EXTRACTING ENERGY FROM THE HIGH TEMPERATURE, HIGH PRESSURE GAS PRODUCED BY THE COMBUSTOR FOR DETERMINING GAS TURBINE BLADES

[1]Rajesh Votarikari, [2]Dhavaleshwar Sannabhimappa Prashant, [3]Mogulappa Mogulappa, [4]Sainoju Pradeep
[1,2,3]Assistant Professor, [4]UG Student, [1,2,3,4]Department of Mechanical Engineering, Brilliant Grammar School Educational Society Group of Institutions Integrated Campus, Hyderabad, India

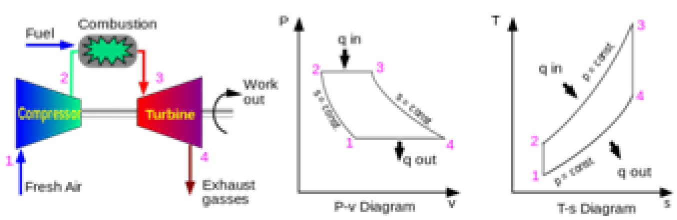
ABSTRACT
The individual part that makes up the turbine portion of a gas turbine is a turbine blade. The high temperature, high pressure gas that the combustor produces must be converted into energy by the blades. Pro/Engineer, a 3D modeling programmed, is used in this research to build and simulate a turbine blade. To improve cooling effectiveness, the blade base is changed in the design. Material selection is crucial since turbo machinery design is intricate and material performance directly affects efficiency. In this project, chromium steel and stainless steel 316L are both potential materials for turbine blades. Optimization is done by varying the materials chromium steel and stainless steel 316L by performing coupled field analysis (thermal and structural) on the turbine blade for the designs (without holes, internal cooling, external coolingand internal-external cooling) .
keywords: CFD, thermal and structural.

INTRODUCTION

An internal combustion engine is a form of gas turbine, often known as a combustion turbine. It has a combustion chamber or space in between, known as a combustor, and an upstream spinning compressor connected to a downstream turbine. The fundamental operation of a gas turbine is comparable to a steam power plant's, with the exception that air is utilized in place of water. A compressor increases the pressure of fresh atmospheric air as it passes through. Next, fuel is ignited and sprayed into the air to provide energy, causing the combustion to produce a high-temperature flow. This gas with a high temperature and high pressure enters a turbine, where it expands to the exhaust pressure and generates shaft work. The turbine shaft work is used to drive the compressor and other devices such asan electric generator that may be coupled to the shaft. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity. The purpose of the gas turbine determines the design so that the most desirable energy form is maximized. Gas turbines areused to power aircraft, trains, ships, electrical generators, and tanks.

Theory of operation

In an ideal gas turbine, gases undergo four thermodynamic processes: an isentropic compression, isobaric (constant pressure) combustion, an isentropicexpansion and heat rejection. Together, these make up the Brayton cycle.



LITERATURE REVIEW

The objective of this project is to design and stresses analyze a turbine blade of a jet engine. An investigation for the usage of new materials is required. In the present work turbine blade was designed with two different materials named as Inconel 718 and Titanium T-6. An attempt has been made to investigate the effect of temperature and induced stresses on the turbine blade. A thermal analysis has been carried out to investigate the direction of the temperature flow which is been develops due to the thermal loading. A structural analysis has been carried out to investigate thestresses, shear stress and displacements of the turbine blade which is been develop due to thecoupling effect of thermal and centrifugal loads. An attempt is also made to suggest the best material for a turbine blade by comparingthe results obtained for two different materials(Inconel 718 and titanium T6). Based on the plots and results Inconel718 can be consider as the best material which is economical, as well as it has good material properties at higher temperature as compare to that of TitaniumT6.

INTRODUCTION TO CAD/CAE:

Computer-aided design (**CAD**), also known as **computer-aided design and drafting** (**CADD**), is the use of computer technology for the process of design and design-documentation.

