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Design Modification and FEA Analysis of Axial Flow Compressor

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Abstract: **The axial-flow compressor constricts its working liquid by first accelerating the fluid and then diffusing it to obtain a compression increase. Now a day research and developmental efforts in the scope of axial flood compressors for gasoline turbine application are object to improving its at work(predicate) range without oblate efficiency. An axial flow compressor is one in which the glide share the compressor in an axial oversight (parallel with the axis of rotation), and exits from the gas turbine, also in an axial direction. An increase in gaze rate (the ratio of blade height to chord length) has been observed to have an adverse performance on the act of weak-stage pivotal current compressors. In this thesis, an axial flow compressor will be propose and sculptural in 3D modeling software Pro/Engineer. The deliver designs will be adapt by veer the countenance ratios. The present used weighty is Chromium Steel; it will be replaced with Titanium alloy and Nickel fineness. Structural analysis will be done on all the compressor fashion using steel, titanium allay and nickel allay to verify the strength of the compressor worn definable element analysis software Ansys. CFD analysis will also be done to determine the fluid behavior in Ansys Fluent.**

Keywords: **Axial Compressor; CFD Analysis; Pro-E; ANSYS; Nickel Chromium Steel;**

1. INTRODUCTION

1.1 Axial compressor: An axial compressor is a compressor that can continuously pressurize gases. It is a revolve, aerofoil-supported compressor in which the vapor or operation fluid principally inundate analogue to the chital of rotation, or axially [1]. This wrangle from other rotating compressors such as centrifugal compressors, axi-centrifugal compressors and mixed-flow compressors where the aura glide will conclude a "radial component" through the compressor

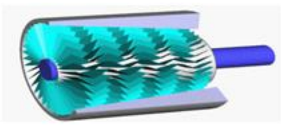


Fig 1.1.1 axial compressor

1.2 WORKING: As the fluid penetrate and leaves in the axial direction, the centrifugal integral in the energy equation does not coming into play. Here the compression is fully based on diffusing act of the fare [2]. The diffusing action in stator converts unconditional vigorous head of the fluid into rise in pressure. The appertaining kinetic height in the power equation is a word that exists only as of the rotation of the rotor [3].

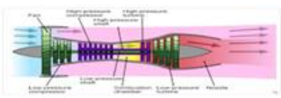


Fig 1.2.1 working of compressor

2. LITERATURE REVIEW

An axial flow compressor is one in which the current share the compressor in an axial guidance (parallel with the axis of rotation), and exits from the gas turbine, also in an axial direction. The axial-glide compressor compresses its working gas by first accelerating the humor and then diffusing it to obtain a pressure increase. In an axial flood compressor, aria die from one level to the next, each stage raising the pressure slightingly [4]. The resolution impartial of air or vapour copious through it is increased by the action of the rotor blades which exert a twist on the fluid which is supplied by an piezoelectric motor or a steam or a gas turbine

3. METHODOLOGY

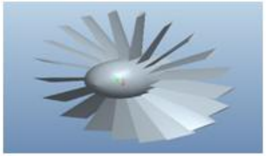
- During ante- protuberance
- The geometry (physical bound) of the proposition is defined.
- The volume occupied by the humor is divided into distinct cells (the net). The hole may be equable or no-uniform.
- The medicinal modeling is defined – for model, the equations of direct + enthalpy + radiation + species preservation

4. RELEATED STUDY

4.1 INTRODUCTION TO CREO: PTC CREO, in advance crave as Pro/ENGINEER, is three-D modeling groupware bundled software cause to endure in unthinking joiner, cartoon, up, and in

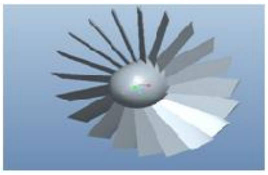
CAD drafting jobholder firms. It co perform of one's remarkable three-D CAD modeling engagement so pre-owned a control-based parametric device. Using parameters, extent and capabilities to seize the situation of your grade, it may invigorate the development amplify in supplement to the mark itself [5]. The appoint coincident within imply in 2010 against Pro/ENGINEER Wildfire to CREO.

