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Volume 08, Issue 11, Pages: 19–26.

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A STUDY AND VIBRATION ANALYSIS OF ROTOR COMPRESSOR USING DIFFERENT MATERIALS

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ABSTRACT:

In this paper, dynamics of rotor systems are studied in a large centrifugal compressor. The rolling piston and the contacted rotor-journal bearing system are basically moving components. Because of the inertia forces and the periodically changing gas force acting on the rolling piston and the rotor, the journal bearing suffers very large loads. It always leads to serious vibration of the rotor-journal bearing system, and the wear of the rotor. In a rotor flow compressor, air passes from one stage to the next, each stage rising the slightly. The energy level of air or gas flowing through it is increased by the action of the rotor blades which exert a torque on the fluid which is supplied by an electric motor or a steam or a gas turbine. In this thesis, rotor flow compressor is designed and modeled in 3D modeling software CATIA and Ansys 15.0 The present design has 30 blades, in this thesis it is replaced with 29 blades and to find the shear stresses, deformation of a compressor and a failure analysis through single blade. A single blade analysis is done for failure conditions. The present used material is Aluminum and magnesium alloy. Static Structural analysis is done on the compressor models to verify the strength of the compressor.

Keywords: Modal analysis, Vibration Analysis, Ansys.

1. INTRODUCTION:

The twin screw air compressor is a positive displacement compressor and has been widely used in gas industries. One of the major advantages of the twin screw compressor is its flexibility under various operation conditions. It utilizes the continual variations of the space formed between rotor grooves and case of the compressor. In this project, the finite element method (FEM) is used for computing the deformation of rotors of twin screw compressor. The male and female rotors are mapped to 3D elements. Finite element method, it is well known numerical method used to solve multi physics problem were governing differential equations are available. FEM consists of discretization process. In this the infinite degree of freedom is converted into finite degree of freedom for solving multi physics problems in an approach that solution can be obtained with minimum error. This method is widely used and is easy for solving the problems whose analytical solution is difficult to obtain such as of complex geometry, load and boundary condition.The modeling method for

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analyzing the rotor deformation of twin screw compressor by using the CAE method instead of CFD method with considering the working temperature and gaseous pressure as well as the contact force between two screw rotors. The thermal-structural coupling method is applied to analyze the rotor deformations and loads as there are many changes on operating clearance due to thermal loadings.

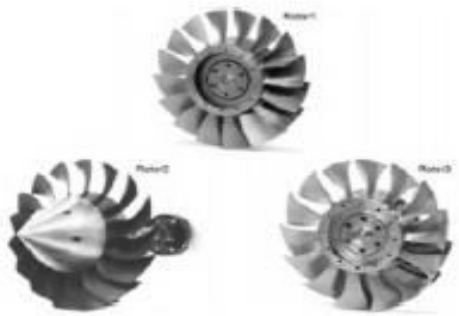

Fig.1.1. Transonic Compressor Test Rotors.

2. RELATED STUDY:

Single and twofold passage compressors are the impellers having bigger distance across inside the compressor where the most present day GTE's are utilized for making their coveted method for the into the valve and can be effortlessly expected that the motor breadth Because and seals the air must enter the motor at right points to the motor pivot, a plenum chamber is required Axial-Flow Compressors for double section compressors. The air must encompass the compressor at a positive weight and the motivation behind the hub compressor is the before entering the compressor to guarantee a same incentive as of the radiating compressor. In a radial com-press or the complex has one outlet port for each combustion chamber. The outlet ports are bolt end to an outlet elbow on the complex. The outlet ports guarantee that the same amount of air is conveyed to each combustion chamber. Every outlet port elbow contains from two to four swinging vanes to change the air flow from spiral to pivotal stream and to diminish air pressure misfortunes by showing a smooth turning surface. The impeller is typically produced using a forged aluminum amalgam that is warm treated, machined, and smoothed for least stream confinement and turbulence. A few sorts of impellers are made from a solitary fashioning, while in different sorts the inducer vanes are separate pieces that are welded in place. As the liquid enters and leaves in the inside point heading, the transmitting part in the centrality condition does not end up being possibly the most basic factor. Here the weight is absolutely in light of diffusing development of the regions. The diffusing activity in stator changes over exceptional dynamic pioneer of the liquid into ascends in weight. The relative motor head in the noteworthiness condition is a term that exists only because of the turn of the rotor. The rotor diminishes the relative dynamic pioneer of the liquid and adds it to unmistakably the dynamic pioneer of the liquid i.e., the effect of the rotor on the liquid particles builds its speed (transcendent) and thusly reduces the relative speed between the liquid and the rotor. Fundamentally, the rotor builds the total speed of the liquid and the stator changes over this into weight rise. Laying out the rotor entry with a diffusing limit can influence a weight to move in spite of its common working. This produces more detectable weight rise per sort out which

