

Design and Analysis of Centrifugal Pump Rotor with Various Materials

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Abstract: A centrifugal pump is a forceful pump that uses an impeller to pump the liquid or a kind of fluids. Divergent pump is ordinarily used to move fluids through a funneling structure. The liquid enters the direction of the impeller and is quickened by the impeller. The stream of fluid is pushed radially outward into a diffuser or volute chamber (packaging) from where it exits into the funneling type casting. The centrifugal pumps use an electric motor or an engine to power the impeller. The pressure created in the fluid is directly proportional to the power of the electric motor or engine. Radial pumps give steady rate of flow of liquids (discharge) because it doesn't have any intermitted motion. If the discharge height increased high power motors are required to lift the liquid against gravity to a more elevated amount. The exchange of energy from the mechanical revolution of the impeller to the movement and weight of the liquid is normally depicted regarding diffusive compel, particularly in more established sources composed before the cutting edge idea of radiating power as an invented drive in a turning reference edge was very much verbalized. The idea of outward drive is not really required to portray the activity of the radial pump. In this study, examination on MS and SS pump impeller is done keeping in mind the end goal to enhance quality of radial pump. This study gives the static and Modal examination of MS and SS Pump Impeller to check quality of pump and vibrations created by pump.

Key words: Centrifugal force, pump, ANSYS, meshing, structural analysis, modal examination

INTRODUCTION

The main use or need of the centrifugal of the centrifugal pump is to increase the pressure of the liquid. Thin *et al.* (2008) and Anagnostopoulos (2009) in the centrifugal pump the energy is converted to hydro dynamic energy from the rotational energy of the centrifugal pump. The mechanical engine or electric motor is used to rotate the impeller of the centrifugal pump. Meduitz *et al.* (2002) the pressurized liquid is exits by the diffuser of the centrifugal pump which it is entered by the impeller of the pump. And another main use of the centrifugal pump is water turbine by the reverse process. Gonzalez *et al.* (2002) the centrifugal pump is commonly used in the maximum industries. The centrifugal pump is classified as three types based on the impeller. They are semi opened impeller, fully opened impeller and enclosed impeller. The centrifugal pump has a very complicated design. The sewage using pumps and petroleum pumps are the best example for the centrifugal pump.

MATERIALS AND METHODS

The vast majority of the diffusive pump impellers are made up with Mild steel which has greater thickness. Huzel *et al.* (1992) this is fundamental driver of high weight of pump. Not with standing this it has high erosion

and less weariness quality. The mellow steel can be supplanted with amalgam material (e.g., SS, inconel, aluminum compounds) to diminish the weight (Jayakumar *et al.*, 2014) enhance consumption resistance and weakness quality is more as contrast with various amalgams material and composite material. Because of less solidness (Karthikeshwaran, 2014) distortions created for a similar material is more when contrasted with composite material and distinctive combinations.

Specification of the pump: An outspread draw particular from the standard information is chosen for plan and examination. Pump detail are: head = 75 m, discharge = 8.5 L/sec, rpm = 1500. The impeller was intended for the operational state of Head (H) = 75 m, stream rate (Q) = 8.5 L/sec and speed (N) = 1500 rpm.

Pre design specific speed: Pre outline particular speed is ascertained utilizing the exact connection appeared and $nq = 16.8$ and it falls in the outspread pump extend.

Design: By utilizing cordier outline and estimation of particular speed (δ) the ideal estimations of external measurement (D2) cover breadth (Ds) and width of trailing edge are ascertained. These qualities are emphatically chooses the capitation conduct of the pump. The 3D model of the centrifugal pump is shown in Fig. 1.

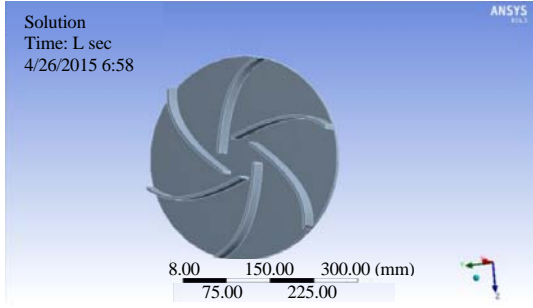


Fig. 1: 3D Model of the centrifugal pump rotor

Blade angle design: By utilizing bay and outlet speed triangles the bay and outlet cutting edge points are figured. Inlet speed triangle is attracted stream is thought to be spiral at bay and meridian part of speed is computed in such way that it is marginally higher than speed at impeller eye.

Point by point method: The co-ordinates for building up the vane profile together with the gulf and outlet point relies upon the range (r). Unthinkable combination technique is utilized for acquiring the co-ordinates. The ranges concerning edge are gotten from the Equation. The estimations of the vane profile arranged and the vane profile are appeared.

Modeling and meshing: Geometry of point by point impeller and circular bend impeller are made utilizing catia V5 programming. The networks are created utilizing ICEM CFD. The fundamental rule in lattice is that it ought to have better components to show signs of improvement precision of the outcome. In the meantime, number of matrices ought not surpass accessible computational limit. To accomplish this target, fine research was utilized where the arrangement angle is higher and coarse research was utilized where there is low arrangement inclination (Fig. 2).

