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USE OF CFD FOR IMPROVING DESIGN OF CENTRIFUGAL PUMP: A REVIEW

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ABSTRACT:

Pumps are found to be one of the vital applications in industries and resident. Several factor affect pump operation and working including their physical arrangement, impeller condition, velocity, suction head, exhaust head, and liquid properties etc. lowered capacity, trembling, condensed efficiency, and cavitations could cause severe problems like suction head available, extreme suction lift, trivial inlet submergence. Category of connection and arrangement are the suction circumstances. The conventional geometry is not efficient centrifugal pump and thus reduced discharge on the delivery side. Impeller is being designed for this work. The previous and modified configurations are studied using CFD techniques while; the best configuration is discovered from the selected geometries.

KEY WORDS: CFD, ANSYS, Centrifugal Pump, etc.

INTRODUCTION:

There are various application of pumps in industries as well as at home. There are several types of pumps available in market. Pumps may have different sizes, materials used as well depending upon the application. Having a wide range of applications, continuously the research experimentations are carried out on the pumps by the researchers. They are used to transfer liquids from low-pressure to high pressure in this system, the liquid would move in the reverse route because of the pressure difference.

Centrifugal pumps are widely used for irrigation, water supply plants, stream power plants, sewage, oil refineries, chemical plants, hydraulic power service, food processing factories and mines. Pumps also found application flike chemical, & water pumping.

A centrifugal pump delivers useful energy to the fluid on pumpage largely through velocity changes that occur as this fluid passes through impeller and the allied fixed passage of the pump. Conversion of mechanical to hydraulic energy occurse in pumps. The output energy is hydraulic force of the fluid being raised or carried. In centrifugal pump, fluid is forced by pressure in a set of rotary vanes. It consists of set of rotation vanes enclosed within a housing or casing that is used to impart energy to a fluid through centrifugal force. Euler's equations are used to calculate the total energy transferred. From this total energy the losses taken place i.e. inner losses (friction) and outer losses (bearings).

LITERATURE REVIEW:

Following is the literature review of some papers giving more information about their contribution in evaluation of fluid structure interaction and CFD analysis of centrifugal pump.Some of the researchers doing their work in flow and design analysis of centrifugal pump.

Manjunatha, Nataraj J R et.al have proposed a design of and analyzed to get the best performance point. The axial pump is choosen for the study since it found plenty of applications in domestic, irrigation, industry, large industries and waterway pumping system. The performance analysis of axial pump is done after design of axial pump. So losses of centrifugal pump are also considered in recital study of axial pump. The Predicted Head and efficiency is compared with analytical results and it shows the good agreement.

Haridass Ramasamy, Prabhu Prakash et.al have dealing with the application and need of CFD analysis in the pump industries. Analysis of of residential well pumps have been carried out. The impeller selected is of enclosed type. It is normally used in household water pumps. In the design formulas formulated by Dr. K.M Srinivasan, from the book Rotodynamic Pumps is used. The impeller modeling is carried out with CAD software and analyzed using CFD package.

Syam Prasad, BVVV Lakshmipathi Rao, A Babji and Dr P Kumar Babu et.al have considered the analysis (static and dynamic) of a centrifugal pump impeller.

Strain, stress, displacement, frequency, & deflection analysis has been carried out. An effort is also made to suggest the best alloy for an impeller of centrifugal pump by comparing the results obtained for three different alloys.

S.Rajendran and Dr.K.Purushothaman et.al has used ANSYS backgroung to extend a three dimensional model. It is completely turbulent model. It founds application in industries and household applications. ANSYS software has made it very easy to understand the performance of the pump.

Kadambi et.al has used Particle Image to investigate the velocities of the slurry in impeller of a centrifugal slurry pump for sodium-iodide solution (NaI) and 500micron glass beads slurry. The experiments conducted at 725 rpm, 1000rpm speed, and1%, 2%, 3% volumetric concentration. They observed that the in clear fluid flow conditions for both the pump rpm, flow parting takes place on suction side of blade in the section below the blade tip. For the same flow conditions, the flow moves smoothly along the suction side of the blade depicting a recirculation zone. The concentration of this recirculation region decreases at the higher concentration of 3%. On pressure side of blade the particles are pushed along the blade surface and can result in the frictional wear.

Egin and Gur et.al have evaluated existing relationship to forecast head poverty of centrifugal slurry pumps. A new relationship has developed to forecast head reductions of centrifugal pumps when handling slurries. The proposed correlation takes into account the individual effects of particle. The proposed relationship is hence suggested for the forecast of recital factors of ‘‘small-sized’’ slurry pumps.

