International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-6, August 2013

Charactrisation and Analysis of Abs Submerged Pump Casing

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Abstract- Pump is a mechanical device which uses suction or pressure to raise liquids. Pump casing assembly consists of single or multiple stages to meet exact system head requirements. A wide range of casing sizes are available to meet the system capacity requirements. Standard construction includes iron casing with bronze impellers on a stainless steel pump shaft. The Main problem associated with ductile iron casing is corrosion, because it will be immersed in water during operations. In this research work an attempt has been made to replace the metallic casing of multistage submersible pump with ABS material. First the geometric modeling of six stage pump is carried out using modeling package CATIA V5.Then the model is imported to preprocessor solver hyper mesh, here finite element model of ductile iron and ABS is generated. After that FE model is imported in to ABAQUS V6.12 solver to carry out the static analysis for different pressures. The von mises stress developed for both the casings are compared. Water flow simulation inside the pump casing for ductile steel and ABS material for different pressures is simulated using Solid WorksV11 solver. The maximum velocity distribution obtained for both materials are same. The prototype model of ABS pump casing is manufactured using FDM technique, this model is tested for physical properties using shore durometer. The obtained hardness values compared with ductile steel casing. Analysis results show that ductile iron can be replaced by ABS as it possesses good corrosion resistance and light weight.

Key words: Submersible pump, composite, corrosion free.

I. INTRODUCTION

A submersible pump is a centrifugal pump, which is attached to an electric motor operating in a vertical position. Although their constructional and operational features underwent a continuous evolution over the years, their basic operational principle remained the same. Produced liquids, 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. Submersible pump has wide range of head and discharge. The pump casing assembly consists of single or multiple stages to meet exact system head requirements. Standard construction includes iron casing with bronze impellers on a stainless steel pump shaft. In recent times the casing of submersibles pumps are made of ductile iron which makes it a metallic component and are prone to corrosion and manufacturing takes a long time. Therefore the metallic component has been replaced by ABS (acrylonitrile butadiene styrene), which is a nonmetallic component having a better corrosion resistance when compared to ductile iron, manufacturing can be done easily and it also reduces the weight of the pump. The prototype model built using Fused Deposition modeling,one of the rapid prototyping technologies exhibits ease of manufacturing submerged pump casing. This technology totally avoids the casting process, time taken to prepare mold, pattern etc. L.A Utracki,F.Nordgren And M.Nyquist [1, 2, 3] reported that the addition of ABS TO PC minimises the drawbacks of ABS such as poor flame, chemical resistance and low thermal stability without affecting its material properties and also generates other usefulcharacteristics such as glossiness and low temperature toughness.Pradeep Kumar Uddandapn [4] conducted impact analysis on car bumper by varying speeds using ABS plastic and carbon reinforced poly ether imide by FEA(solid works). He replaced steel by PEI and ABS plastic and came to a conclusion that ABS plastic is better to be utilized than PEI since it has high impact strength. JagdishShinhare and S.B Jain [5, 6] studied the main objective to introduce ABS plastic substrate in place of RT duroid for microwave filters.Sung-Hoon et al. [7] have characterized the properties of ABS parts fabricated by the FDM 1650, using a Design of Experiment (DOE) approach and measured tensile strengths and compressive strengths of directionally fabricated specimens which are compared within ejection molded FDM ABS P400 material. They have formulated several build rules for designing FDM parts based on experimental results. The cost of ABS plastic was less than that of RT duroid and it was tested. The performance of filters was verified over temperature range of -10 degree Celsius to 60 degree Celsius and he concluded that the performance of ABS plastic microwave filters was superior when compared to that of RT duroid and it was of low cost and light Fixities of Centrifugal Pump Casing weight.

Manuscript published on 30 August 2013.
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II. METHODOLOGY

- 3D modeling of the casing is made and the meshing is carried out using hyper mesh.
- Loading condition and boundary condition are applied.
- Outer constant pressure of2 bar is applied on pump casing.
- By selecting the appropriate material the pressure input for loading in bar is applied i.e. 5 bar and 9 bar.
- Linear static analysis is carried out and the results of ABS are compared with ductile iron results.

