



Article Title: **Optimization of Split Volute in the Double Volute Mono Set System Using CFD Analysis**

Optimization of Split Volute in the Double Volute Mono Set System Using CFD Analysis

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ABSTRACT

Recently most of the research problems focused on Single volute centrifugal pump and optimize the certain level of parameters such as number of impeller blades, angle and profile of the blade etc. that leads to improve the performance of the centrifugal pump [1]. Some of the authors conduct the research to reduce the radial force and noise level by implementing double volute centrifugal pump with fixed split structure for improving the performance of the Centrifugal Pump [2], but efficiency and head is dropped in the system at certain level of variation in radial force and noise. From this study, objective of this research paper is to reduce the radial force and noise level without sacrificing the efficiency and head of the Centrifugal pump. Existing single volute pump operate under constant speed (2800 rpm) has been taken for analysis and it consists of 6 vanes with forward curves impeller. This research mainly reduces the radial force by optimizing different position of split volute using CFD approach in order to improve the noise reduction in the double volute region. Numerical simulation of the existing pump also calculated by using CFD Technique and Investigation on Experimental analysis of existing centrifugal pump also done in research Laboratory. In this research, Optimization of split volute found the best way to reduce the radial force in the double volute pump. Different model can be simulated by using ANSYS-CFX to find the optimum position of split volute mono set centrifugal pump in order to develop uniform pressure in the volute region and reduce the radial force and noise of the Centrifugal pump.

Keywords: Centrifugal Pump, CFD Technique, single volute pump.

1 Introduction

Pumps enable a liquid to, flow from a region or low pressure to one of high pressure, flow from a low level to higher level and flow at a faster rate. Mechanical pumps serve in a wide range of applications; it includes pumping water from well, aquarium filtering, water cooling and fuel injection in the Engines, in the energy industry for pumping oil and natural gas, for operating cooling towers, Heating, ventilation and air conditioning system. Centrifugal pump is used in domestic as well as in industry because of its simple in construction, more volume discharge and maximum hydraulic efficiency among the rest of the pump [3]. Different types of the centrifugal pumps are used for various applications at present scenario. Mostly the



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researchers carried out the research on single and double volute pump. Single volute pump performs under the higher efficiency compared to double volute pump but the vibration phenomenon is a major drawback in single volute pump due to development of radial force from unbalanced static pressure distribution [2]. For this difficulty exist in the single volute pump, at present research mainly focused on reducing radial force through creation of split structure in the single volute region called double volute and it is observed that the vibration and noise level reduced due to radial force reduction. Even reduced radial force in the double volute, the head and efficiency of the pump decreased due to low volume output. To find optimum level output, this research approached to create and analyze the different model and found the best one by using CFD analysis.

2 Research Problem

Non uniform static pressure distributions generated in the outlet of the impeller affect the volute casing by development of radial force. Most of the literature survey shows that only the radial force is reduced by developing double volute split casing that divide the single volute into two sections [4]. So, this work is mainly focused on optimization of the split structure in order to minimizing the radial force by developing uniform pressure distribution in the double volute casing. Optimization of split structure in the double volute centrifugal pump is for different cases simulated by using ANSYS-CFX software to predict the pressure variation around the casing. There is an improvement in uniform static pressure distribution around the casing in order to reduce the vibration or radial force.



Figure 1: *CFD Result for existing single volute centrifugal pump*

The Fig.2.1 is CFD result of existing model (Single Volute), pressure variation around the volute is not in uniform therefore unbalanced vibration occur in the pump it creates the vibration and affect the system. Pressure variation at outlet of the pump is reduced due to larged volume and increased velocity of the pump.



