

A STEADY STATE ANALYSIS ON AXIAL FLOW COMPRESSOR SUBJECTED TO STRESSES AND DEFORMATION

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ABSTRACT

Axial flow compressor in which helps in passing a high compressor air and is which can be alternate the air. In a pivotal stream compressor, air goes starting with one phase then onto the next, each stage rising the somewhat. The vitality level of air or gas coursing through it is expanded by the activity of the rotor sharp edges which apply a torque on the liquid which is provided by an electric engine or a steam or a gas turbine. In this postulation, a hub stream compressor is outlined and displayed in 3D demonstrating programming CATIA and Ansys 15.0 The present plan has 30 cutting edges, in this theory it is supplanted with 29 sharp edges and to discover the shear stresses, disfigurement of a compressor and a disappointment investigation through single edge. A solitary cutting edge investigation is improved the situation disappointment conditions. The present utilized material is Aluminum and magnesium combination. Static Structural investigation is done on the compressor models to confirm the quality of the compressor.

Keywords: Axial Flow compressor, Ansys, CATIA.

INTRODUCTION

A hub stream (axial flow) compressor is one of the mechanical gadgets it is proceeds pressurize the gasses the gadget turning in utilized air and oil based. The compressor takes a shot at the standard of the liquid in directional stream and parallel to the hub of revolution. The distinction of turning compressors, for example, diffusive compressors, pivotal outward compressors are blended for a stream where the liquid stream will incorporate a "spiral segment" through the compressor. Transonic pivotal stream compressors are today generally

utilized as a part of air ship motors to get most extreme weight proportions per single-organize. High stage weight proportions are critical on the grounds that they make it conceivable to diminish the motor weight and measure and, in this manner, speculation and operational expenses.

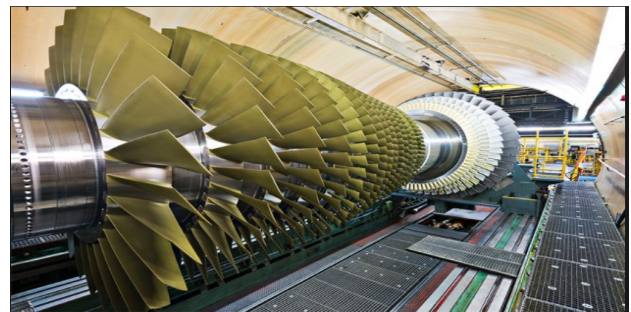


Fig 1.1 Transonic lpc (left) and hpc (right) Eurofighter typhoon engine EJ200 Three-dimensional shape blades

2. LITARATURE REVIEW

[1] J H Horlock (1958), displayed the two dimensional or pitch line plan investigation of compressor falls. Thermodynamic stage plan relations and liquid stream relations including free and constrained vortex streams, spiral xxvii harmony conditions and so forth were exhibited in view of a few test systems. These connections are extremely helpful in deciding the critical stage execution measuring parameters like stage proficiency. S Lieblien (1958), led misfortune and slow down condition examination in hub stream compressor falls

to decide different misfortune coefficients, for example, profile misfortune, skin contact misfortune, end divider misfortune and so on. Quantitative estimations to decide the size of misfortunes were done.

[2] S Lieblen (1960), completed the investigation of low speed air compressor with customary cutting edges to decide the liquid stream attributes as far as rate and deviation plots for least misfortune. Course hypothesis of compressors and cutting edge streamlined relations were used to bring knowledge into the conduct of liquid at various occurrence and deviation edges. Lakshmi narayana and J H Horlock (1963), built up the articulation for stream model to decide the freedom between the tip of the sharp edges and compressor packaging divider amid a blocked stream condition. The model predicts the abatement in organize productivity because of tip leeway impact.

