A REVIEW ON IMPROVEMENT OF EFFICIENCY OF CENTRIFUGAL PUMP THROUGH MODIFICATIONS IN SUCTION MANIFOLD

Mr. Amitkumar Bhimrao Salunkhe
Vice Principal,
Shree Shivajirao Deshmukh Institute of Technology,
Red-Shirala, Maharashtra, India

Mr. Ranjit Ganaptrao Todkar
Professor,
Department of Mechanical Engineering/
ADCET, Shivaji University, Maharashtra, India

Mr. Kedar Madanrao Relekar
HOD,
Shree Shivajirao Deshmukh Institute of Technology,
Red-Shirala, Maharashtra, India

ABSTRACT

The paper reviews the literature available on the improvement of efficiency of centrifugal pump through modification in suction manifolds. The paper discusses the available material of performance improvement through various parameters and mainly focuses on the research related to manifold modifications.

INTRODUCTION

1.1 Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps are classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.
Pumps operation is by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.
Mechanical pumps are used in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers.

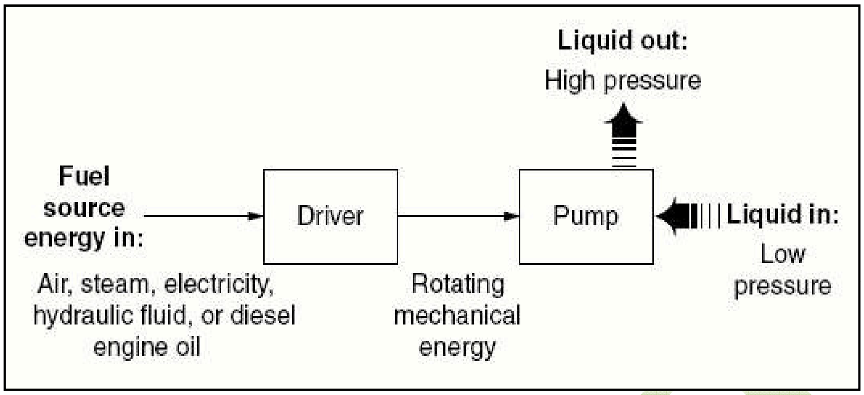

Figure 1. Working principle of Pump

Centrifugal Pump:

Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy generally comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits. Common uses include water, sewage, petroleum and petrochemical pumping.

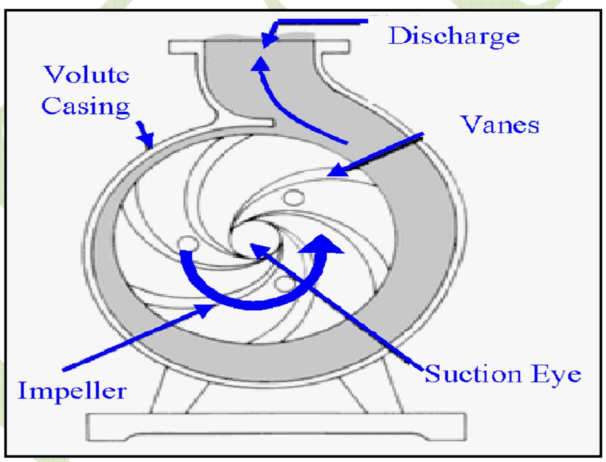

Figure 2: Liquid flow path inside a centrifugal pump

The opposite or reverse function of the centrifugal pump is a water turbine converting potential energy of water pressure into mechanical rotational energy. Inability to deliver the desired flow and head is just one of the most common conditions for taking a pump out of service. There are many other conditions in which a pump, despite suffering no loss in flow or head, is considered to have failed and has to be pulled out of service as soon as possible. Effective troubleshooting requires an ability to observe changes in performance over time, and in the event of a failure, the capacity to thoroughly investigate the cause of the failure and take measures to prevent the problem from reoccurring.