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constitutes a stator and a rotor together. This is the response oversee in turbo machines. In the event that half of the weight ascend in a phase is gotten at the rotor area, it is said to have a half response. Significant stream compressors are for the most part utilized at applications with low differential weight (head) prerequisites and high stream rates. A normal critical compressor includes a drum, to which sharp edges of particular geometry are joined. Normal employments of tremendous size center point compressors are those used to pack the air confirmation of gas turbines.

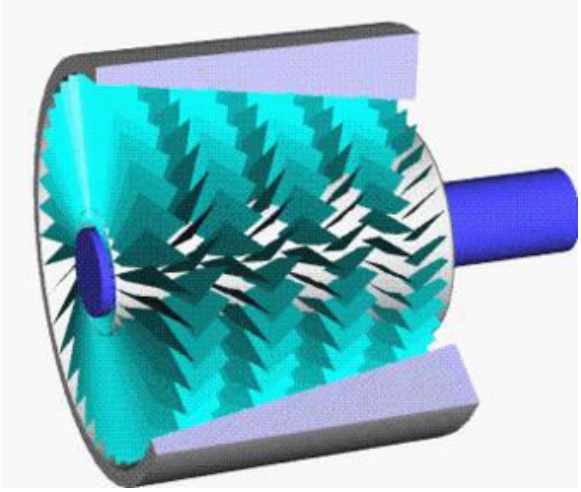

Fig.2.1. simulation of rotary compressor.

3. DESIGN METHODOLOGY:

Essential strides associated with the venture

1. Design of hub stream compressor is finished by utilizing CATIA V5 R20
2. The plan process goes ahead with regarded measurements.
3. The investigation gets completed by utilizing an ANSYS variant 15.0
4. The Ansys is finished by using materials
5. .Analysis of the section static, assistant and shear strain ,shear extend

The geometry gave for the compressor a stream in center point bearing and the compressor design at a geometric balanced for the most outrageous efficiency at a layout point. The dynamic consistency μ, thickness ρ and velocities of sound a1, a2 rely upon the physical and thermodynamic properties of the gas.

• Losses. The stator and rotor misfortunes from all sources (profile drag, tip freedom misfortune, and so forth.) are lumped into stagnation weight misfortunes Δpos andδpor

By applying Buckingham's π-hypothesis and applying dimensional investigation, might be rearranged to the accompanying dimensional frame:

$$\eta_{tt} = f(\phi,\psi,R,w_1/u,c_2/u,M_1,M_2,R_{em},\zeta_r,\zeta_s)$$

Where M1 and M2 are the rotor and stator exit Mach numbers that are defined as

$$M_1 = W_1/a_1$$

$$M_2 = W_2/a_2$$

4. STATIC STRUCTURAL ANALYSIS WITHALUMINIUM:

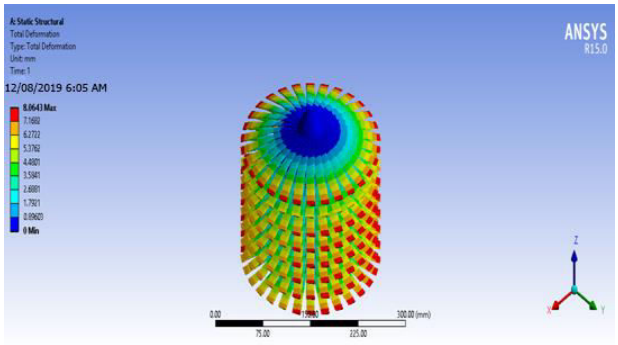

Figure 4.1 staticstructural total deformation

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Details of "Total Deformation"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Total Deformation
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Results	
Minimum	0. mm
Maximum	8.0643 mm
Minimum Value Over Time	
Minimum	0. mm
Maximum	0. mm