Fig.1 Tetra mesh of Submerged Pump Casing

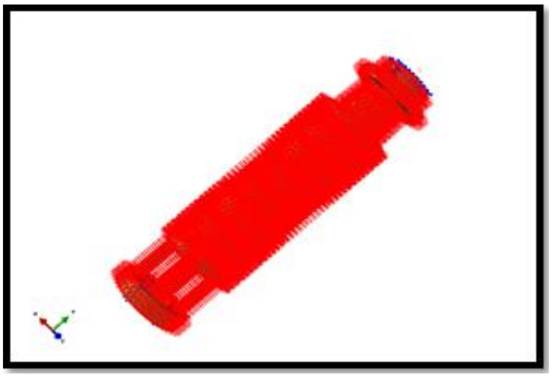

Fig.2 Outer Pressure Application Location of Submerged Pump Casing

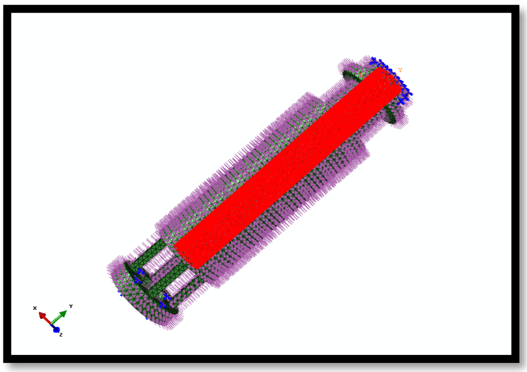

Fig.2 Inner Pressure Application Location of Submerged Pump Casing

Inner Pressure Data for Analysis

S.I NO.	PRESSURE (in bar)
1	5
2	9

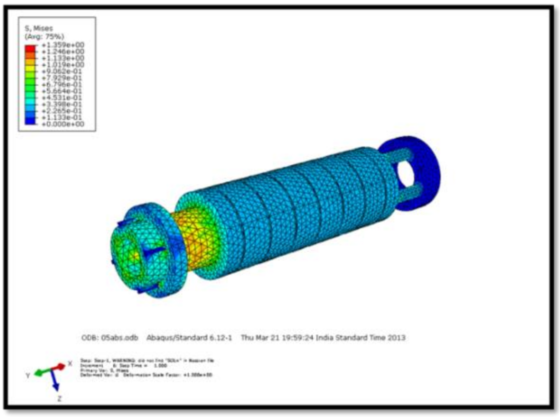

Fig.4 Von-Mises Stress Distribution for 5 bar Pressure on ABS Material

From the figure 4, it is seen that maximum von-mises stresses 1.359N/mm^{2}induced are well below the allowable stresses and, are induced at the inner circumference of the casing i.e. the inner fillet region of the casing.

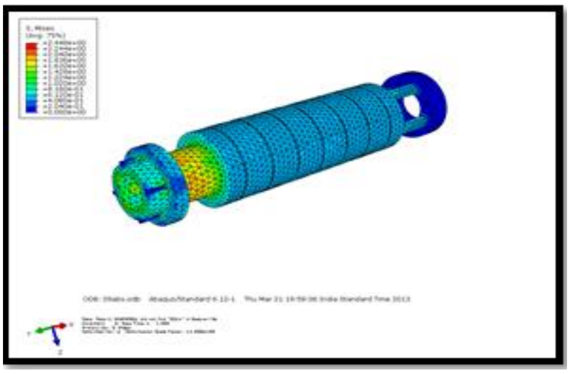

Fig.5 Von-Mises Stress Distribution for 9 bar Pressure on ABS Material

After increasing the inlet fluid pressure from 5 bar to 9 bar, the maximum von-Mises stresses induced is 2.448 N/mm^2 which is below the allowable stress and, the induced stress location is same as that of 5 bar pressure.