The fact of the matter is that there are three types of problems mostly encountered with centrifugal pumps:

[1] Design errors
[2] Poor operation
[3] Poor maintenance practices

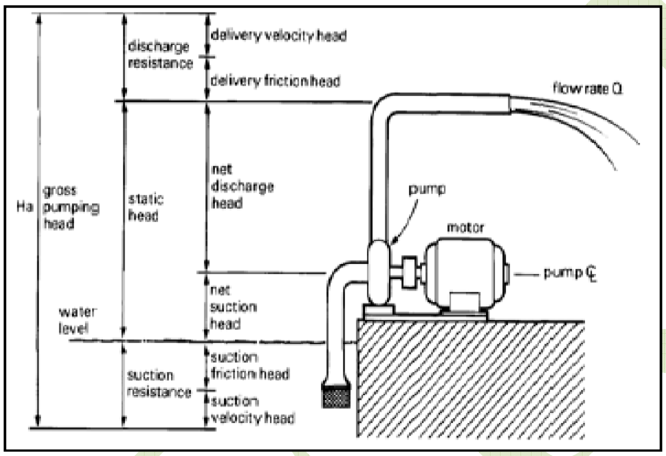

Figure 3: Centrifugal pump system

A centrifugal pump operated at constant speed delivers any capacity from zero to maximum depending on the head, design and suction conditions. The operating pressure of the system is a function of the flow through the system and the arrangement of the system in terms of pipe length, fittings, pipe size, the change in liquid elevation, pressure on the liquid surface.
Every unit of power saved in the application contributes towards conservation for the environment and towards Green Earth. Every inch of enhancement in the `head' at the output side adds to the efficiency of the pumping system. This work aims at improving the performance of the system with a focus on the suction side while contributing to the global effort in upgrading the performance. This work is relevant in the context of lowering power consumption or improving the effective head of the pumping system.

LITERATURE REVIEW

The task deals with the optimization and analysis in suction of centrifugal pump so in related to this following research papers have been studied:-

Vibha P.Pode, Shylesha Channapattanna[2014] have proposed a study to be done on the suction side of a centrifugal pump, the objective of the study was to improve the performance and provide the best alternative design for the suction side.

Sumit N.Gavande, Prashant D.Deshmukh, Swapnil S.Kulkarni[2014] have studied the various methodologies to increase the discharge of the pump. Some methodologies relate to the change in design of the suction side and some relate to change in design of pump.

Bin Cheng al.[2012] the objective of this study was to analyze the inlet flow characteristics of the lateral diversion and intake pumping stations and access the capacity of flow adjustment of the guide splitter with numerical simulations, based on turbulent model and SIMPLEC algorithm. The main conclusions was, the inlet flow pattern is more complex than single lateral division or lateral intake pumping station and the flow pattern in the lateral diversion part is similar with bend flow.

Honggeng Zhu al.[2012] have investigated the internal flow patterns of a volute type discharge passage, in a mixed flow pumping system based on the Computational Fluid Dynamics(CFD). Analysis shows that the internal flow pattern of volute-type discharge passage is very complex; there is vortex and flow separation in typical cross-sections.

S. P. Asok al.[2011] have demonstrated the three dimensional CFD analysis in prediction of pressure drop taking place in helical-grooved labyrinth seals and having good agreement with experimental results. Helical-grooved labyrinth seals have better pressure reduction characteristics over the circular-grooved and/or sinusoidal grooved seals. They bring in additional energy losses due to flow bending effects and vortices operating in the azimuthally direction also..

HSIAO Shih-Chun al.[2011] has been examined the hydrodynamics of a pump sump consisting of a main channel, pump sump, and intake pipe is examined using Truchas, a three-dimensional Navier-Stokes solver, with a Large Eddy Simulation (LES) turbulence model. The numerical results of stream wise velocity profiles and flow patterns are discussed and compared with experimental data, fairly good agreement is obtained.

