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DESIGN MODELLING AND ANALYSIS OF AIR FLOW COMPRESSOR STRUCTURE

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Abstract

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into potential energy by forcing air into a smaller volume and thus increasing its pressure. The air flow compressor is used mainly in engine of high speed turbine and also that represents new approach of development application and also in this thesis designed air flow compressor and blades depend of literature review and also study the effect changes of materials about the efficiency and the speed. Also in this thesis used four metals have good and proper properties that are tolerance the hard condition. The energy in the compressed air can be stored while the air remains pressurized. The energy can be used for a variety of applications, usually by utilizing the kinetic energy of the air as it is depressurized. The centrifugal air compressor is a dynamic compressor which depends on transfer of energy from a rotating impeller to the air. In this thesis, a centrifugal air compressor is modeled in 3D modeling software Pro/Engineer. The most used material for compressor blades is steel. In this project comparison is made for steel metal and Monel K500, Titanium alloy and Magnesium. And for each metal have different properties. Static analysis is done on the compressor to verify the strength using the four materials

Keywords: Centrifugal air compressor

1. INTRODUCTION

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into kinetic energy by compressing and pressurizing air, which, on command, can be released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or negative-displacement types. The compressor functions to increase the pressure of the air to provide conditions favorable for combustion and expansion of the hot gases through the turbine. At first glance, one may wonder why an engine needs a compressor at all. However, without a compressor, the engine could never develop static thrust. Engines which don't employ compressors (or turbines) are called ramjet engines; these devices must rely on compression of the air from the inlet alone and cannot be started until they reach transonic speeds. For this reason, a compressor-driven engine is useable over a much wider range of conditions. Compressor efficiency is measured in terms of energy losses (due to friction and flow separations) which occur during the air compression process.

2. Literature survey

Dynamic simulation of a centrifugal compressor system Johan Lied man Robert Manson 2013 A compressor system from an oil platform in the Norwegian Sea has been simulated in HYSYS Dynamics TM in order to evaluate a planned reconstruction. The model has been validated with operating data from the current system and then extended to simulate critical events of the new system. The focus of the simulations is on dynamic processes such as start-up and is intended to complement existing steady-state models. The validation proved that the model mimics the real dynamics well with some exceptions, such as temperature profiles. When evaluating the proposed compressor system redesign, it was found that the anti-surge system of second compressor stage performed below expectations. Other benefits of using dynamic simulations in process design are also illustrated Design and Analysis of Stator, Rotor and Blades of the Axial flow Compressor, Ujjawal A. Jaiswal 2013 Axial flow compressor is one of the most important parts of Gas turbine. In design of Axial flow compressor the work presented comprises of basic

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flow parameters and dimensions of parts, this makes the further design process quite simple and the results will be helpful to take further changes or improvement at the time of detailed design. The objective of work presented is to design Axial flow compressor by using mean line method for a given mass flow rate and required pressure ratio. The parameters determined also include thermodynamic properties of the working fluid, stage efficiency, number of rotor and stator blades, tip and hub diameters, blade dimensions (chord, length and space) for both rotor and stator, Mach number, flow and blade angles (blade twist) .The same parameters are also determined for all five stages. The twist of the blades can be calculated along the blade length at any required number of sections selected by the designers to obtain smooth blade twist profile. NACA 65410 profiles is used to generate coordinates of the blade. Further, in the process the first stage of axial flow compressor blade is developed using Solid works modeling. Also CFD simulation has been carried out using Ansys CFX to validate the results. Also Static structural Analysis has been performed to check whether the rotor is safe at given speed.

3. MODEL PREPARATION

The system uses a 3D solid modeling system as the system uses a 3D solid modeling system as the core, and applies the feature-based, parametric modeling method. Pro/ENGINEER was the first CAD system entirely based upon feature-based design and parametric modeling. Today most software producers have recognized the advantage of this approach and shifted their product onto this platform. Nevertheless, the differences between a feature-based, parametric solid modeling CAD system and a conventional CAD system include