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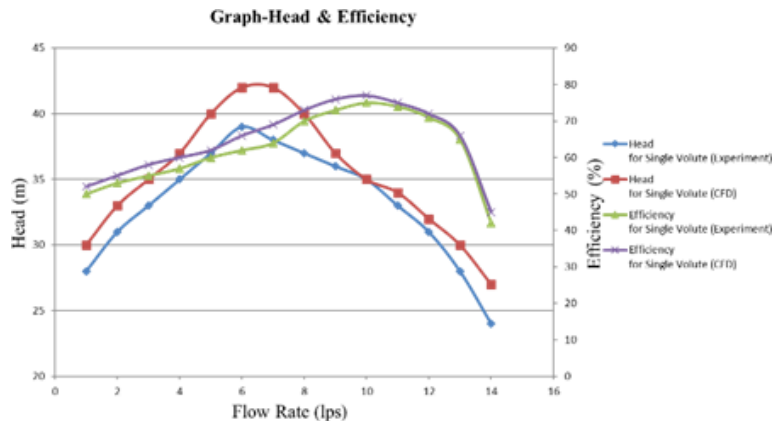


Figure 2: Graph for Head (m) and Efficiency (%) by Experimental and CFD

The above graph shows that both head and efficiency curve taken from the Experiment analysis and CFD analysis are coincide with certain minimum and acceptable variation. The range of variation of head falls from 0% to 3% and efficiency varies from 1% to 5%. Head and efficiency gradually increased with flow rate then decreased, it shows that after certain point the efficiency of the pump is decreased. The maximum head absorbed in the graph for experiment and CFD is 39m & 42m and 75% & 77% are the maximum efficiency achieved in the existing single volute centrifugal pump.

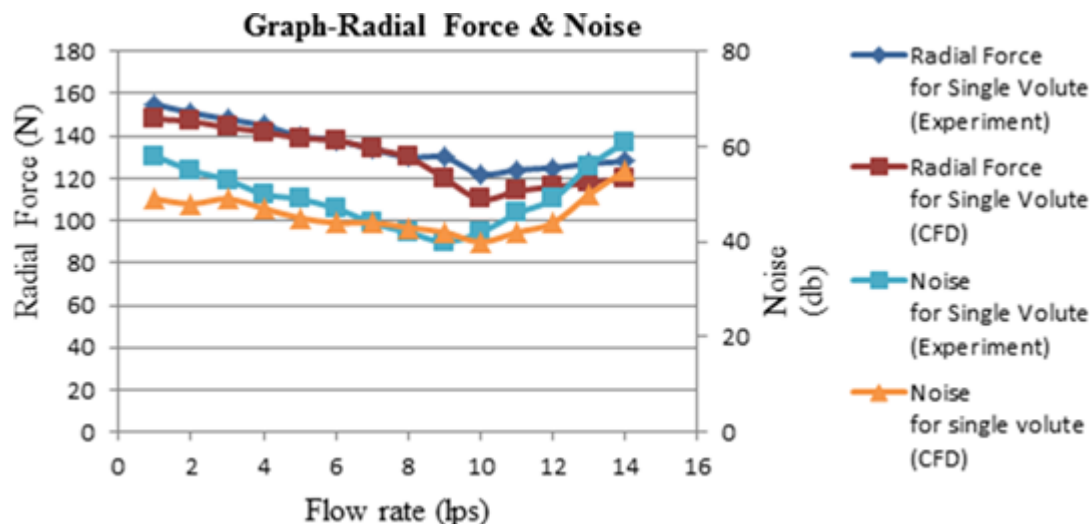


Figure 3: Graph for Radial force (N) and Noise (db) of the Existing Pump

Figure 3 shows graph between Radial force and noise and it is observed that both Experiment analysis and CFD results are coincide with minimum and acceptable level of variation. The variation of radial force varies between the 0% to 12% and noise changes from 0% to 9%. Radial force and noise gradually decreased while flow rate is increased, after certain point both the curve is increased and it shows that if radial force and noise either decreased, the



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head and efficiency have dropped. The maximum radial force absorbed in the graph for experiment and CFD is 155 N & 148 N and 61db & 55db are the maximum noise get from the single volute centrifugal pump.

