Analysis Of Flow Through Turbine Blade For Effective Cooling Using CFD

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Abstract— **Gas turbine blade will be exposed to very high temperature due to that ever nine hundred hours of flying aircraft a blade must be changed which requires change of blade hence it is necessary for us to provide effective cooling by using bypass air from compressor will be drawn to cool the blade without effecting the efficiency of combustor. In this project an effective cooling has been provided by changing the shape of the cooling hole there by increasing surface area of cooling. By providing effective cooling of gas turbine blades life span of blade can be increased which results in effective cost saving. Here effective cooling has been provided by changing the shape of cooling holes and number of cooling holes. Since convective heat transfer depends on fluid property and shape of the domain. The number of cooling holes restricted to thirteen since more the number will decrease the strength of the blade and consumes more amount of air which in turn decreases the efficiency of combustor.**

Keywords— **turbine, compressor, cooling.**

Introduction

Gas turbine blade will be exposed to very high temperature due to that ever nine hundread hours of flying aircraft a blade must be changed which requires change of blade hence it is necessary for us to provide effective cooling by using bypass air from compressor will be drawn to cool the blade with out effecting the efficiency of combustor.

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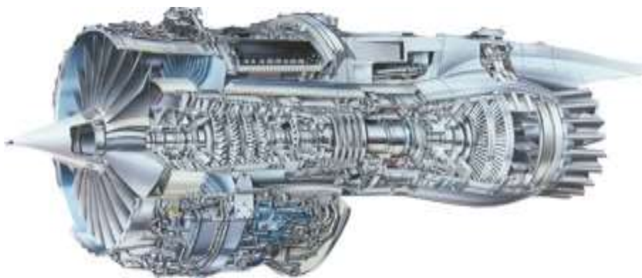
The use of turbine technology are to extract the highest amount of energy from the working fluid to change it into valuable work with highest possible wasting very little while working or producing something by means of a plant having extreme reliability, minimum cost, minimum supervision and The gas turbine gets its power by using the energy to burnt gases and the air which is at high temperature and pressure by expanding through the more than two, but not a lot of rings of fixed and touching vanes

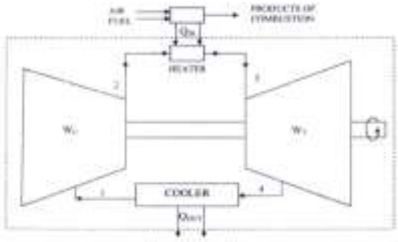
Aero engine gas turbine blades are airplane wing shape in cross section are warped and fixed on ring-like disc, which in turn is attached to rotating disc blades work at high speed and temperature leading to induction of pertaining to each person or thing stresses. For air- cooling purpose, blades are given number of minute cooling holes 0.5 to 0.8mm on the hollow walls of the blades from end to end which pressurized air is ejected. Holes are indirect and hard to understand, leaning at compound angles and are stress raisers and lower the resistance of the blade to thermal tiredness.

Analyzing the thermal design of a blade with accepting the complex speed and thermal edge layers about the blade describing a possible future event) highly (in a way that's close to the truth or true number the blade surface heat energy created by the hot gas stream touching over the blade is extremely important to describing a possible future event the similar thermal stresses inside the blade. In more than two, but not a lot of engineering applications it is becoming essential to go with the computation of flow and connected heat move from one place to another in the fluid.

Gas turbine of aircrafts



Gas turbine application for power generation



Closed Cycle Gas Turbines

METHODOLOGY

To generate the blade profile, the co-ordinates were imported to the CATIAV5 through EXCEL Sheet command.

The co-ordinates were joined together by using the spline in CATIA.

The individual spline was then join together and is extruded to get the solid blade.

This blade is then imported to the ICEM CFD for Mesh generation. The unstructured mesh was generated. The different boundary details like inlet, outlet, wall, surface, etc. was included.

For the analysis of the file from ICEM CFD was imported to the CFX pre-processor. In this different boundary conditions are defined. After this the model was solved.

To see the results the solved pre-processor is directed to the post-processor where the different counter plot was obtained

Circular Hole selection

m= ρAV

$0.01 = 0.98X\pi/4\ X\ D^2\ X\ 117$

$D = \sqrt{4}X\frac{0.01}{0.98}X\pi\ X117$

D = 10.5mm

<u>5 hole taken</u>

4mm, 3mm, 2mm, 1mm, 0.5mm =10.5mm

<u>8 hole taken</u>

4mm, 3mm, 1mm, 0.5mm, 0.5mm, 0.5mm, 0.25mm,0.25mm =10.5mm

<u>13 hole taken</u>

4mm, 3mm, 1mm, 1mm, 0.4mm, 0.4mm, 0.4mm, 0.3mm =10.5mm

5, 8, 13 hole ellipse

Area of Circular = Area of ellipse

$\pi D^2/4 = \pi AB$

$\pi\ X\ 10.5^2/4 = \pi\ X\ 3\ X\ B$

B =9.18mm

5 holes = 9.18mm (main axis)
3mm (minimum axis)