Figure 4.2 total deformation of all bodies

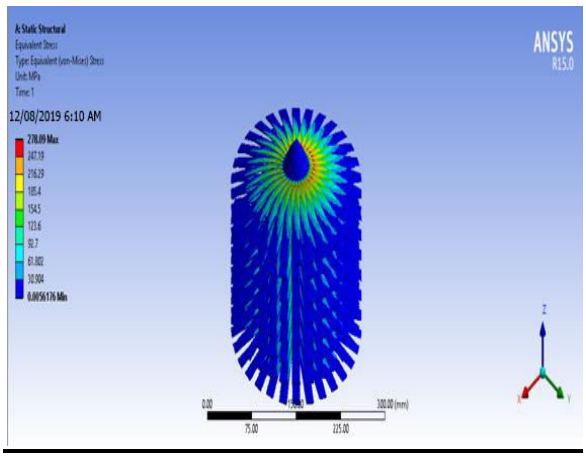

Figure 4.3 Static structural equivelent stress

Details of "Equivalent Stress"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Equivalent (von-Mises) Stress
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	5.6176e-003 MPa
Maximum	278.09 MPa

Figure 4.4 equivalent stress

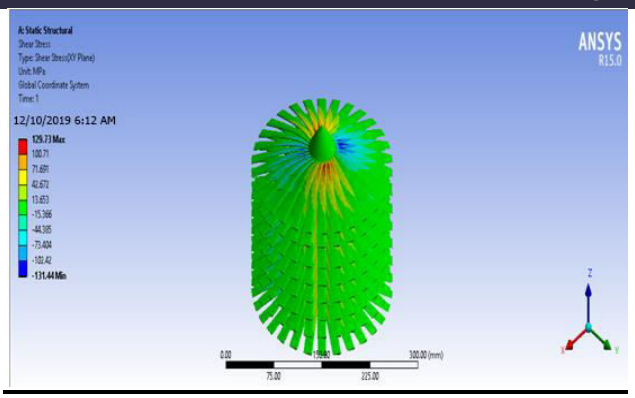

Figure 4.5 Static structural shear stress

Details of "Shear Stress"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Shear Stress
Orientation	XY Plane
By	Time
Display Time	Last
Coordinate System	Global Coordinate System
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	

Figure 4.6 details of shear stress

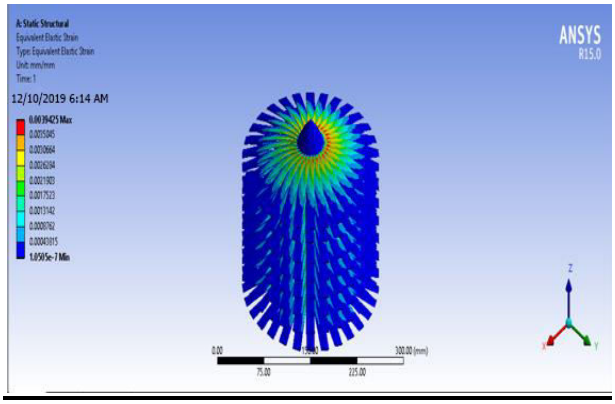

Figure 4.7 Staic structural equivalent elastic strain

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Details of "Equivalent Elastic Strain"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Equivalent Elastic Strain
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	1.0505e-007 mm/mm
Maximum	3.9425e-003 mm/mm

Figure 4.8 shows that equivalent elastic strain.

STATIC STRUCTURAL ANALYSIS OF TITANIUM:

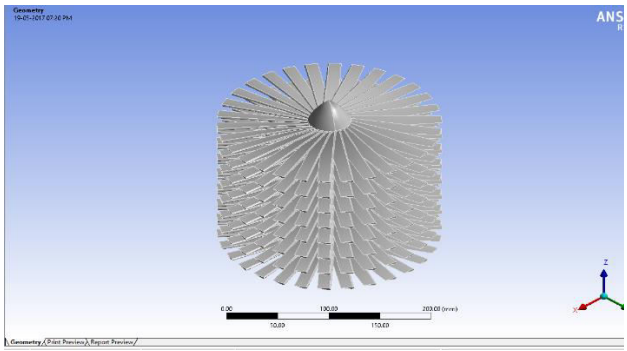

Figure 4.9Geometric model

Details of "Geometry"	
Definition	
Source	C:\Users\Prasanth\AppData\Local\Temp\WB_DESKT...
Type	DesignModeler
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Properties	
Statistics	
Basic Geometry Options	
Advanced Geometry Options	