3 CFD Analysis

Computational fluid dynamics is a technique in which flow characteristics analyzed to know the behavior of the system. The internal flow behavior of the pump is based on flow velocities, flow pressure and stream of the flow [5]. ANSYS CFX is required certain input data to find out the pump performance characteristics and creation of mesh model quite complicated in 3D model for analysis compared to 2D analysis. Once model created using design software then it is ready to import to any analysis software such as ANSYS-CFX or Fluent etc., and it is important to know that after import the model, proper meshing is selected for model or geometry in which analysis carried out. Initial and boundary condition is essential to making the system function and active, sometime output data is given when it is required [6]. In this research, 3 different models can be taken for analysis to know the pump performance of the system.

Figure 4 represent a Model I and it shows that split angle starting with 270° , for model II it is having 225° and model III starts with 180° . Optimum split structure is selected based on the result obtained for the different cases by using CFD analysis.

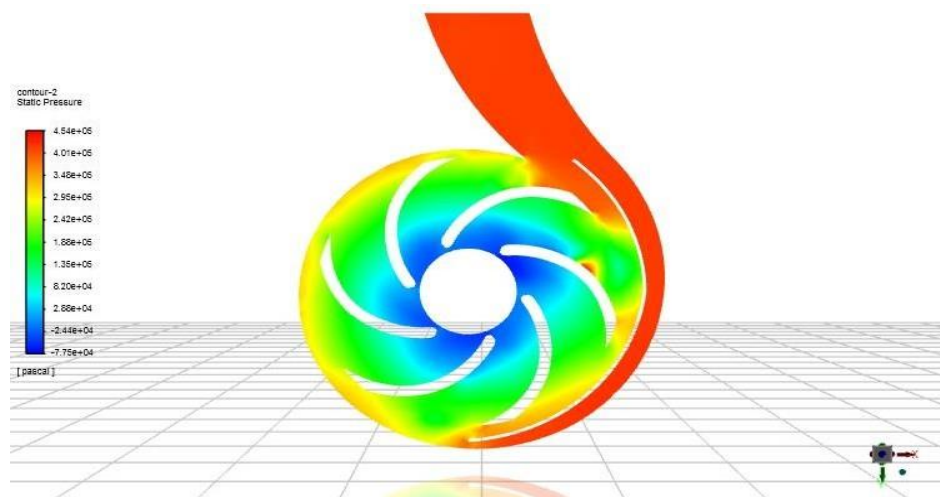


Figure 4: Static Pressure distribution for Model-I

Model-I have the fluid pressure and it is decreased at the inlet and then it is gradually increased up to high pressure generated around the impeller surrounding or split areas. In which pump get balanced but radial force is developed around the casing may be reduced at minimum level.



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Figure 5: *Static Pressure distribution for Model-II*

Figure 5 is Model II have uniform pressure distribution obtained throughout the area from inlet to the split casing. The system fluctuation is balanced and radial force may be reduced certain level. Figure 6 is Model-III also has a uniform pressure obtained in the boundaries and radial load may be reduced at maximum level. For the different cases, static pressure is measured and the radial force measurement has been taken for analysis from the result point of view to select the optimum model to function the pump with minimum radial load, at the same time, the efficiency should not fall below the curves obtained in the single volute.

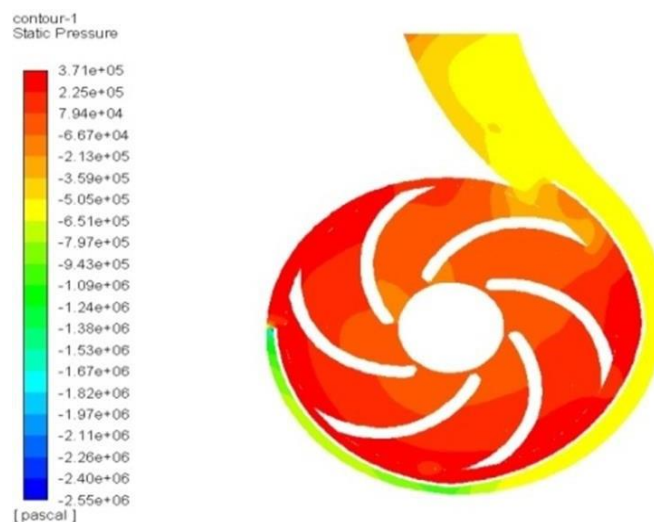


Figure 6: *Static Pressure distribution for Model-III*

4 Result and Discussion

CFD analysis was performed for three different cases and graph is plotted from ANSYS CFX to find the optimum results or model. Single volute centrifugal pump is having their own advantages and disadvantages and radial force is a challenging parameter to reduce in the