[4] MC Kenzie AB (1980) The Semi observational relations and connections for pivotal stream compressor cutting edges, in view of the tests directed on a low speed hub stream compressor. execution was observed to be a component of three fundamental parameters, i.e.; the development proportion, particular speed and a measurement less parameter which represents real turbine measurements. C Koch (1981), introduced a building way to deal with the issue of anticipating greatest weight rise capacity (or) foreseeing the most extreme estimation of slow down edge coefficient. A semi-observational model was created in view of the tests directed on a low speed pivotal stream compressor.

[7] Cohen, GFC Roger et al (2001) they talked about the hub stream compressor qualities, factors influencing execution, organize plan relations, mean line and off-

outline estimations. A strategy for arrange shrewd outline of pivotal stream compressor was introduced. T W Song, T Skim et al (2001), proposed another technique for foreseeing the execution of multi arrange pivotal stream compressors. The proposed strategy used the stage execution bends of pivotal stream compressor. Dissimilar to the customary stage stacking strategy it utilized a reliable useful definition technique for administering conditions to ascertain all the while all the entomb organize factors like temperature, weight and stream speed of working liquid. Introduced a novel bifurcation based slow down/surge controller. The controller balances out the pivotal stream compressor for safe operation at crest weight focuses. The controller keeps the pivotal stream compressor from unexpectedly entering the turning slow down zone. The controller keeps up framework dependability even under substantial irritations.

[8] Tomita JT and Barbosa JR (2004)

They completed the outline and investigation of a hub stream compressor which can be used for MW gas turbine applications. The compressor organize execution was broke down in view of xxxiii mean line stream properties. Stage stacking was utilized to examine the various phases of the compressor. built up another outline framework for the sharp edge areas utilized for mechanical compressors. The outline framework presented new controlled dissemination air foils for wide surge range and high volume prerequisites. The plan technique joins the parametric geometry definition strategy, cutting edge to sharp edge stream solver and another reproducer hereditary calculation. The framework was tried on the center phases of a mechanical hub stream compressor introduced a novel technique for determination of sharp edge material for pivotal stream compressors. The

strategy depends on the outward anxieties created at the foundation of the cutting edge in the primary phase of the compressor. Cutting edge tip speed, rotational speed, edge stature and edge material were observed to be the most vital parameters that decide the size of stresses created inside the sharp edges.

3. METHODOLOGY

3.1 DESIGN OPTIMIZATION OF AXIAL FLOW COMPRESSOR:

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 examination gets completed by utilizing an ANSYS form 15.0
4. The Ansys is done by utilizing materials
5. Analysis of the segment static, basic and shear strain ,shear stretch

The geometry provided for the compressor with a stream pivotal way and the compressor outline at a geometric adjusted for the most extreme proficiency at a plan point. By applying the examination having a measurement for a solitary stage and making the suspicions, for example,

1. Steady hub speed C_x
2. Steady mean range $r_m = 1/2(r_h + r_t)$.
3. Indistinguishable speed vectors C_1 and C_3 at passage to and exit from the phase at the mean range r_m . The proficiency η of this stage is needy upon the accompanying factors.

The factors having a thermodynamic staganation with an enthalpy ascend to

locate the more noteworthy stage models of connotes organize stacking to indicate the enthalpy of h_1, h_2, h_3 which are demonstrated to exchange the vitality through the stages.

- Speed measure
- Velocity triangles
- Speed and size both are autonomous factors.
- Properties of working substances

By applying Buckingham's π -hypothesis and applying dimensional examination, might be improved to the accompanying dimensional shape:

$$\eta_{it} = f\left(\phi, \psi, R, \frac{W_1}{U}, \frac{C_2}{U}, M_1, M_2, Re_m, \zeta_R, \zeta_s\right)$$

Where M_1 and M_2 are the rotor and stator exit Mach numbers that are defined as

$$\left. \begin{aligned} M_1 &= \frac{W_1}{a_1} \\ M_2 &= \frac{C_2}{a_2} \end{aligned} \right\}$$