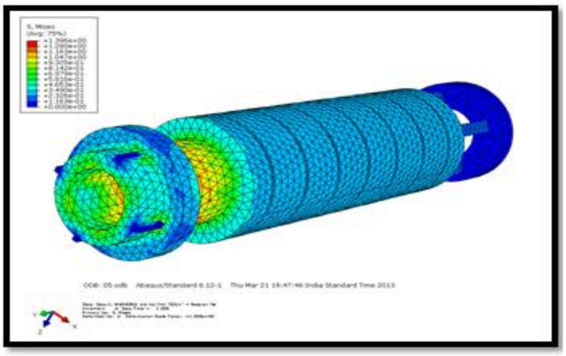

Fig.6 Von-Mises Stress Distribution for 5 bar Pressure on Ductile iron

From the figure 6 maximum von-mises stress 1.396 N/mm^2 induced are well below the allowable stresses and the maximum stresses location is same as for the materials, but the maximum stresses are higher than that compared to ABS materials for the same pressure.

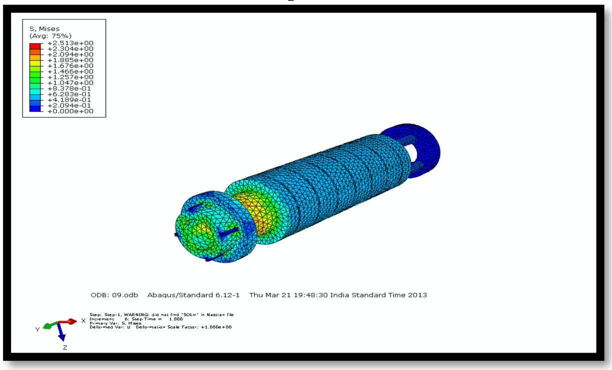

Fig.7 Von-Mises Stress Distribution for 9 bar Pressure on Ductile iron

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After increasing the inlet fluid pressure from 5 bar to 9 bar, the maximum von-Mises stresses induced is 2.513 N/mm² which is below the allowable stress and, the induced stress location is same as that of 4bar pressure. From the figure in section 6 and 7 it is clear that the fluid pressure can be increased further

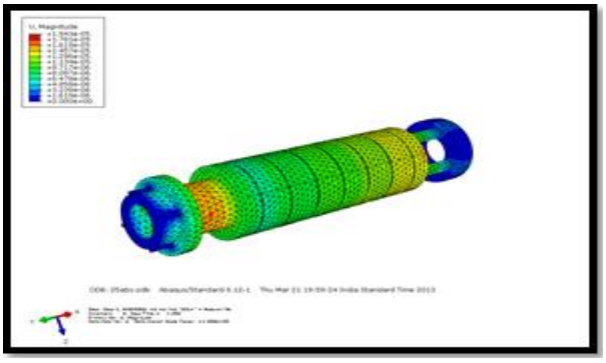

Fig.8 Displacement Distribution for 5 bar Pressure on ABS Material

The maximum nodal displacement found to be 1.943e-5 mm for 5 bar fluid pressure with ABS as the material.

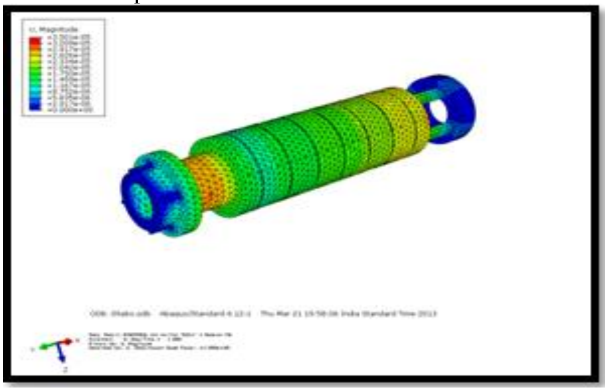

Fig.9 Displacement Distribution for 9 bar Pressure on ABS Material

The maximum nodal displacement found to be 3.501e-5 mm for 9 bar fluid pressure with ABS as the material. From the above figure it is seen that the maximum displacement induced are comparatively higher