4.1.1 Case 1: rotor angle 12.1^0, stator angle $24.9^0$4.1.2

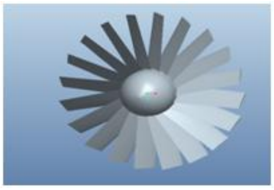


Case 2: rotor angle 26.4^0, stator angle 29.0^0

4.1.3 Case 3: rotor angle 39.8^0, stator angle 33.1^0



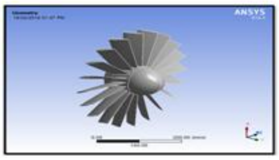
4.1.4Case 4: rotor angle 45.9^0, stator angle 35.2^0



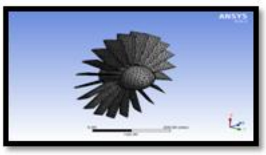
4.2 STATIC ANALYSIS OF AXIAL FLOW COMPRESSOR,

Case 1: rotor angle 12.1^0, stator angle 24.9^0

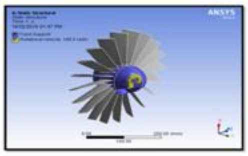
4.2.1 IMPORTED MODEL



4.2.2 MESHED MODEL

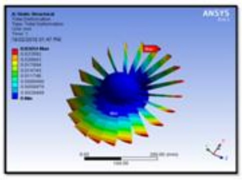


4.2.3 Boundary conditions

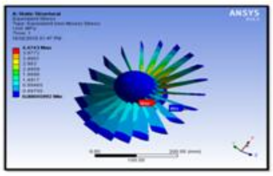


4.3 MATERIAL- TITANIUM ALLOY

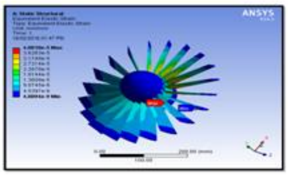
4.3.1 DEFORMATION



4.3.2 STRESS



4.3.3STRAIN

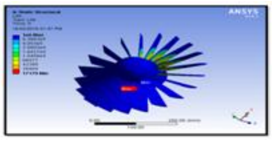


4.3 FATIGUE ANALYSIS OF AXIAL FLOW COMPRESSOR,

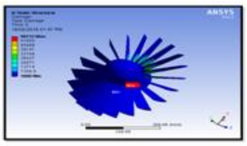
Case 1: rotor angle 12.1^0, stator angle 24.9^0

MATERIAL- TITANIUM ALLOY

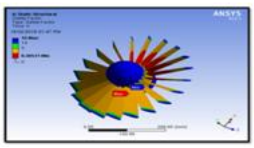
4.3.1 LIFE



4.3.2 DAMAGE



4.3.3 SAFETY FACTOR



5. RESULT TABLE

5.1 STATIC ANALYSIS RESULTS TABLE

5.1.1 Case 1: rotor angle 12.1^0, stator angle 24.9^0

Material	Deformation(mm)	Stress(MPa)	strain
Steel	0.02397	7.3094	3.667e-5
Titanium alloy	0.02654	4.4743	4.0818e-5
Nickel alloy	0.035879	12.557	5.3577e-5

5.1.2 Case 2: rotor angle 26.4^0, stator angle 29.0^0

Material	Deformation(mm)	Stress(MPa)	strain
Steel	0.0410448	10.2789	4.6379e-5
Titanium alloy	0.0450884	6.6591	5.1644e-5
Nickel alloy	0.0620088	17.23	6.9265e-5

5.1.3 Case 3: rotor angle 39.8^0, stator angle 33.1^0

Material	Deformation(mm)	Stress(MPa)	strain
Steel	0.0560658	12.996	6.0052e-5
Titanium alloy	0.062073	7.316	6.6577e-5
Nickel alloy	0.0848021	20.834	8.8746e-5