Re_m is the stage Reynolds number based on mean radius

$$Re_m = \frac{U r_m}{\nu}$$

$$\left. \begin{aligned} \zeta_R &= \frac{\Delta P_{oR}}{\frac{1}{2} \rho W_1^2} \\ \zeta_s &= \frac{\Delta P_{os}}{\frac{1}{2} \rho C_2^2} \end{aligned} \right\}$$

ϕ, ψ are the flow and work coefficients defined as

$$\left. \begin{aligned} \phi &= \frac{C_x}{U} \\ \psi &= \frac{\Delta h_o}{U} \end{aligned} \right\}$$

3.2. DEPENDENT DESIGN VARIABLES:

$$\zeta_R = f_1(\phi, \psi, R, Re_R, M_1)$$

$$\zeta_s = f_2(\phi, \psi, R, Re_s, M_2)$$

Where, the blade row Reynolds numbers Re_R and Re_s are based on rotor and stator blade chords l_R and l_s .

$$Re_R = \frac{W_1 l_R}{\nu}$$

$$Re_s = \frac{C_2 l_s}{\nu}$$

$$\eta_{tt} = f(\phi, \psi, R, \zeta_R, \zeta_s)$$

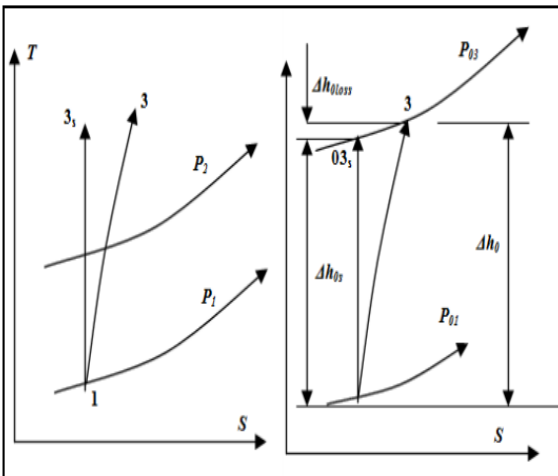


Fig 3.1 T-S and h0-S diagrams for an axial-compressor stage.

$$(\Delta h_0)_{loss} = h_{03} - h_{03s}$$

$$\Delta h_0 = h_{03} - h_{01}$$

From the conventional definition of η_{tt} = stagnation enthalpy rise for an ideal stage/stagnation enthalpy rise for the actual stage

$$\eta_{tt} = \frac{h_{03s} - h_{01}}{h_{03} - h_{01}} = 1 - \frac{(\Delta h_0)_{loss}}{\Delta h_0} = 1 - \frac{(\Delta p_0)_{loss}}{\rho \Delta h_0} = 1 - \frac{1}{\psi} \left(\frac{(\Delta p_0)_{loss}}{\rho U^2} \right)$$

$$\eta_{tt} = 1 - \frac{1}{2\psi} \left(\phi^2 + \frac{1}{4}(1+\psi)^2 \right) (\zeta_R + \zeta_s)$$

DESIGN OF AXIAL FLOW COMPRESSOR USING CATIA:

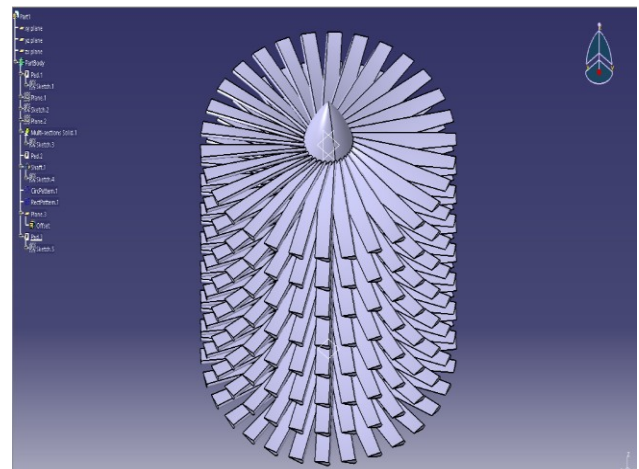


Figure 3.1 blade design axial flow compressor.

