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REVIEW OF COMPUTER AIDED SIMULATION OF GAS TURBINE BLADES

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ABSTRACT

Gas turbine engines are extremely prevalent in today's society, being used in power plants, marine industries and aircraft propulsion. Hence investigations for improving their performance are very important. Most engineering problems in gas turbine are extreme temperature, high pressure, high rotational speed, vibration and small circulation area which affects the blade life. So turbine blade requires cooling. One of the effective method is internal cooling, that involves extracting air from the compressor and forcing it through a plenum and into channels inside the blade. The effective cooling increases the blade life and also improves the thermal efficiency of the engine. This paper introduces the study of the computer- aided modeling and simulation methodology to study the mechanical and thermal stresses produced in the gas turbine. Since there are few related numerical analytic simulations that have been done in this research field, this paper intends to provide the numerical simulation methodology to investigate and understand the stress mechanism in gas turbine operation. All these studies can help to optimize future gas turbine design and improve the performance.

Keywords: *Turbine entry temperature, Thermal failure analysis, Blade coating & Blade cooling.*

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1. INTRODUCTION

This Review paper deals with the study of simulation of gas turbine using various softwares such as CAD,CFD AND ANSYS.

In a gas turbine engine, a single turbine section is made up of a disk or hub that holds many turbine blades. That turbine section is connected to a compressor section via a shaft (or "spool"), and that compressor section can either beaxial or centrifugal . Air is compressed, raising the pressure and temperature, through the compressor stages of the engine. The temperature is then greatly increased by combustion of fuel inside the combustor, which sits between the compressor stages and the turbine stages. The high-temperature and high-pressure exhaust gases then pass through the turbine stages. The turbine stages extract energy from this flow, lowering the pressure and temperature of the air and transfer the kinetic energy to the compressor stages along the spool. This process is very similar to how an axial compressor works, only in reverse.

1.1 We studied the following papers

1.Computational Fluid Dynamics Analysis Of Turbine Blade Cooling Passage With V-Shape.
2.Performance Analysis of Gas Turbine Blade Cooling by CFD.
3.Computer Aided Modeling on Gas Turbine Blade.
4.Computer -Aided Method Of Diagnostics Of Gas Turbine Blades.
5.Modelling, Structural,Analysis And CFD Fluent Analysis Of High Speed Gas Turbine Blades.

2. COMPUTATIONAL FLUID DYNAMICS ANALYSIS OF TURBINE

2.1 BLADE COOLING PASSEGE WITH V-SHAPE

This paper specialises in 3D CFD Analysis of Rotary engine blade cooling passage during which the required domain is subjected to vital load.

In this paper we studied How the rotary engine blade is cooled and how the warmth is transferred around the duct surface and analysed.And by using the Finite component volume tool ANSYS-Fluent.The simulation is done where required.

The goal of this paper was to hold out heat transfer constant at the rotary engine blade.

This paper also focuses on analysis of V-shape 35 deg truncated ribs.This shows that 35 deg truncated ribs is the best than the traditional truncated ribs.

2. 2 Performance Analysis of Gas Turbine Blade Cooling by CFD.

This thesis presents an investigation into the base temperature of a turbine blade when coolant is ejected from the trailing edge at a span-wise angle. Thus the current study measures the

effect on the temperature difference when coolant is ejected from the trailing edge of turbine blade.

The results obtained during this analysis was temperature reduction rate of the turbine blade without cooling passages was 3.727% and for the blade with cooling passages was 53.63%.

Hence,in the end it was found that internal cooling method is found better to reduce the extreme temperature of the blade and which increases the span of the blade.

2.3. Computer Aided Modeling on Gas Turbine Blade.

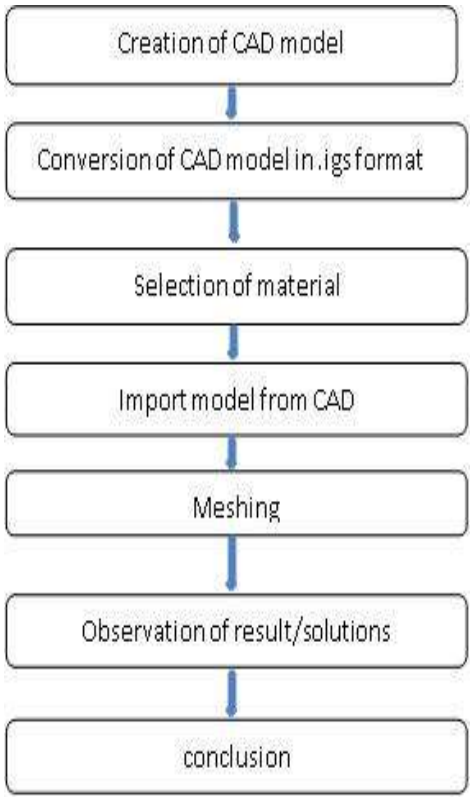
This paper uses the computer aided modelling and numerical simulation which justifies the performance and improves the design without the need of real turbine parts. The simulation results indicate the important features of hot spinning process because the combined stress from thermal and mechanical contributions has been significantly decreased in gas turbine functioning parts. During this paper One prototyped unit was built and tested to verify the computational modeling and numerical simulation. The computational simulation shows very close results compared to the prototype testing and this validates the analytic methodology applied in this research. The future improvement on this research will be continuously analyzing the gas turbine performance by trying different composite material, modifying turbine design parameters for system optimization, and planning more prototype experiment.