Flow simulation using CFD: CFD approach was completed to examine the conduct of stream field in the impeller utilizing the ansys familiar 14.5 programming. Familiar programming is a capable CFD device that empowers creators to rapidly and effectively recreate liquid stream for the achievement of plans. Configuration cycles are costly and tedious. CFD investigation can help the fashioners to advance the plans by mimicking a few ideas and situations to make supreme appraisal. Familiar illuminates time-subordinate three-dimensional Reynolds-arrived at the midpoint of navier-stokes conditions utilizing the k-omega turbulence demonstrate with the Finite Volume Method (FVM).

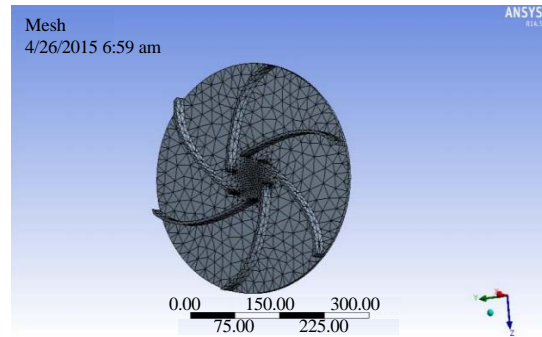


Fig. 2: Coarse meshing of the model

RESULTS AND DISCUSSION

For mild steel: Directional deformation is the deformation of an object in a particular axis. Total deformation is the vector sum of all directional deformation of the object. Figure 3 shows the total deformation of the pump rotor made up of mild steel.

Von Mises stress also called equivalent stress. It allows any 3D stress state to be representing a single stress value. Maximum equivalent stress failure used to predict deformation of a material. Figure 4 shows the equivalent stress of the pump impeller made up of mild steel.

For stainless steel: Directional deformation is the deformation of an object in a particular axis. Total deformation is the vector sum of all directional deformation of that object. Figure 5 shows the total deformation of pump rotor made up of stainless steel.

Von Mises stress also called equivalent stress. It allows any 3D stress state to be representing a single stress value. Maximum equivalent stress failure used to predict deformation of a material. Figure 6 shows the equivalent stress of the pump impeller made up of stainless steel.

The most extreme diversion initiated in metallic pump fan, i.e., MS material is 0.00283 mm which is in safe points of confinement. Subsequently in light of unbending nature the outline is sheltered. The greatest prompted worry for a similar material is 12.04 MPa which is not as much as the suitable anxiety, i.e., working stress by considering element of wellbeing. Thus, the plan is protected in light of quality. On the off chance that we look at relating miss happening of the material SS on above outcomes MS material, SS having least distortion in the direct fan as contrast with MS materials. Consequently, the quality of pump gets expanded on account of the SS material. From the above outcome