Stephan Bross et.al forecasted influence of diverse design parameters on wear performance of centrifugal slurry pump’s impeller suction sealing. For this purpose he developed simple model and using this model he calculated the velocity field in the impeller suction side and also a comparison was done between analytical solution & numerical solution provided by a CFD package CFX.

OBJECTIVE:

Continuous developments are going on in the field of pumping equipments. Basically a pump transfer mechanical energy to the liquid flowing through it and losses occur in energy conversion process. This project deals with application of CFD analysis in design improvement of domestic water pumps. By using CFD we can analyze the various flow parameters under varied flow condition and save the wastage of money and machine.

MODELLING OF CENTRIFUGAL PUMP:

GEOMETRIC MODELING OF PUMP:

In order to attain better design in CFD, subsequent procedure is applied so that fluid flow can easily be modelled. Initial design of the model is a forecast judgment and the geometry is created depending on these initial design considerations, using either CFD modelling tools or other Design tools. The first task to accomplish in a numerical flow simulation is the definition of the geometry, followed by the grid generation. This step is the most important step for the study of an isolated impeller assuming an axis symmetric flow simplifies the domain to a single blade passage.

Before the modelling of blade, a generalized program is written for the design of the blade. The program is based on the design methodology discussed in the previous chapter. The parameters which were considered initially are Head, Flow Rate, Pump Speed, Volumetric efficiency and Overall Efficiency. The output of the program is given in the table. Some of the output parameters of this design were used as input of the Blade Modeller.

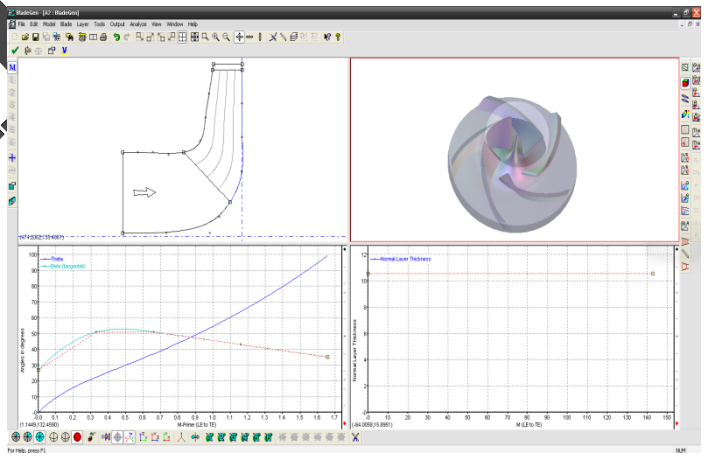

Fig. 4.1 Fig.1:Blade Modeller Pump Model

4.2 CONVERGENCE CRITERIA:

The iterative method is carried out until the change in the variable from one iteration to the next becomes so small that the solution can be considered converged.

At convergence:

All discrete conservation equations (momentum, energy, etc.) are obeyed in all cells to a specified tolerance. The solution no longer changes with

additional iterations. Mass, momentum, energy and scalar balances are obtained. Residuals measure imbalance (or error) in conservation equations. The convergence of the simulations is said to be achieved when all the residuals reach the required convergence criteria. These convergence standards are establishd by monitoring the in the drag. The convergence criterion for the continuity equation is 1E-4 and it is set to 1E-3 for the momentum, k and ω equations. The convergence of the residuals is shown in Fig.4.2

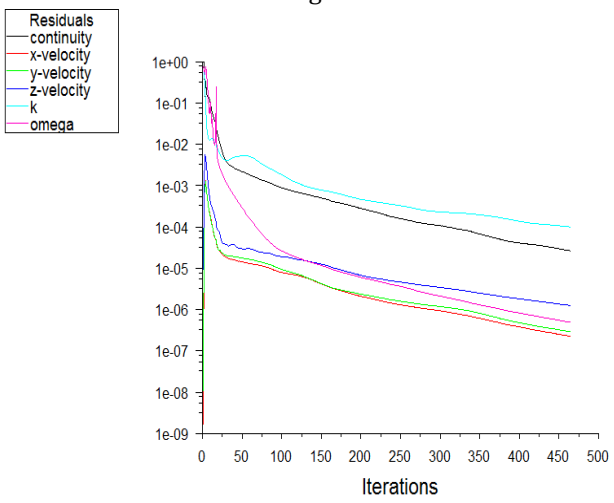

Fig.4.2 Convergence Criteria

CONCLUSIONS:

The paper presented a literature review concerning the studies on review of use of CFD for improving design of centrifugal pump found that there have been noteworthy novel expansion in the area of pumping tools and CFD analysis is very useful for predicting pump performance at various mass-flow rates. It is observed that CFD can be more efficiently used for the investigation and enhancement of design and the complex internal flow fields can be investigated by using the ANSYS-CFX code.

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