INTRODUCTION TO PRO-ENGINEER

Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry- leading productivity tools that promote best practices in design while ensuring compliance with your industry and companystandards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

Different modules in pro/engineer

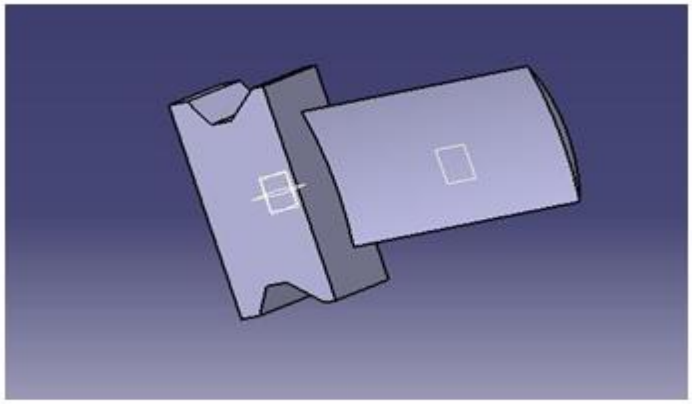
Part design, Assembly, Drawing& Sheetmetal.

INTRODUCTION TO FINITEELEMENT METHOD:

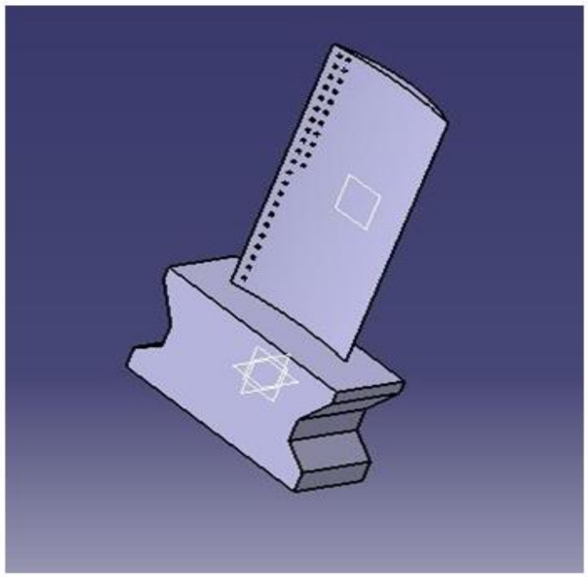
Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysistechnique for resolving and substitutingcomplicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

1. RESULTS AND DISCUSSIONS:

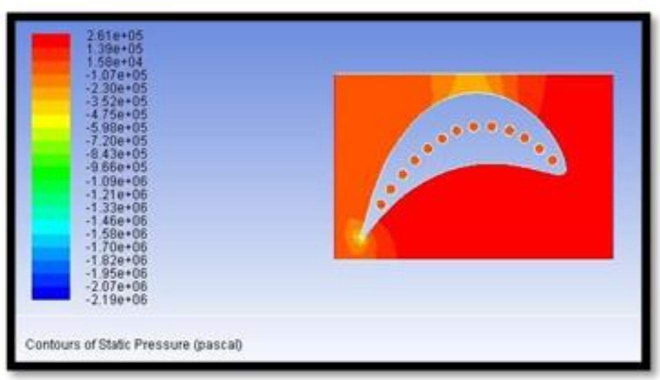
Models of pro-e wildfire 5.0:
Gas turbine blade 3D model (without holes)



with holes



CFD ANALYSIS OF FILM COOLINGTURBINE BLADE
PRESSURE

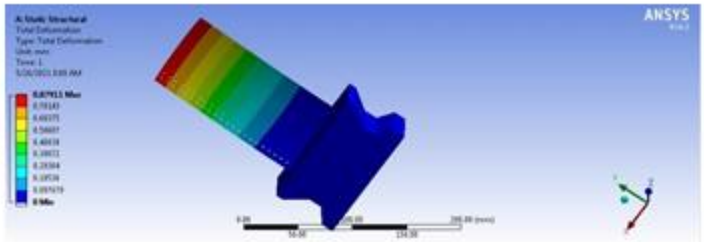


VELOCITY
HEAT TRANSFER COEFFICIENT

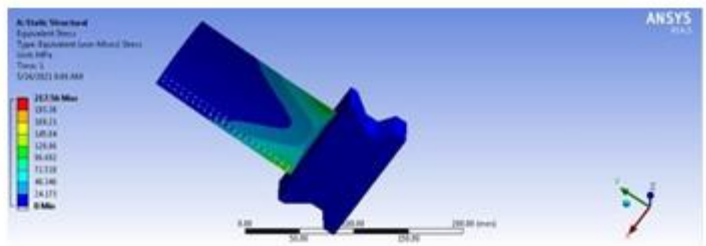
Mass Flow Rate	(kg/s)
inlet	82.889244
interior-_trm_srf	501.84143
outlet	-82.707085
wall-_trm_srf	0
Net	0.18215942

