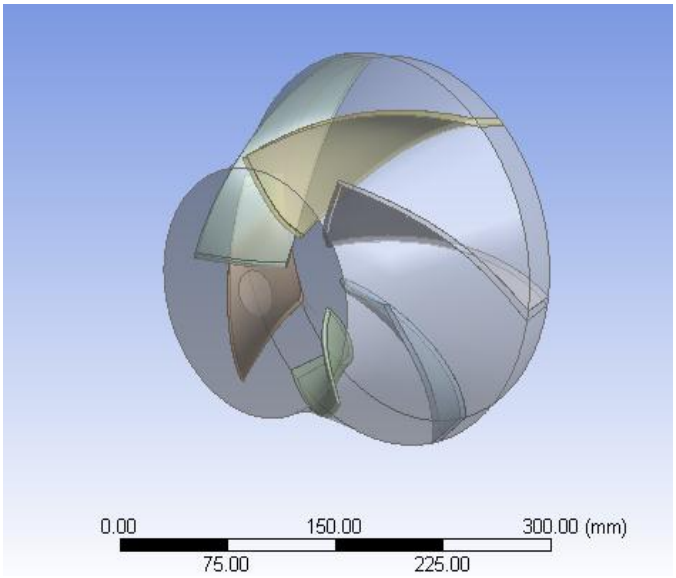

Fig. 2 model of impeller

III. CHANGE THE INLET AND OUTLET ANGLE OF BLADE

For the improvement in design of impeller to get the best efficiency of pump, we should change the inlet & outlet angle of the blade. We can change the inlet & outlet angle as increase inlet angle 10%, 20% & decrease 10%, 20% and increase outlet angle 10%, 20% & decrease 10%, 20% from the calculating angles that we can use as the exiting parameter.

TABLE II VARIOUS INLET & OUTLET ANGLE

Sr no.	Variation in angles	Inlet angle	Outlet angle
1	20% decrease	17.76	36.32
2	10% decrease	19.98	40.86
3	Calculating angles	22.2	45.4
4	10% increase	24.42	49.9
5	20% increase	26.64	54.58

All simulation with different angles was carried out in ANSYS software. The equation which is use to find out head & efficiency is given below:

A. *Equations*

Head: $H = \frac{Q}{\rho g}$ (m)

Input power: $P = \frac{2\Pi NT}{60}$ (kw)

Output power: $P = \frac{\rho g q h}{1000}$ (kw)

Efficiency: $\eta = \frac{output\ power}{input\ power} * 100$

IV. RESULT & DISCUSSION

In the result & discussion we can find the various head & efficiency with the help of equations.

A. *Head at various inlet & outlet angle*

TABLE III HEAD AT VARIOUS INLET & OUTLET ANGLE

outlet angle	head (m) at 17.76 inlet	head (m) at 19.98 inlet	head (m) at 22.2 inlet	head (m) at 24.42 inlet	head (m) at 26.64 inlet
36.32	24.1033	25.5184	24.768	25.7733	25.8787
40.86	23.5735	23.5432	22.7263	22.6132	20.2877
45.4	16.256	22.753	20.289	18.754	39.0105
49.9	8.821	16.4305	16.2239	15.892	21.9061
54.48	26.427	23.057	27.798	35.518	17.8579

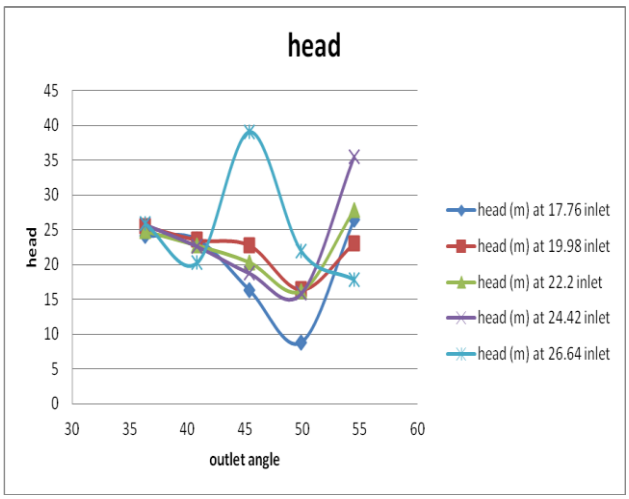

Fig. 3 Head at various inlet angle vs outlet angle

B. Efficiency at various inlet & outlet angle

TABLE IV EFFICIENCY AT VARIOUS INLET & OUTLET ANGLE

outlet angle	effi. (%) at 17.76 inlet	effi. (%) at 19.98 inlet	effi. (%) at 22.2 inlet	effi. (%) at 24.42 inlet	effi. (%) at 26.64 inlet
36.32	76.07	78.58	79.5	87.8	84.34
40.86	70.7	74.29	71.35	70.63	75.75
45.4	41.17	46.86	60.23	28.63	33.1
49.9	26.61	9.899	55.05	19.07	17.622
54.48	74.29	63.34	71.48	52.87	59.8

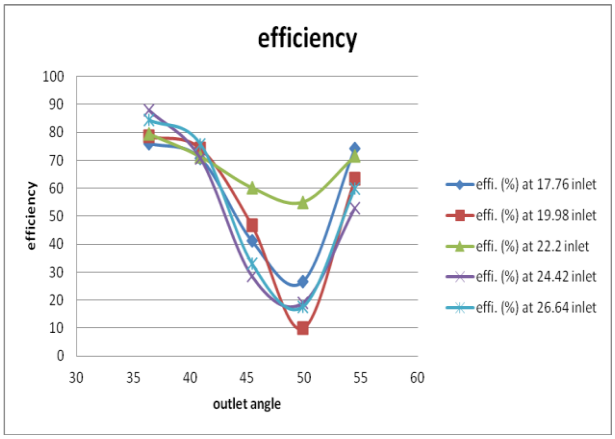

Fig. 4 Efficiency at various inlet angle vs outlet angle

V. CONCLUSION

From result & analysis we can conclude that,

Inlet angle changes will changes range between 17.76° to 26.64° & outlet angle changes will changes range between 36.32° to 54.58°. from the fig. 3 maximum head at the point of inlet angle 26.64° & outlet angle 45.4°.

From fig. 4 maximum efficiency at the point of inlet angle 24.42° and outlet angle 36.32°.

So that we can conclude that best design point of impeller of pump that we can give the maximum efficiency of pump that is inlet angle 24.42° and outlet angle 36.32°. Here we can take the only efficiency for the design point of view.

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