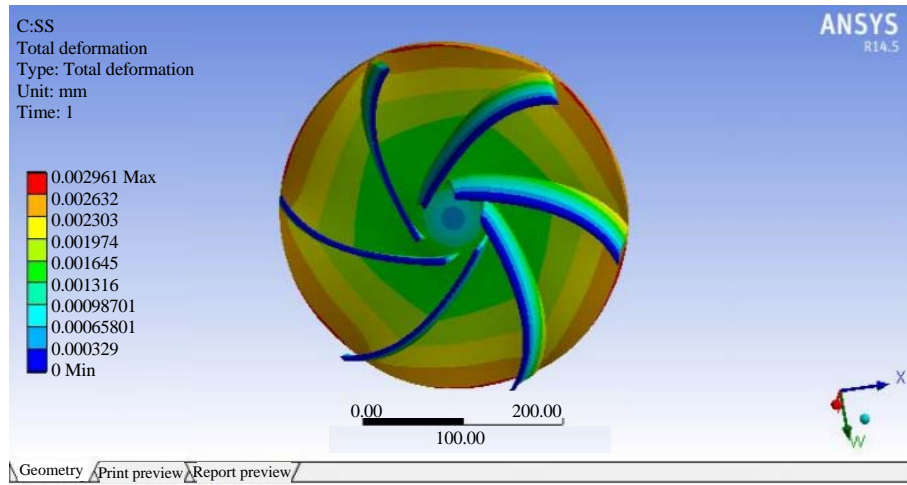


Fig. 3: Total deformation for mild steel

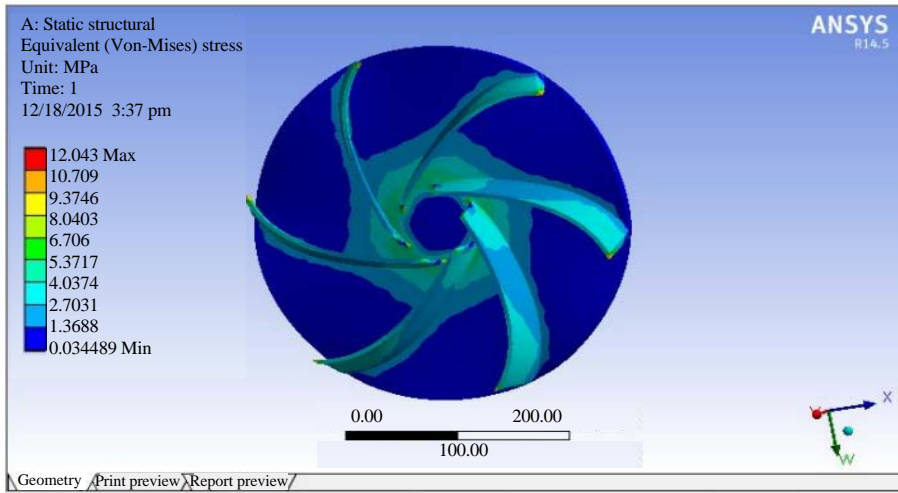


Fig. 4: Equivalent stress for mild steel

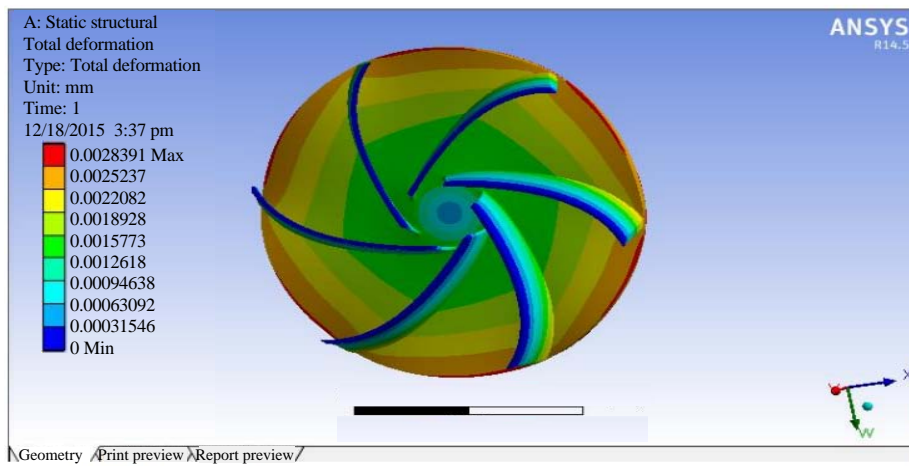


Fig. 5: Total deformation for stainless steel

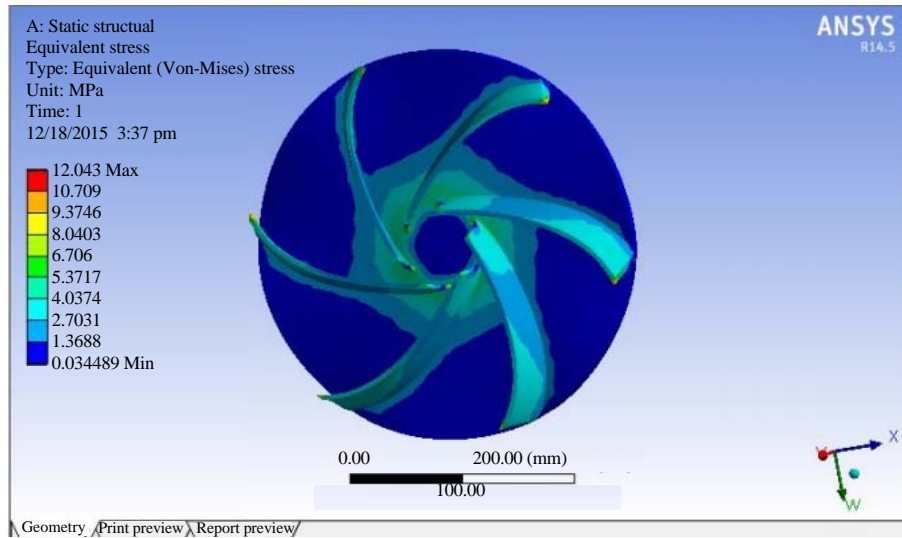


Fig. 6: Equivalent stress for stainless steel

Table 1: Analysis results comparison for MS and SS

Material	Deformation	Stress
Mild steel	0.00283	12.04
Stainless steel	0.00296	11.97

Table 1 plainly weight of the SS pump (28.8 kg) fan material is least when contrasted with MS (29.20 kg) material, hence, forth weight of the pump fan decreased (improved).

CONCLUSION

On doing static and modular examination of pump impeller obviously, the greatest redirection prompted in metallic pump fan, i.e., MS material is 0.003839 mm which is in safe points of confinement. The most extreme incited worry for a similar material is 22.043 MPa which is not as much as the reasonable anxiety, i.e., working worry by considering variable of wellbeing (260 GPa). Hence, the outline is sheltered in view of quality. On the off chance that we look at relating distortion of the material SS on above outcomes MS material, SS having least disfigurement, hence, there are less odds of disappointment of the direct fan as contrast with MS materials. Consequently, the quality of pump gets expanded on account of the SS material. From the above outcome Table 1 plainly weight of the SS pump (38.83 kg) fan material is least when contrasted with MS (39.202 kg) material, subsequently weight of the pump fan lessened (improved). The normal frequencies of MS pump fan are more than SS pump impeller.

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