RESULTS

4.1 -BLADES ANALYSIS: - ALUMINUM:

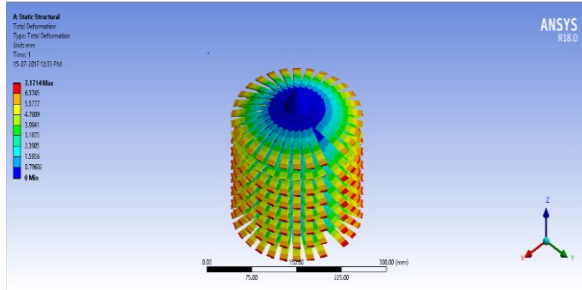


FIGURE 4.1 TOTAL DEFORMATIONS OF 29-BLADES OF ALUMINUM

4.2 - BLADE ANALYSIS WITH: MAGNESIUM

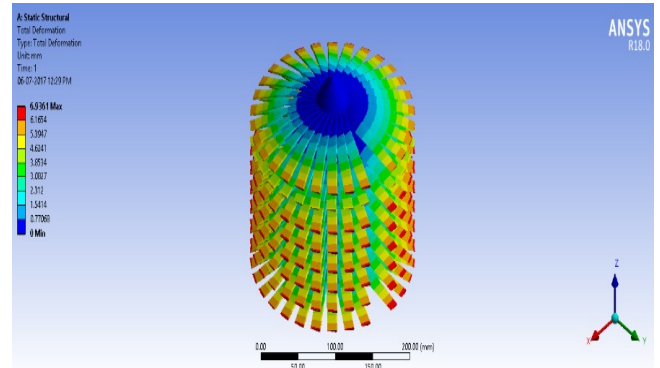
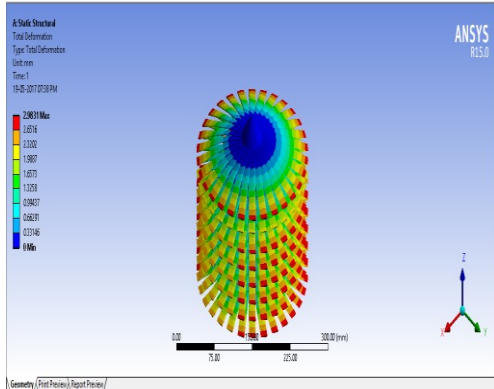


FIGURE 4.2 TOTAL DEFORMATION OF 29-BLADES OF MAGNESIUM

Details of total deformation	
Scope	
Scoping method	Geometry selection
Geometry	All bodies
Definition	
Type	Total deformation
By	Time
Display time	Last
Calculated time history	Yes
Identifier	
Suppressed	No
Results	
Minimum	0.mm
Maximum	7.1714mm
Minimum occurs on	Part 1
Maximum occurs on	Part 1

Details of total deformation	
Scope	
Scoping method	Geometry selection
Geometry	All bodies
Definition	
Type	Total deformation
By	Time
Display time	Last
Calculated time history	Yes
Identifier	
Suppressed	No
Results	
Minimum	0.mm
Maximum	6.9361 mm
Minimum occurs on	Part 1
Maximum occurs on	Part 1

