Scientific Journal of Impact Factor(SJIF): 3.134
e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 1,Issue 12, December -2014

DESIGN OPTIMIZATION & ANALYSIS OF DIFFUSER USED IN MULTISTAGE ELECTRIAL SUBMERSIBLE PUMP (ESP)

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Abstract— *The submersible pumps used in Electrical Submersible Pump (ESP) installations are multistage centrifugal pumps operating in a vertical position. The liquid lifted by Submersible Pump, after being subjected to great centrifugal forces caused by the high rotational speed of the impeller, lose their kinetic energy in the diffuser where a conversion of kinetic to pressure energy takes place. This is the main operational mechanism of radial and mixed flow pumps.*

The Pump is typically multistage containing two or more impellers (depending on head requirements) housed in a Diffuser assembly. Submersible pumps are multi-staged centrifugal pumps; each stage consists of a rotating impeller and stationary diffuser.

The Diffuser of Multistage Submersible Pump will be designed with the help of Pro-E. Pro-E is Parametric by nature so by designing the Diffuser in Pro-E we can redesign the component anytime so time needed for redesign the component will be reduced. Model will be imported from Pro-E to ANSYS to optimize the design of Diffuser by doing Static Structural analysis in ANSYS.

Keywords*- Diffuser, Submersible pumps, impeller, pump casing, power cable, motor shaft.*

I. INTRODUCTION

In recent years, the industrial process related to the aerodynamic design of pumps has undergone a significant evolution, due to both changes in industrial requirements and constraints and the development of new and more powerful design tools. Two interesting discussions concerning modern trends in industrial pump design are reported in two papers by Gopalakrishnan [1] and Hergt. Gopalakrishnan emphasizes that today the primary pump characteristics, required by end users to manufacturers supplying a worldwide customer base, mainly relate to cost and reliability. Technical performance is not ignored, but it represents a minimum requirement for a pump to be an acceptable offering. Similarly, Hergt [2] highlights how, from the early 1970s to present, the main focus of pump design has moved from the so called "primary task of turbo machinery design" to the "second task:" that is, from finding the best geometry, which provides maximum efficiency and reliability for given operating data, to designing the hydraulic contours, which make it possible to meet the requirements of modern, low-cost manufacturing methods, while satisfying the desired operating characteristics (head, efficiency, operating range, and behavior). Nevertheless, the cost benefit principle, which has by now become the judging factor for the final choice on the end-user side, has pushed industries to concentrate efforts on improving pump efficiency within stricter and stricter manufacturing constraints. This often implies the understanding of complex flow physics, so, to achieve this target, a closer cooperation between industries and basic research carried out in universities has proved to be fruitful.

Diffusers are extensively used in Submersible Pumps, centrifugal compressors, axial flow compressors, ram jets, combustion chambers, inlet portions of jet engines etc. The energy transfer in these machineries involves the exchange of significant levels of kinetic energy in order to accomplish the intended purpose. As a consequence, very large levels of residual kinetic energy frequently accompany the work input and work extraction processes, sometime as much as 50% of the total energy transferred. A small change in pressure recovery can increases the efficiency significantly. Therefore diffusers are absolutely essential for good turbo machinery performance

An interesting design solution, already presented and discussed, for example, by Goto and Zangeneh [3], is to couple the radial impeller with a bowl type diffuser, similar to those ones used in mixed flow stages. However, the matching of the diffuser with the upstream centrifugal impeller is not an easy task to accomplish.

Many persons have done a lot of tests on geometric parameter of diffuser Sovran and Klomp [1967] [4] who tested over one hundred different geometries, nearly all of which had conically diverging center bodies with an inlet radius ratio [Ri/Ro] of 0.55 to 0.70. The tests were carried out with a thin inlet boundary layer and the diffusers have free discharge.

The tests were present as Contours of pressure recovery plotted against area ratio and non-dimensional length Howard [1967] [5] also tested symmetrical annular diffusers with center bodies of uniform diameter, using fully developed flow at inlet. The limits of the various flow regimes and the optimum performance lines were established.

Besides it, some other researchers also contributed in the field of annular diffuser and concluded various important results

Area ratio and non-dimensional length tells the overall diffusion and pressure gradient respectively, which is the main factor in boundary layer development. Paterson Cockrell and Markland [1986] [6] found that a variation in the AR from 2.5 to 8.0 has a small effect on the loss coefficients of the 2-D diffuser. Sharan [7],[1972] reported that for a constant AR the performance of diffuser deteriorates with the increase in diffusion angle. Reneau [1967] concluded that for two dimensional straight diffusers the maximum pressure recovery at a constant area ratio occurs in the range of diffuser angle equal to 6-8 degree.

Effect of geometry on the performance of annular diffuser governs by Arora B.B., [8] Pathak B.D. [2005]. Numerical analysis of the impact of conical diffuser geometry change on velocity distribution in its outlet cross-section by Krystynaprync-skotniczny [2006]. Correlation of annular diffuser performance with geometry, swirl and blockage is given by Japikse Dr. David [2003] [9].

II. METHODOLOGY

Diffusers play a vital role in many fluid machines to convert kinetic energy into pressure energy. The efficiency of this conversion process is important as it affects the overall performance of the machine. The pressure recovery, which is the measure of performance of diffusers, depends on many geometrical and dynamical parameters. Some geometrical parameters that govern the performance of a diffuser are inlet length and size of the duct, area ratio of the diffuser, angle of expansion, length of the diffuser, shape of the exit duct with free or submerged discharge conditions, etc. The dynamical parameters are inlet velocity profile, boundary layer parameters, Reynolds number, Mach number and so on. Swirling flow in the diffuser plays an important role in controlling the flow separation and therefore the performance of the diffuser. Consequently, increased attention is being paid to the prediction of the swirling flow characteristics in the diffuser in order to optimize design .

III. CONCLUSION

In this work basic concept of Diffuser design and Optimization of it by Static Structural Analysis are introduced. In Pump industries while using many parts in those some parts there is unnecessary material is used. The design of part is safe although the more material is used to Design and manufacture the part because of which the part design will be over safe. So considering this criterion, Design of Diffuser is improved by optimizing it with the condition of the safe design. By optimizing the part the material saving will be there and at the end company will also get the profit**.**

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