Figure 4.10 Details of geometry

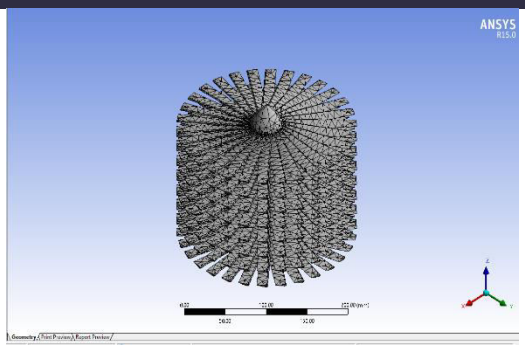

Figure 4.11 Meshed model

Details of "Mesh"	
Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Inflation	
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	Yes
Advanced	
Defeaturing	
Statistics	

Figure 4.12 Meshed details

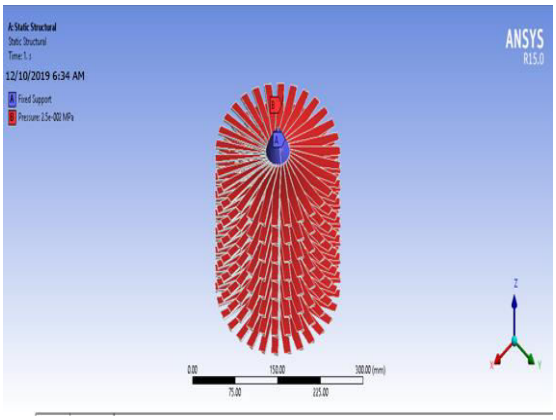

Figure 4.13 static structural model

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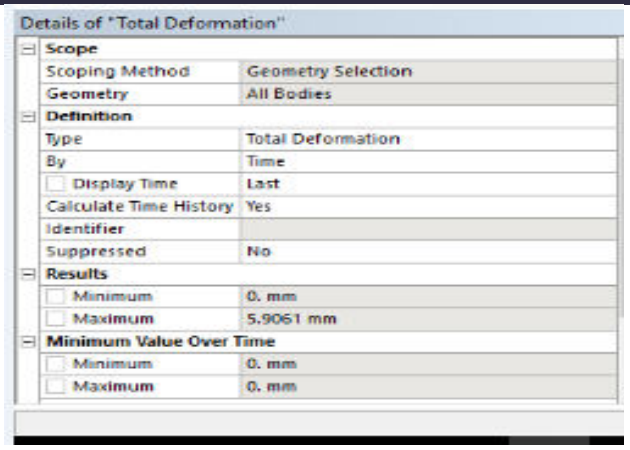