ZHANG De-sheng al.[2010] have simulated the unsteady turbulent flow in the adjustable axial-flow pump based on software Fluent, and the pressure fluctuation, static pressure distributions and axial velocity at the rotor outlet at different time steps were discussed. From the test results, they come to know that, the unsteady results are more accurate than the steady results, The time-domain spectrums showed that the static pressure fluctuation curves at the rotor inlet, the outlet and the stator outlet are periodic, and the pressure fluctuation amplitude increases from the hub to the tip at the rotor inlet and outlet, but decreases at the stator outlet.

WANG Fu-jun al.[2007] have been successfully simulated the three-dimensional turbulent flows generated by an axial-flow pump equipped with an inducer, using the multiple reference frame approach. The effects of angular alignment of inducer and impeller blades and the axial gap between inducer and impeller have been examined.

GUO Jia-hong al.[2007] has presented a numerical model for three-dimensional turbulent flow in the sump of the pump station. A reasonable boundary condition for the flow in the sump with multi-intakes, each of which may have different flow rates, has been proposed. They have used finite volume method to solve the governing equations. The fluid flow in a model sump of the pump station is calculated and compared with the experimental results. The comparison between the numerical and the experimental results showed that they fairly agree with each other. Therefore, the present method can be applied to simulate the flow field in the sump with multiple water intakes effectively, and can be used in the design of the sump.

SUMMARY

- Vortices and cavitations' introduce inefficiency on the operation of the centrifugal pump.
- The suction head and the delivery head has a bearing on the output of the pump in terms of discharge achieved per KW of pump power.
- The intake pumping stations requires a desirable intake flow pattern in order to ensure the operation of pump units.
- The intake pumping stations needs a uniform flow distribution of the sumps in order to ensure the operation of pump units.
- CFD model used to study the effect of various parameters which reduces time as well as cost and hence could become an important tool for optimization of pump sump geometry.
- Redesign of the suction side of the pump facilitated the flow of water and improves the discharge and consequently the performance of the centrifugal pump.

REFERENCES

1. Vibha p.pode, shylesha channapattanna, *evaluating performance of centrifugal pump through cfd while modifying the suction side for easting discharge, international journal of research in engineering and technology eissn: 2319-1163 | pissn: 2321-7308, jan-2014*

2. Sumit n.gavande, prashant d.deshmukh, swapnil s.kulkarni, *a technique to enhance the discharge of a multi intake centrifugal pump, international journal of advanced engineering research and studies e-issn2249–8974, volume: 03 issue: 01 | jan-2014*

3. S. Bin cheng, yonghai yu, *cfd simulation and optimization for lateral diversion and intake pumping stations, 2012 international conference on modern hydraulic engineering, procedia engineering 28 (2012) 122 – 127.*

4. Honggeng zhu, rentian zhang, guoqiang luo, bin zhang, *investigation of hydraulic characteristics of a volute-type discharge passage based on cfd, 2012 international conference on modern hydraulic engineering, procedia engineering 28 (2012) 27 – 32*

5. S.p. asoka, k. Sankaranarayanasamy, t. Sundararajan, g. Vaidyanathan, k. Udhaya kumar, *pressure drop and cavitation investigations on static helical-grooved square, Triangular and curved cavity liquid labyrinth seals, nuclear engineering and design 241 (2011) 843–853*

6. Chuang wei-liang, hsiao shih-chun, *three-dimensional numerical simulation of intake model with cross flow, journal of hydrodynamics 2011,23(3):314-324, doi: 10.1016/s1001-6058(10)60118-7.*

7. Zhang de-sheng, shi wei-dong, chen bin, guan xing-fan, *unsteady flow analysis and experimental investigation of axial-flow pump 2010,22(1):35-43 doi: 10.1016/s1001-6058(09)60025-1.*

8. Li yao-jun, wang fu-jun, *numerical investigation of performance of an axial-flow pump with inducer, journal of hydrodynamics, ser.b, 2007,19(6):705-711*

9. Chen hong-xun, guo jia-hong, *numerical simulation of 3-d turbulent flow in the multiintakes sump of the pump station, journal of hydrodynamics, ser.b, 2007,19(1):42-47*