3. COMPUTER AIDED SIMULATION

3.1 Methodology For Steady And Transient State Thermal Analysis

Blade failures in rotating engines may have severe impact on the availability of engines. Therefore, it is observed as an important challenge especially, in gas turbine engines. Blade failures are caused by a number of mechanisms under the turbine operating conditions of high rotational speed at elevated temperatures. These failures may have different causes, such as creep or fatigue damage, external and internal damage of blade tip and turbine casings. so our main aim is to find the material response of different 4 materials for 4th stage blade by steady and transient state analysis. The basic procedure of entire project will start from reverse engineering If only one original part is available, it has to be handled with utmost care during the process as the original part is crucial for validation. The component must be thoroughly examined and the prominent geometric feature affecting the working of that component must be extracted and the feature which can be measured manually is also estimated. Such features encompass prismatic and geometric shapes .All other features such as free-formed surfaces and complex contours and 3D surfaces are measured using. Vernier Calipers, height gauge, etc

The typical process can be summarized in the following sequence:-



3.2 CAD MODELING OF GAS TURBINE BLADE

CAD modeling of gas turbine blade is an important part of entire project. Because the blade profile is very complex and it will decide the nature of the hot flowing fluid over a blade. The advanced CAD software i.e. CATIA V5R17 is selected for modeling the gas turbine blade.

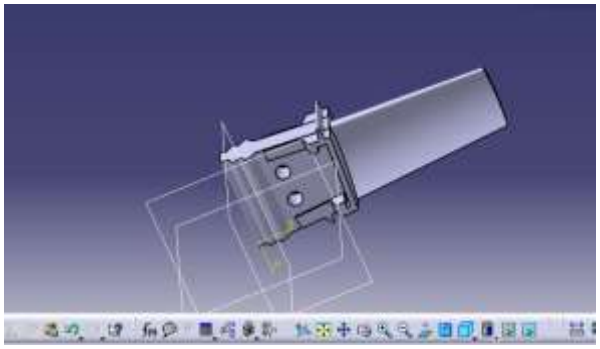


Figure 3.2: CAD model of fourth stage gas turbine Blade.

4. EXPERIMENTAL ANALYSIS

4.1 Modeling

Turbine Blade Model has been imported from the references and the shape, specifications are observed to study the flow rate of the flue gases.

4.2 . Overview Of Turbine Blade

Fig. 4.2.shows Imported Model of a Turbine Blade

Fig. 4.2.1. Imported Model of a Turbine Blade

The coolant air is sent through the plenum in the holes to extract heat

4.3 Turbine Blades With Cooling Passage

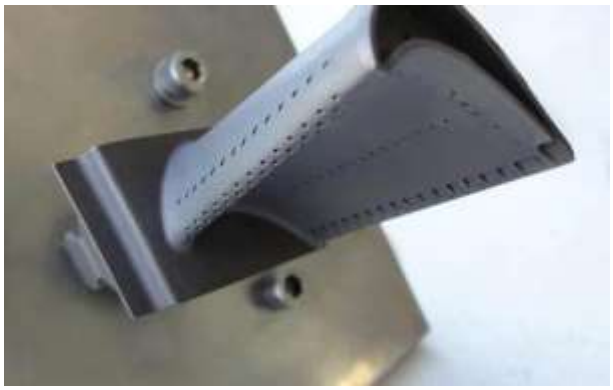


Fig: 4.3. Turbine blade with cooling passage

The Turbine Blade area with cooling passages considered for temperature distribution is developed by using CFD boundary conditions and the meshed view describes the element and nodal conditions.

5. CONCLUSION

This paper focuses on the study of gas turbine function through computer-aided simulation.

A computational modeling methodology is studied to understand the mechanism of thermal and centrifugal stress profiles produced in gas turbine, analyze the effect of critical turbine parameters, and further improve gas turbine performance.

Hence we understand from above paper the computer aided simulation can be done.

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