4.3 Blade ANALYSIS USING ALUMINUM:

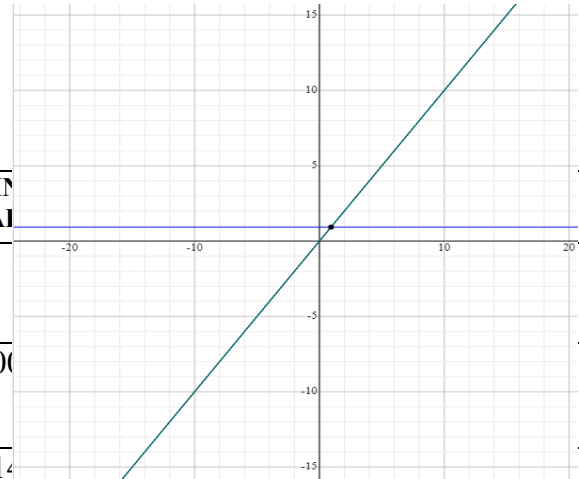


$$y = \cos(75.006) + \sin(41.983)$$

$$y = \cos\left(\left(\frac{37503}{500}\right)^\circ\right) + \sin\left(\left(\frac{247180}{1059}\right)^\circ\right)$$

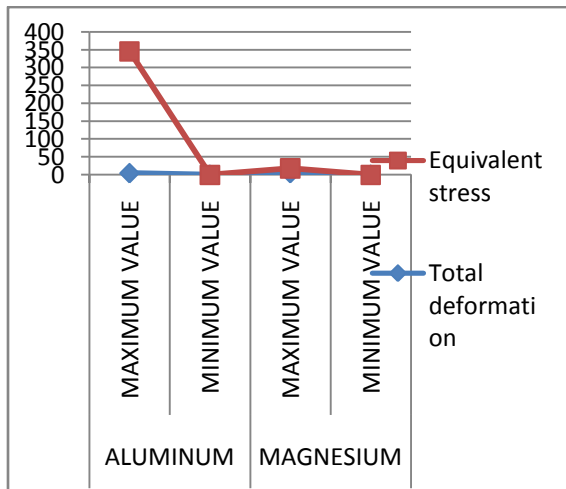
Decimal $y = 0.92763$

$$y = \cos\left(\left(\frac{37503}{500}\right)^\circ\right) + \sin\left(\left(\frac{14820}{353}\right)^\circ\right)$$



GRAPH 4.13 EQUIVALENT ELASTIC STRAIN MAGNESIUM

	MAXIMUM VALUE	MIN VALUE
Total deformation	4.5951	0
Equivalent stress	340.34	0.00
Equivalent elastic strain	0.0017923	6.14



GRAPH 4.7 SINGLE BLADE ANALYSIS ALUMINUM AND MAGNESIUM OF MAXIMUM AND MINIMUM VALUES

EQUIVALENT ELASTIC STRAIN MAGNESIUM:

CONCLUSION

The investigation of the task is composed and displayed in 3D demonstrating programming CATIA. The outline is improved the situation 30 cutting edges. The present outline has 30 cutting edges, the investigation design of the question it is supplanted 29 edges.

The present utilized material is aluminum and will be having higher quality material than Magnesium.

Investigation is finished by utilizing ANSYS and the parameters, for example, disfigurement and the proportional anxieties are gotten for both the materials and are looked at. Here we have done the examination for a solitary sharp edge finding the disappointment investigation of edges.

So utilizing stainless steel 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.

By utilization of 29 cutting edges stretch utilizing 29 sharp edges the burdens are expanding, yet are inside the points of confinement. Static basic examination is done to check the stream of air. The outlet speed is expanding for 29 cutting edges, weight is more for 30 sharp edges and mass stream rate is more for 29 edges. So it inferred that using magnesium than stainless steel for 29 sharp edges is better for compressor.

Here we have additionally found the periodicity for a solitary cutting edge examination for finding the quality and disappointment investigation of the compressor. The Blade profile has been produced two rotors and stator logically. The computation spread sheet is influenced so by input the qualities one to can get the expected parameters to produce the sharp edge organizes. While contrasting both plan aftereffects of materials, it is watched that the static auxiliary examination result partakes in assentation inside satisfactory range in both the materials.

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