Figure 4.14 Total deformation

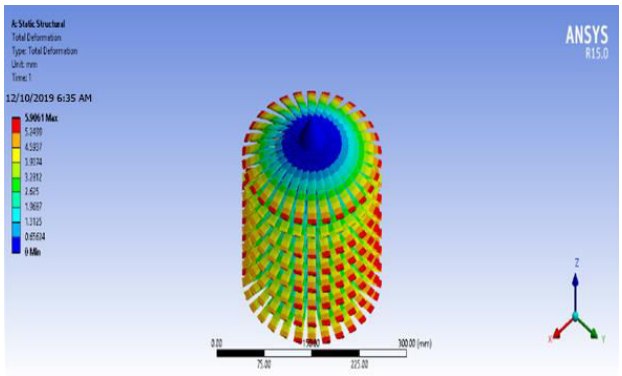

Figure 4.15 Static structural load deformation

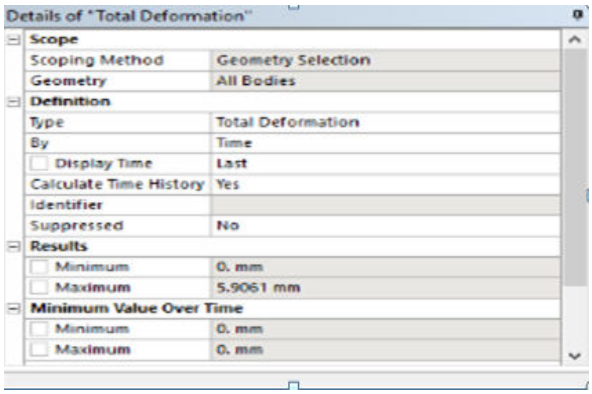

Figure 4.16 Total deformation values

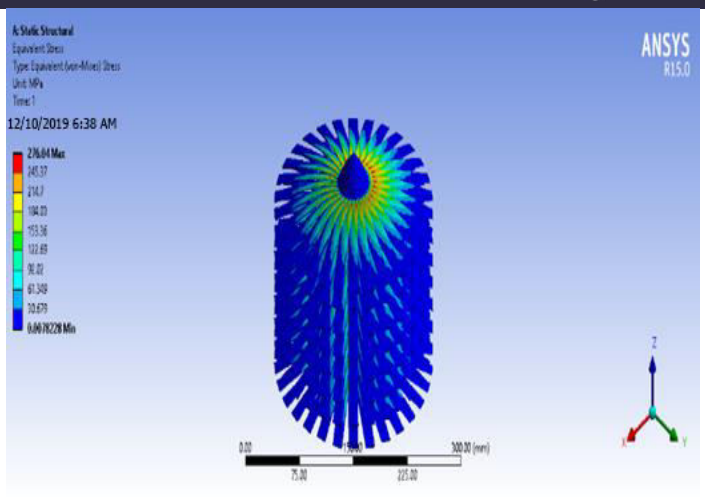

Figure 4.16Static structural equivalent load

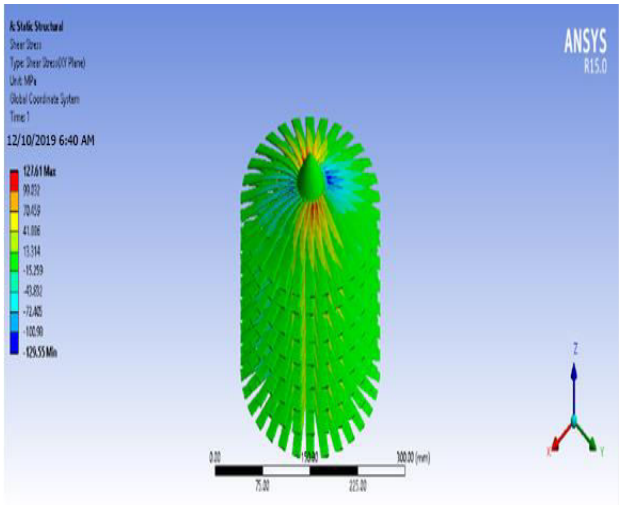

Figure 4.17 static structural Shear stress

5. CONCLUSION:

The investigation of the venture is planned and demonstrated in 3D displaying programming the present outline has 30 cutting edges, the examination design of the question it is supplanted with 20 sharp edges and 19 edges (assuming that there is a bird hit or any other reason where there is a failure of one blade). The present utilized material is Chromium Steel, it is supplanted with Aluminum Titanium compound are

high quality materials than recolor less Steel. So utilizing Titanium compound for compressor cutting edge diminishes the quality of the compressor Structural investigation is done on the compressor models to check quality of the compressor to confirm the quality of the compressor. The anxiety esteems for not as much as the particular yield push esteems for Titanium combination magnesium The anxiety esteem is less for titanium composite than Nickel amalgam, so utilizing titanium better. By utilization of 19 cutting edges push utilizing 19 sharp edges the burdens are expanding, yet are inside the cutoff points. Static basic investigation is done to confirm the stream of air. The outlet speed is expanding for 19 sharp edges, weight is more for 30 cutting edges and mass stream rate is more for 19 edges. So it inferred that utilizing Titanium compound and 19 cutting edges is better for compressor sharp edge. With accessible information Mass stream rate,Pressure proportion and Pressure at given Altitude. The Blade profile has been produced two rotors and stator logically. The other plausibility of stream partition is likewise checked with Machnumber and Pressure co productive. The computation spread sheet is made so by input the valuesone can get the expected parameters to create the edge arranges. While looking at hypothetical outline comes about with analytical comes about, it is watched that the static auxiliary examination result shares in understanding inside satisfactory scope of hypothetical outcomes.

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