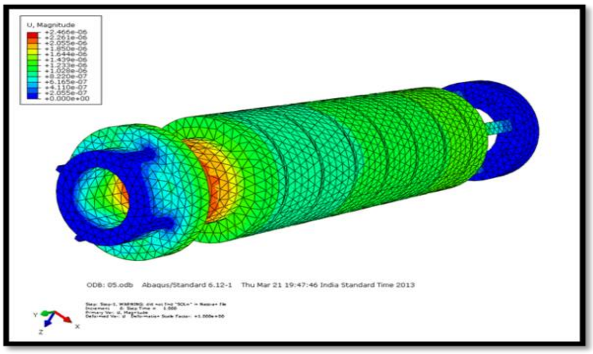

Fig.10 Displacement Distribution for 5 bar Pressure on Ductile iron

The maximum nodal displacement found to be 2.466e-6 mm for 5 bar fluid pressure with ductile iron as the material.

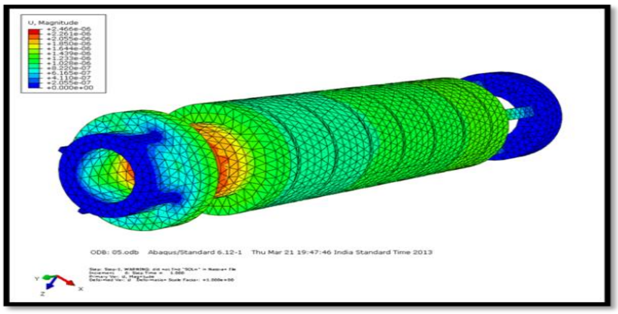

Fig.11 Displacement Distribution for 9 bar Pressure on Ductile iron

The maximum nodal displacement found to be 4.466e-5 mm for 9 bar fluid pressure with ductile iron as the material. Comparing the nodal displacement of ABS and ductile iron material, it is clear that iron is stiffer. Comparing all the load cases, the maximum nodal displacement for both the material is increasing linearly, but the increase in ABS material is higher than iron casing.

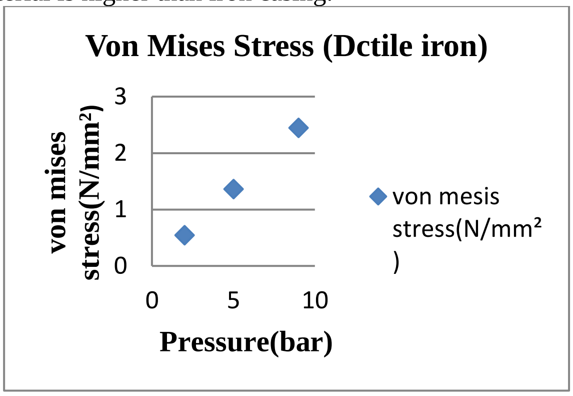

Fig.12 Pressure v/s Stress, for ductile iron material

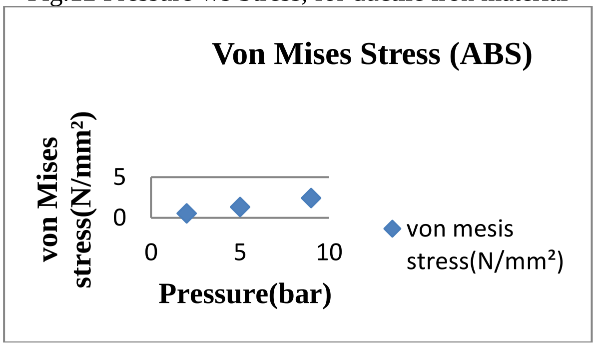

Fig.13 Pressure v/s Stress, for ABS

Hardness Test Results of Ductile iron

Ball dia	10mm
Type of Hardness test	Brinell Hardness test
Applied load	3000 Kg
Avg dia of indentation	5.00mm
BHN	143

Hardness Test Results of ABS Plastic

Type of Hardness test	Shore Durometer Hardness test
Hardness Number	96

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Prototype of the submerged pump casing fabricated using Fused Deposition Modeling (FDM) Process for the scale of 1:16 is show in figure 14

