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CFD Analysis of Centrifugal Pump with Impeller Made of Various Materials

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ABSTRACT: The purpose of this study is to model and simulate CFD in centrifugal pump with different impeller material. Using CFD technique impeller with four different materials are analysed and compared. Aluminium, steel, T300 and glass fibre are the four materials are used for study. T300and glass fibbers are belong to composite fibre (additive manufacturing). From result, data is compared and performance of centrifugal pump with impeller made by additive materials are compared with steel and aluminium. Results shows that composite materials (T300 and Glass fibre give performance as same as steel, so composite material or additive manufacturing for impeller can replace conventional metals like steel and aluminium.

KEYWORDS: Additive manufacturing, Comparison, impeller

I. INTRODUCTION

Centrifugal pump is commonly used engineering invention. It has been widely used in all segment of market like water treatment, food processing, dairy and milk, oil and gas etc. There are different conventional metals are being used for manufacturing of centrifugal pump. Impeller is important part of centrifugal pump. It has been manufactured by different conventional metals like steel, aluminium. Now a days with recent technology many new materials like plastic, fibres are invented and are replacing conventional metals . In this study we are using Carbon fibre (T300) and Nylon 6/10 With 50% Glass fiber. CFD analysis of centrifugal pump is done by using these two composite materials against conventional material like steel and aluminum. Result of CFD analysis for all these four materials is compared.Water is used as a fluid in this study. Performance of composite materials i.e. Carbon fiber T300 and Nylon 6/10 With 50% Glass fiber is checked against steel and aluminum and Conclusion is made.

II. METHODOLOGY

CAD modelling of centrifugal pump will be done using CAD software. CFD analysis of impeller will be done with four types of materials. Carbon fiber T300 and Nylon 6/10 With 50% Glass fiber, steel and aluminium are used for impellers. Water will be used as fluid for CFD analysis. Result for CFD analysis of centrifugal pump with impeller made of each material will be recorded. On the basis of Result obtained from CFD analysis for all four materials. Result will be compared among all four materials of impeller. And conclusion on performance will be made

Properties of materials used in this study

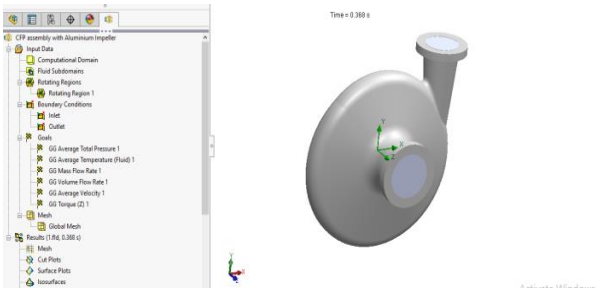
Sr. No.	Material	Young's Modulus E	Poisson's Ratio υ	Density ρ	Yield Stress	Ultimate Tensile Stress
1	SS316L	200 GPa	0.26	8027 kg/m3	170 MPa	485 MPa
2	Aluminium	68.9 GPa	0.33	2700 kg/m3	214 MPa	241 MPa
3	Carbon fibre T300	140 GPa	0.25	1760 Kg/m3	1790 Mpa	1820 MPa
4	Nylon 6/10 With 50% Glass fiber	152 Gpa	0.28	1400 Kg/m3	240 MPa	600 MPa

III. CFD ANALYSIS

In this section a case study is done on centrifugal pump . CAD model of centrifugal pump is prepared and CFD analysis is made with different materials. Following steps are used