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single volute. If the radial force is reduced for certain level using double volute, the vibration level minimized in the casing areas [7]. CFD technique ensures the performance model that static pressure is uniformly distributed around the impeller and casing. So that radial force is minimized and optimum result could be selected based on the following graph without affecting the normal system. The result part contain graph for the different three models, in which results obtained.

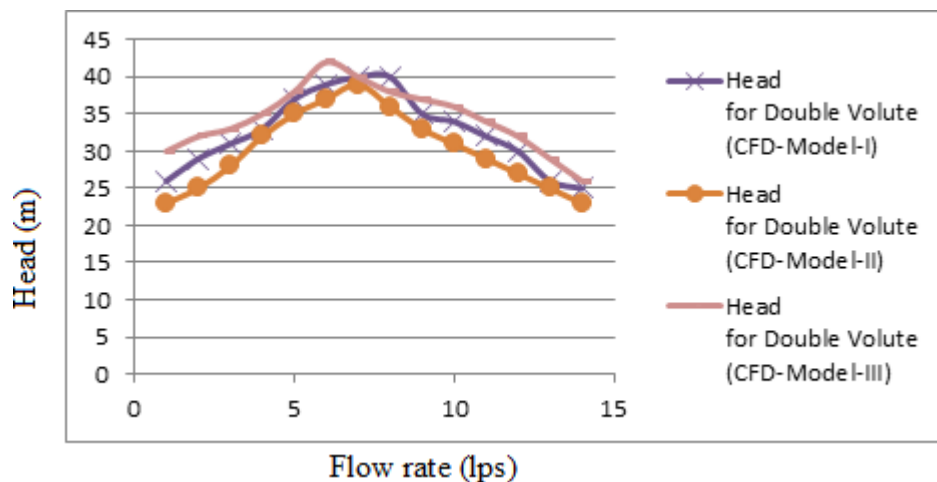


Figure 7: Head (m) Vs Flow rate (lps) for different model

From the graph, it is observed that head is increased while increasing flow rate after it is reduced for the all cases and maximum head is obtained for Model III and minimum head observed for the Model I & Model II. Same it is from efficiency graph; Model III has higher efficiency and other model having lower level.

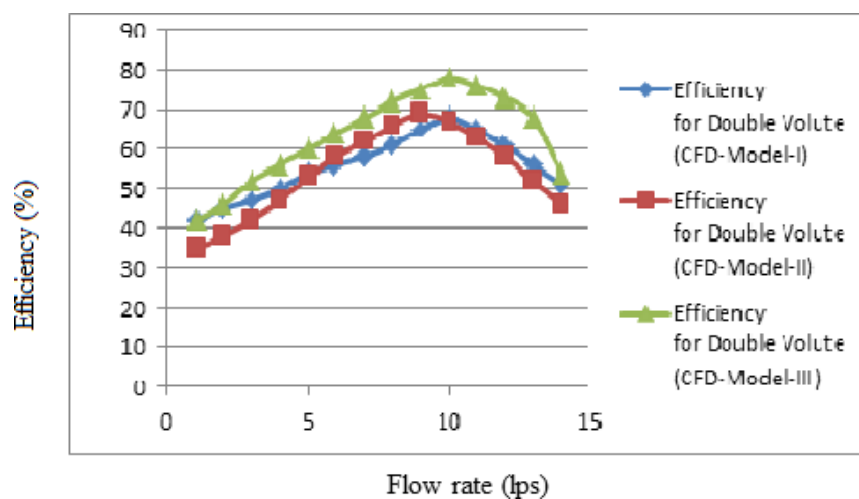


Figure 8: Efficiency (%) Vs Flow rate (lps) for different model



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Radial force for the third case reduced large amount compared to other two models and for the third model it is observed that radial force begins with lower level then increased slowly where as in other two cases radial load starts with maximum point and decreased then it is increasing.