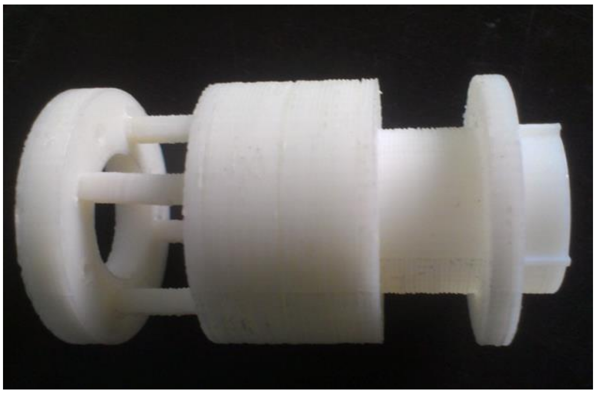

Fig.14. Prototype of ABS Pump Casing by FDM

III. VALIDATION

Pressure load values1.359 N/mm² and 2.448 N/mm² shown in figure 15, are also well below the allowable stresses and the maximum stresses location is same as for the materials, but the maximum stresses are slightly higher than that compared to ABS materials for the same pressure. Obtained FEM results shows that ABS material is the mirror reflection of ductile iron, for different pressure values applied, hence ductile iron can be replaced with ABS material. From the linear static analysis results it can be clearly seen that maximum von-mises stresses induced on ABS are 1.359 N/mm² and 2.448 N/mm² for the applied pressure load values 0.5 N/mm² and 0.9 N/mm² shown in figure 16, are well below the allowable stresses. Von-mises stress 1.396N/mm²and 2.513N/mm²are induced on ductile iron for the

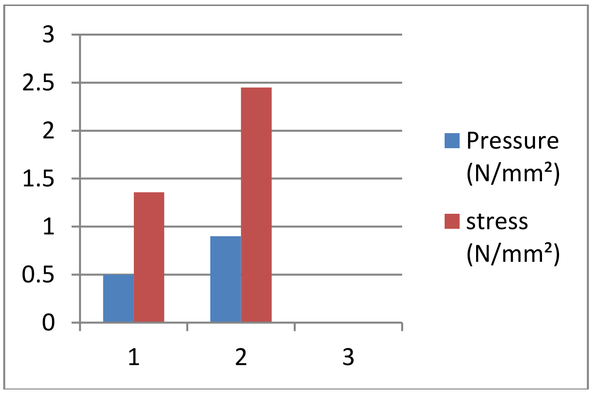

Fig.15 Stress Induced on ABS Material

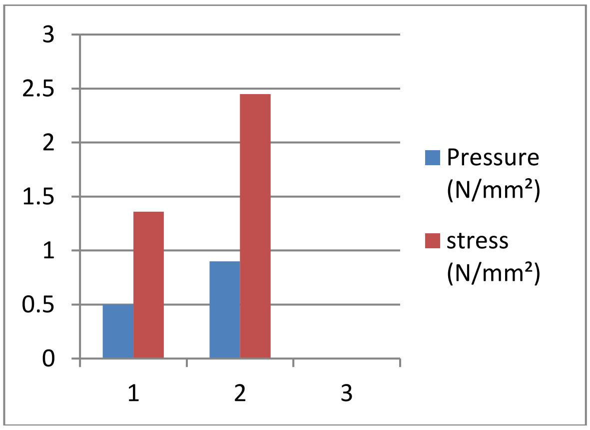

Fig.16 Stress Induced on Ductile Iron

IV. CONCLUSION

A submersible pump is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged inside the fluid. Research work is mainly concentrated on replacement of metallic pump casing with a non-metallic ABS casing, as ABS is corrosion resistance and lighter than ductile iron casing. The geometric modeling of six stage pump is carried out using modeling package CATIA V5 and finite element model of ductile iron and ABS is generated using hyper mesh. ABAQUS V6.12 solver is used to carry out the static analysis for different pressures. Water flow simulation inside the pump casing for ductile steel and ABS material for different pressures is simulated using Solid WorksV11 solver. The prototype model of ABS pump casing is manufactured using FDM technique and tested for physical properties. The obtained hardness values were compared with ductile steel casing and analysis results shows that ABS casing can be used as an alternative material for existing ductile iron pump casing it exhibits good corrosion resistance and have light weight.

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