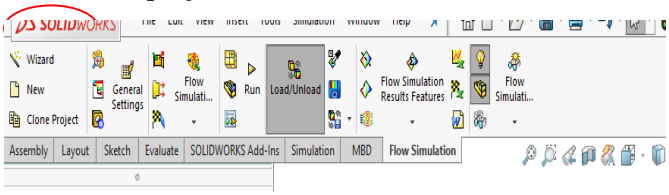
1. Create CAD model

a

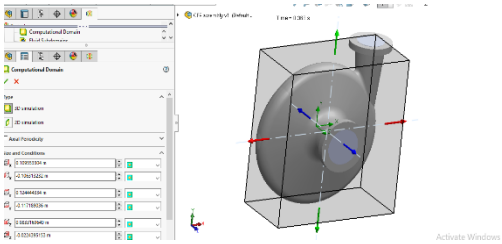


2. Open flow simulation

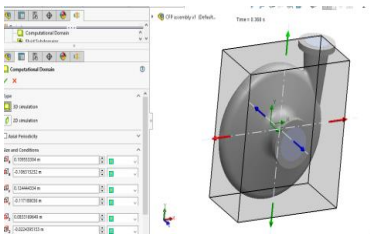
3. Set new project with Wizard



4. Create Lid to open end

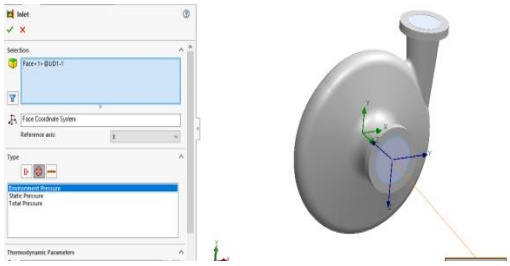


5. Apply boundary to computational domain

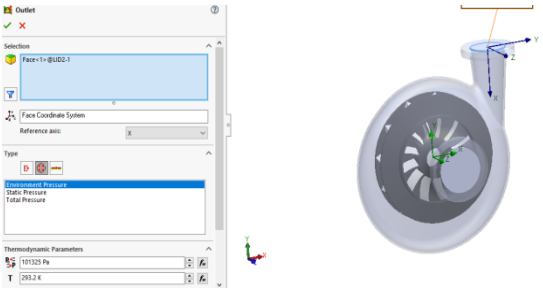


7. Apply boundary condtions

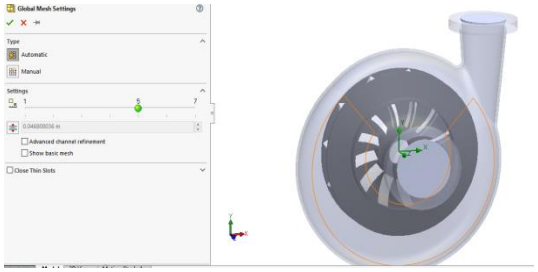
i) Outlet Massflow1



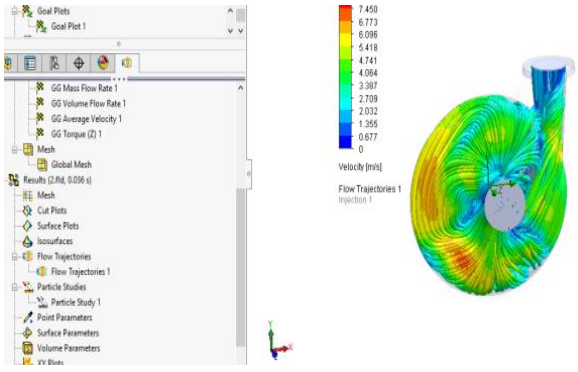
ii) Environmental Pressure1



8. Mesh



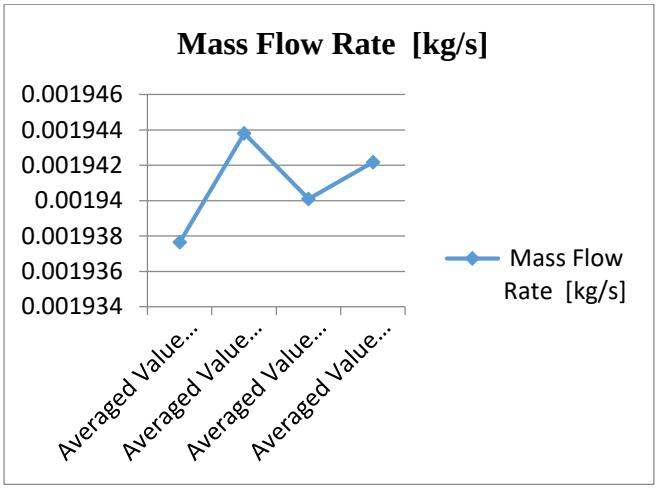
9. Results of CFD Analysis

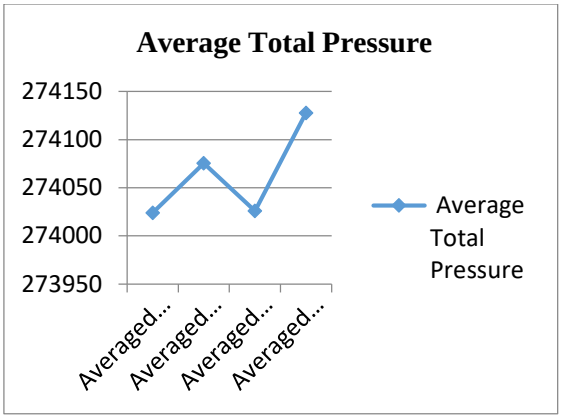


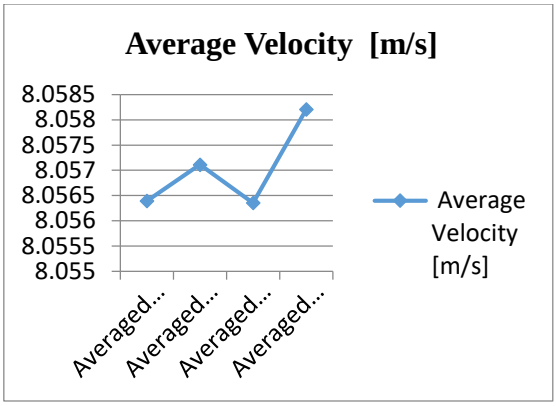
IV. COMPARISON OF PERFORMANCE PARAMETERS OF CFP WITH DIFFERENT MATERIAL

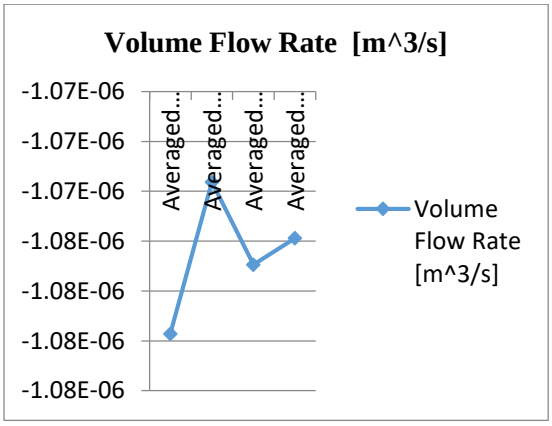
Goal Name	Unit	Averaged Value Aluminum	Averaged Value Steel	Averaged Value T300	Averaged Value Glass fibert