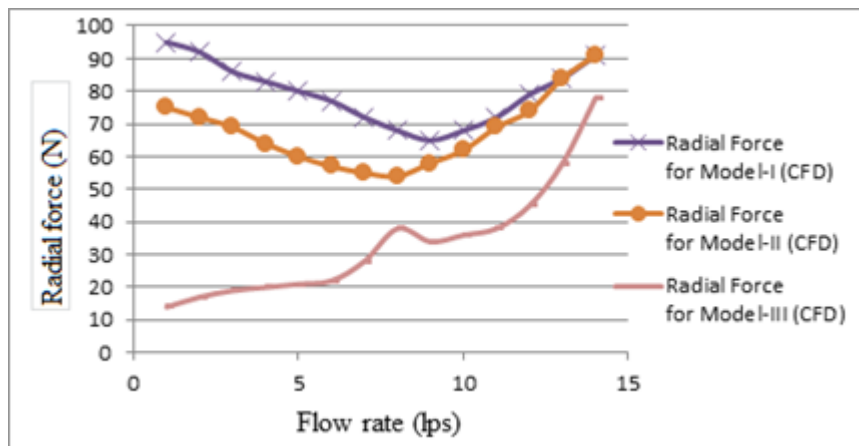


Figure 9: Radial force (N) Vs Flow rate (lps) for different model

Both the graph (radial force & noise) shows that there is an improvement for the Third model & the pump will perform well in order to reduce the vibration without compromise efficiency and head.

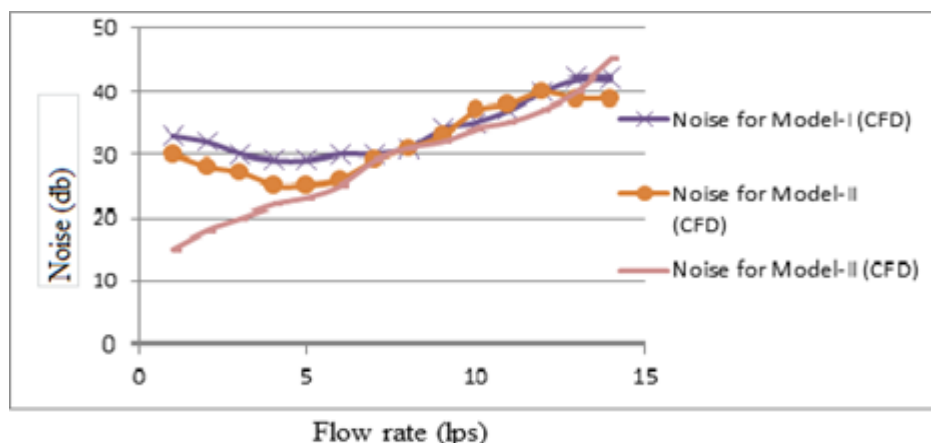


Figure 10: Noise (db) Vs Flow rate (lps) for different model

5 Conclusion

Radial force is a major drawback in a single volute centrifugal pump because of development of unbalanced static flow surrounding in the volute. From this research, optimization of split volute region carried out for three different models and results compared and based on the result obtained, Model III have satisfied with objective of this research. The following major



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conclusion was arrived from this research paper.

Results obtained from CFD and Experimental analysis is coinciding with minimum variation for existing single volute centrifugal pump for simple validation.

Three models have generated and analyzed using CFD, it is for getting uniform pressure distribution at the surrounding of volute.

The results compared with the following output parameters from the CFD results such as radial force, noise and head & efficiency of the pump.

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