



Department of Mechanical Engineering

Computer Aided Mechanical Design (MECH 6451)

Modeling and Analysis of Centrifugal Pump

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"We certify that this submission is the original work of members of the group and meets the Faculty's Expectations of Originality"

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Objectives

Due to evolution of the modern industry, systems are becoming more complex and intricate, so engineering design process has become a complex task. Therefore, the idea of a design assistant that can predict design variables based on knowledge base is required. In the given report, the documentation of the design project for the design of a centrifugal pump is discussed. To establish constraints an optimum value of all the dimensions that accounted for factors such as pump efficiency and head was simulated on MATLAB with the help of input/output parameters like flow rate, did of impeller etc. A centrifugal pump is a rotating device with two main components: impeller and its volute casing. The impeller is the rotating component, and the volute is the static component. A design framework is essential to guide designers step-by-step to complete their tasks. Given the practical difficulties mentioned above, we conducted this investigation using a multi-optimization design approach to overcome these limitations during the design process. This design methodology is now common not only in mechanical design, but also in other related fields.

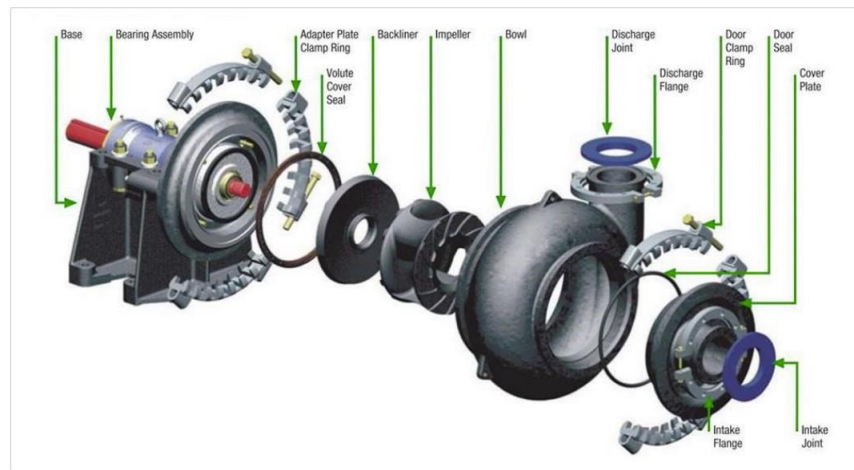


Figure 1Exploded view of the centrifugal pump^[2]

Methodology

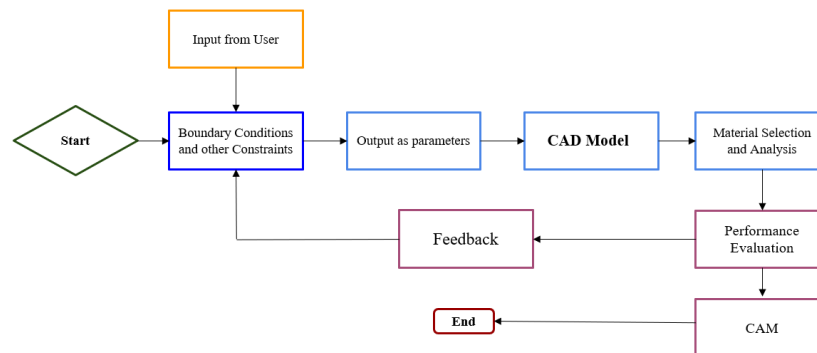


Figure 2 Block diagram of Design System^[2]

For the overall design of mechanical system starts with the decision on the boundary condition, constraints and the equations for creations and generalize the output as parameters. The constraints are decided to satisfy the user requirements (according to the application), and the actual design parameters values. Then putting the required condition (flow rate, pressure at outlet, speed, efficiency, potential material for specific application and many more) and generating the equations manually then with using the MATLAB the whole data set is generated in the form of the parameters (length, breath, height, volume, Inner and outer diameter of the system and many more) which is used for designing the mechanical part CAD model. And then conducting the analysis on ANSYS after obtaining the optimum result and then performing the CAM.

Scope

Impeller: An impeller is a rotor used to increase the kinetic energy of the flow.

- Material - Cast Iron
- Manufacturing method - Casting Process

Volute casing: The casing contains the liquid and acts as a pressure containment vessel that directs the liquid flow in and out of the centrifugal pump.

- Material - Bronze, cast steel, cast iron, composite, Carbon structural steel
- Manufacturing method - Casting Process

Shaft and shaft sleeves: The impeller is mounted on a shaft. A shaft is a mechanical component for transmitting torque from the motor to the impeller.

- Materials - Stainless Steel, Leaded bronze, Hardened nickel-plated
- Manufacturing method – Machining Process

Bearings: Bearings constrain the relative motion of the shaft (rotor) and reduce friction between the rotating shaft and the stator.

- Material - Sintered carbon, Ceramic material, PEEK
- Manufacturing method – Stamping and forming, forging, and machining

Mechanical seals: Centrifugal pumps are provided with packing rings or mechanical seal, which helps prevent the leakage of the pumped liquid.

- Material - Carbon-Ceramic, Silicon carbide, alumina oxide, tungsten carbide
- Manufacturing method – Machining Process

Challenges

The major challenges which arise during the designing of the centrifugal pump are given below.

- Selecting the Input parameters and Output parameters
- The Manually calculation and deriving the equations will be a challenging and coding that equation in the MATLAB and generating the data and obtaining the result.
- Then creating the CAD model according to the output obtained and doing the analysis of the CAD model and trying to meet the user requirements.
- Complex design of impeller, designing of the velocity triangle and volute casing.



Figure 3 Shaft Sleeve^[2]



Figure.4 Volute Casing^[2]

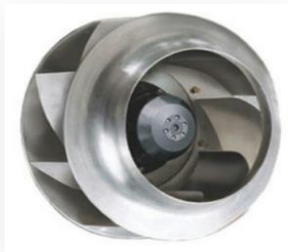


Figure.5 Closed Impeller^[2]



Figure.6 Mechanical Seals^[2]

References

1. Hye In Kim , Tae-Seong Roh , Hwanil Huh, Hyoungh Jin Lee, “*Development of Ultra-Low Specific Speed Centrifugal Pumps Design Method for Small Liquid Rocket Engines*”, Aerospace
2. Shahin S. Nudehi, John R. Steffen, “*Analysis of Machine Elements using SOLIDWORKS Simulation 2021*”