Average Total Pressure 1	[Pa]	274023.8691	274075.5272	274025.9562	274127.7
Average Temperature (Fluid) 1	[K]	294.3750858	294.3751411	294.3750393	294.3751
Mass Flow Rate 1	[kg/s]	0.001937633	0.001943798	0.00194009	0.001942
Volume Flow Rate 1	[m^3/s]	-1.07972E-06	-1.07363E-06	-1.07695E-06	-1.1E-06
Average Velocity 1	[m/s]	8.056391903	8.057110223	8.056353632	8.058207

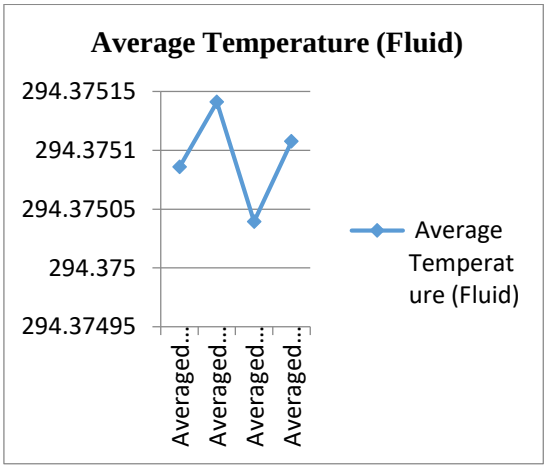
V. GRAPH SHOWING VARIATION IN PARAMETERS WITH DIFFERENT MATERIAL











VI. CONCLUSION

Average Values of mass flow rate, volume flow rate and velocity of T300 fiber and Glass fiber are approximately same with Steel and aluminum.

So from comparison of result from both phase it has been observed that centrifugal Impeller made in additive manufacturing/3d printing technology can replace Conventional metals like Stainless steel and Aluminum.

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