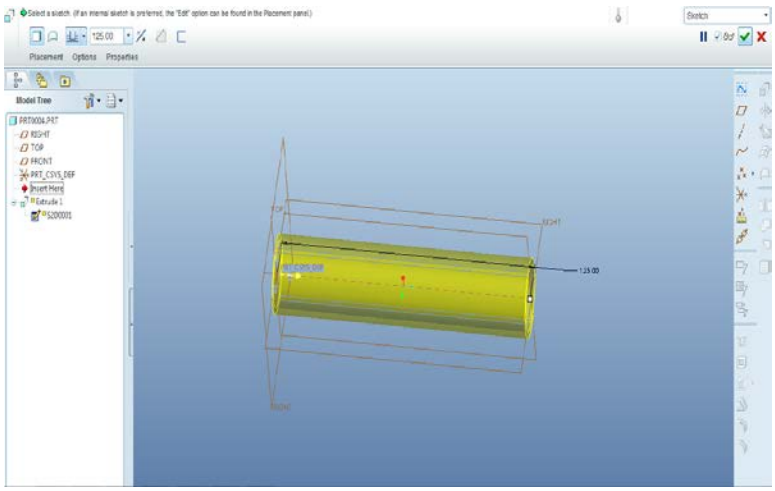

Figure 1: 3D model of centrifugal compressor Extrude to create shaft

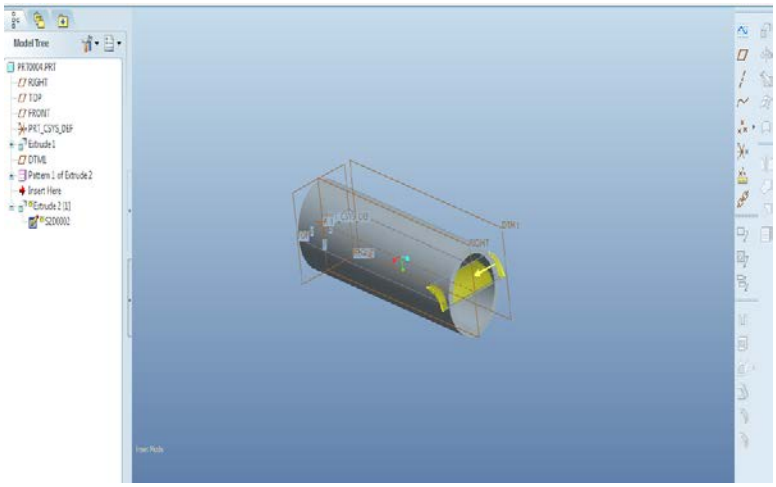

Figure 2: Extrude to create impeller blade

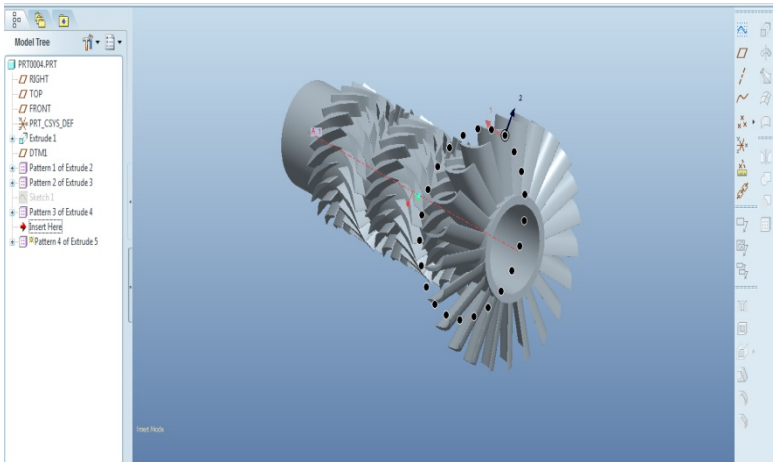

Figure 3: Pattern of impeller blades

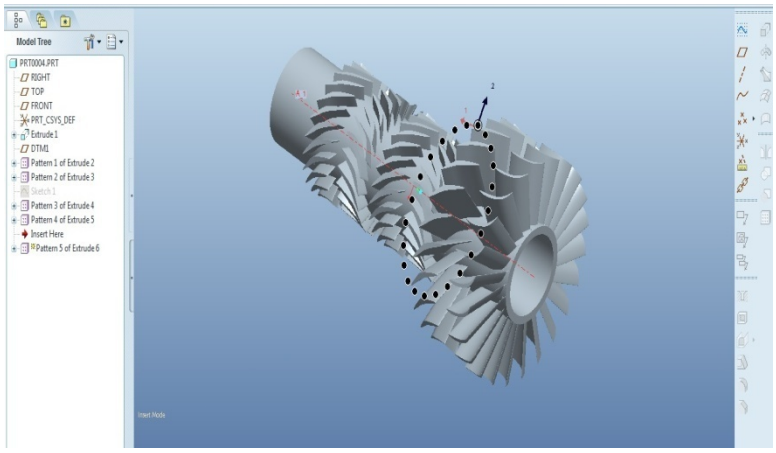

Figure 4: Final Model of Compressor

4.0 FINITE ELEMENT ANALYSIS

ANSYS is a general purpose software, used to simulate interactions of all disciplines of physics, structural, vibration, fluid dynamics, heat transfer and electromagnetic for Engineers. So ANSYS, which enables to simulate tests or working conditions, enables to test in virtual environment before manufacturing prototypes of products. Furthermore, determining and improving weak points, computing life and foreseeing probable problems are possible by 3D simulations in virtual environment.