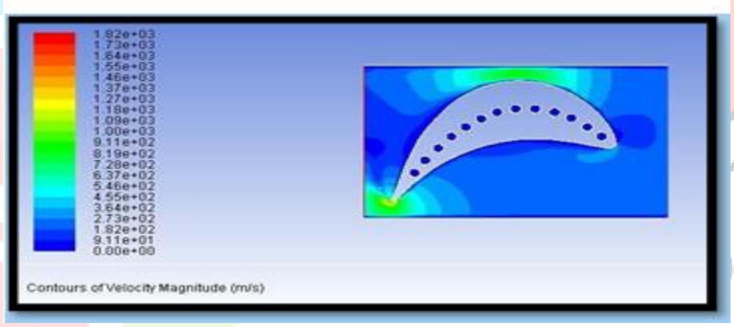
STATIC ANALYSIS OF GASTURBINE BLADE

Deformation

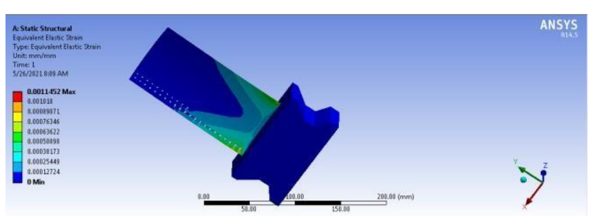


STRESS



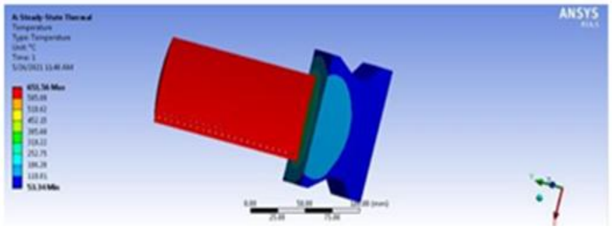


STRAIN

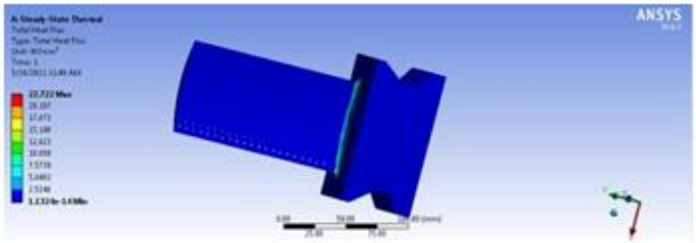


THERMAL ANALYSISON GASTURBINE BLADE

TEMPERATURE



HEAT FLUX



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RESULTS AND DISCUSSIONS

STATIC ANALYSIS

CASES	MATERIAL	Deformation (mm)	Stress (N/mm^2)	Strain
Without	Chromium steel	1.1897	227.16	0.0011601
	Stainless steel 316L	1.2058	225.45	0.001772
Internal	Chromium steel	1.1335	223.54	0.0011314
	Stainless steel 316L	1.1485	220.42	0.001159
External	Chromium steel	0.85002	218.22	0.0011088
	Stainless steel 316L	0.87911	217.56	0.0011452
Internal And External	Chromium steel	0.78297	204.26	0.0010376
	Stainless steel 316L	0.80993	203.55	00.0010713

THERMAL ANALYSIS

CASES	MATERIAL	Temperature (^0C)	Heat flux (W/mm^2)
Without	Chromium steel	650.26	15.05
	Stainless steel 316L	650.25	19.056
Internal	Chromium steel	651.12	16.002
	Stainless steel 316L	651.04	20.685
External	Chromium steel	651.66	17.583
	Stainless steel 316L	651.56	22.722
Internal And External	Chromium steel	650.45	19.805
	Stainless steel 316L	650.42	25.594

CONCLUSION

The designed a turbine blade used in gas turbines and modeled in 3D modeling software PRO-E. Models are (without holes, internal cooling, external cooling and internal-external cooling).

We have done structural and thermal analysis on all the models of turbine blades using chromium steel and stainless steel 316L. By observing the analysis results, the analyzed stress values are less than their permissible stress values. So using both the materials is safe. The stress and deformation values are more for stainless steel 316L.By observing the thermal results, thermal flux is more for stainless steel 316L and chromium steel. So using stainless steel 316L is better than chromium steel. But the main advantage is its weight. So we can conclude that by using stainless steel 316L with internal – external cooling method is better.

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