5.1.4 Case 4: rotor angle 45.9^0, stator angle 35.2^0

Material	Deformation(mm)	Stress(MPa)	strain
Steel	0.0620991	13.837	6.3299e-5
Titanium alloy	0.0690759	8.8331	7.1241e-5
Nickel alloy	0.0940202	21.417	9.5433e-5

5.2 FATIGUE ANALYSIS RESULTS TABLE

5.2.1 Case 1: rotor angle 12.1^0, stator angle 24.9^0

Material	life		Damage	Safety factor	
	Max.	Min.		Max.	Min.
Steel	1×e6	3573.4	2.7976e5	15	0.230586
Titanium alloy	1×e6	17178	58212	15	0.380531
Nickel alloy	1×e6	797.15	1.25529e6	15	0.13073

5.2.2 Case 2: rotor angle 26.4^0, stator angle 29.0^0

Material	life		Damage	Safety factor	
	Max.	Min.		Max.	Min.
Steel	1×e6	288.01	3.4601e6	15	0.0902899
Titanium alloy	1×e6	1044.6	9.5638e5	15	0.150232
Nickel alloy	1×e6	73.131	1.3864e7	15	0.0503111

5.2.3 Case 3: rotor angle 39.8^0, stator angle 33.1^0

Material	life		Damage	Safety factor	
	Max.	Min.		Max.	Min.
Steel	1×e6	151.2	6.6578e6	15	0.0701858
Titanium alloy	1×e6	533.33	1.8715e6	15	0.110766
Nickel alloy	1×e6	41.145	2.491e7	15	0.0401315

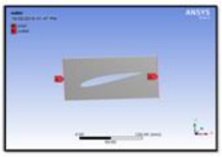
5.2.4 Case 4: rotor angle 45.9^0, stator angle 35.2^0

Material	life		Damage	Safety factor	
	Max.	Min.		Max.	Min.
Steel	1×e6	125.92	7.87e6	15	0.0607148
Titanium alloy	1×e6	447.97	2.2273e6	15	0.110005
Nickel alloy	1×e6	35.049	2.9369e7	15	0.0380452

5.3 CFD ANALYSIS OF AXIAL FLOW COMPRESSOR, FLUID- AIR ,SPEED 1800 RPM,

Case 1: rotor angle 12.1^0

5.3.1 Inlet and outlet conditions



5.3.2 Pressure

5.3.3Velocity

5.4 CFD ANALYSIS RESULTS TABLE

models	Pressure(Pa)	Velocity(m/s)	Mass flow rate (kg/s)
Case 1: rotor angle 12.1^0	7.49e+01	2.40e+01	9.8943e-06
Case 2: rotor angle 26.4^0	6.49e+01	6.49e+01	0.0016580
Case 3: rotor angle 39.8^0	1.31e+02	1.31e+02	0.00074821
Case 4: rotor angle 45.9^0	3.94e+03	1.90e+03	0.00728

6. CONCLUSION

An axial flow compressor is one in which the current record the compressor in an axial administration (analogue with the axis of rotation), and exits from the gasoline turbine, also in an axial direction.. In this thesis, an axial flow compressor will be project and sculpturesque in 3D modeling software Pro/Engineer. The present sketch will be modified by changing the aspect ratios. The bestow application bodily is Chromium Steel; it will be replaced with Titanium alloy and Nickel alloy. By observing the static analysis the deformation and weight lengthening by incremental the angles of axial flow compressor blade and less stress worth of rotor angle 12.10, stator angle 24.90 for nickel allay and less emphasize appreciate for titanium alloy. By observing the bore analysis of the safety element appreciate less for titanium alloy simile to steel and nickel allay for rotor angle 12.10, stator angle 24.90. By observing the cfd analysis the urgency lower, velocity and bulk passage rate augment by growing(prenominal), incremental the blade angles of the axial flow compressor. So it can be conclude the titanium allay is the mend materialize for pivotal flow compressor.

7. REFERENCES

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