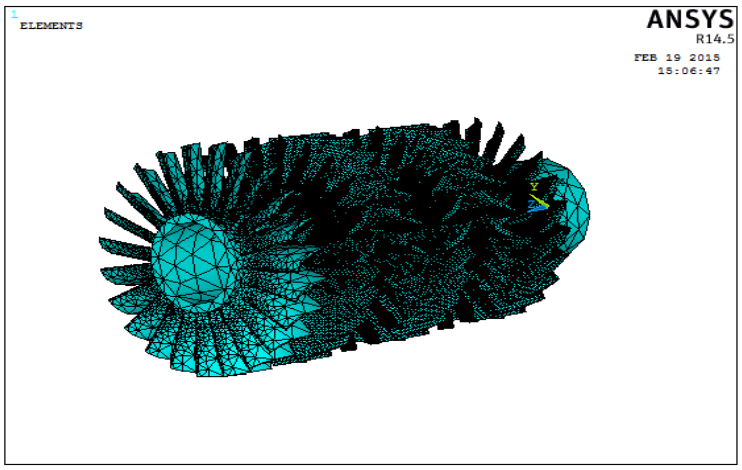

Figure 5: Meshed of model Centrifugal compressor (material – aisi – 4340)

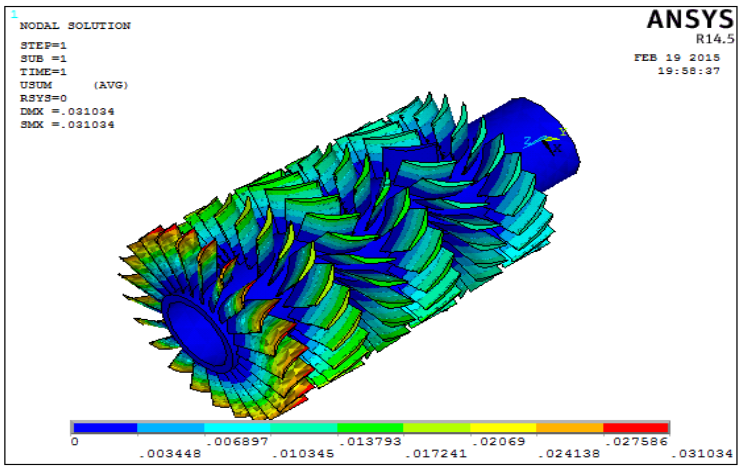

Figure 6: Displacement of Centrifugal compressors (material – aisi – 4340)

Young's Modulus (EX) : 192000Mpa
Poisson Ratio (PRXY): 0.29
Density : 0.00000785 kg/mm^3

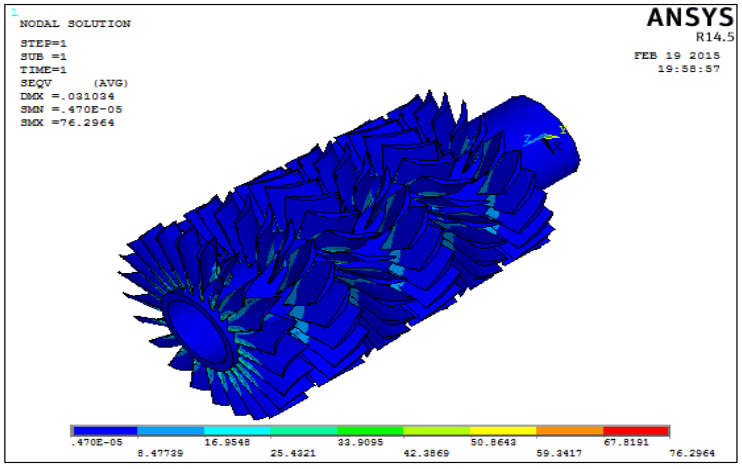

Figure 7: Stress of Centrifugal compressors (material – aisi – 4340)

	Displacement (mm)	Stress (N/mm^2)	Strain
AISI-4340	0.031034	76.29	0.372E-03
MONEL-K 500	0.35377	76.4231	0.425E-03
TITANIUM ALLOY	0.57473	75.4451	0.686E-03
MAGNESIUM	0.143017	74.7714	0.001699

RESULTS AND DISCUSSION

In this thesis, a centrifugal air compressor is modeled in 3D modeling software Pro/Engineer and done the analytical by using static structure ansys The most used material for compressor blades is steel. In this project comparison is made for Monel K500, Titanium alloy and Magnesium. Static analysis is done on the compressor to verify the strength using the four materials Static analysis is done in Ansys. When made compared between that four materials and getting the result for each metal the values of displacement, stress and strain .the values of the k-Monel 500 is the better than of others material and is metal have best condition and tolerance the hard condition By

observing the static analysis results, the stress values are less than their yield strength values of every material. The strength is more for Monel K – 500, which is a nickel alloy. So using Monel K-500 is better than other materials. But the main disadvantage is its weight. And also the result of ansys show that the titanium alloy is good since the density of that is less that of Monel K - 500

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