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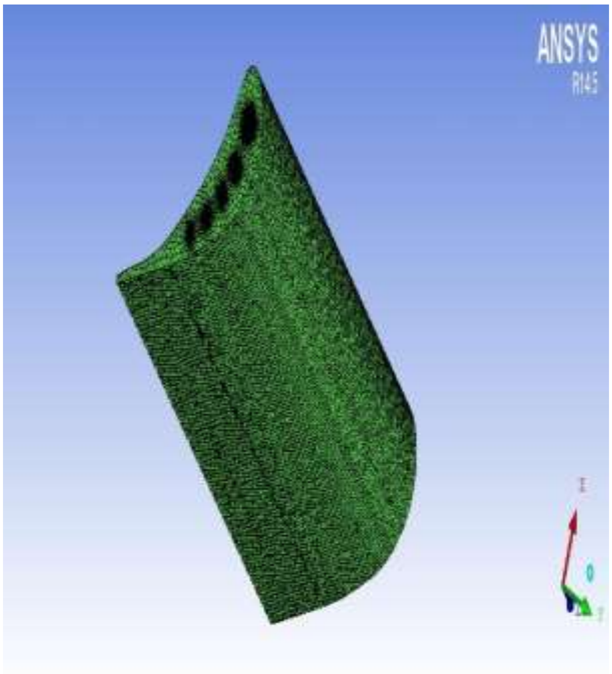
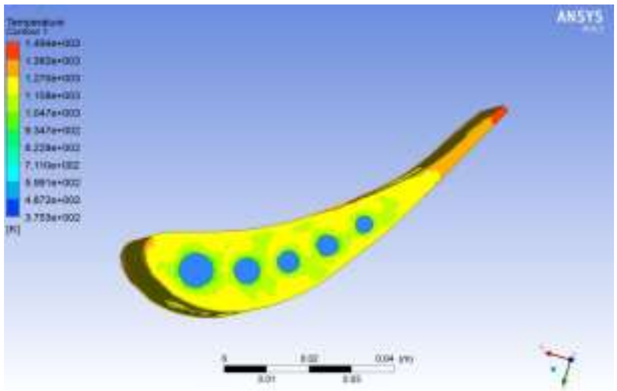


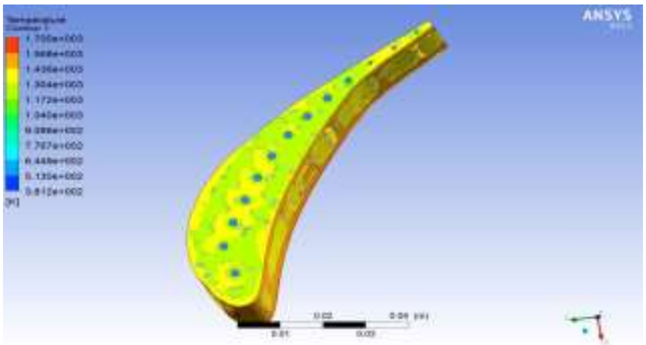
Unstructured mesh

TEMPERATURE CONTOUR 5 holes

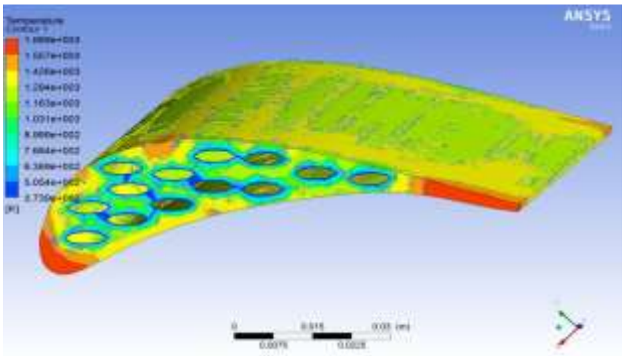
The above figure shows temperature contour at out let where there is an decrease in temperature.



Temperature contour 8 holes



Temperature contour 13 holes



Thirteen holes eliipse

Temperature Vs No. of holes circular

No of holes	*5*	*8*	*13*
SURFACE Temperature(k)	*1270*	*1150*	*1050*

RESULTS AND DISCUSSION

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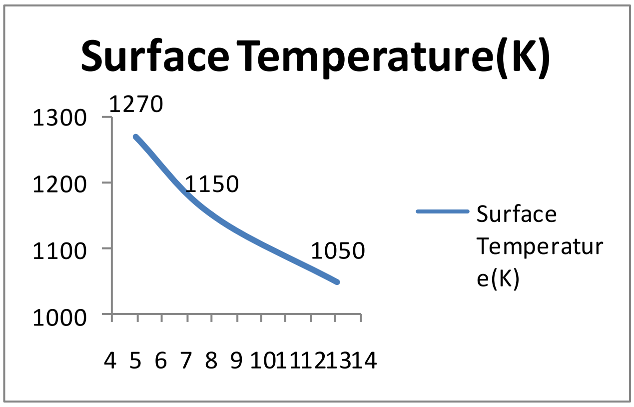
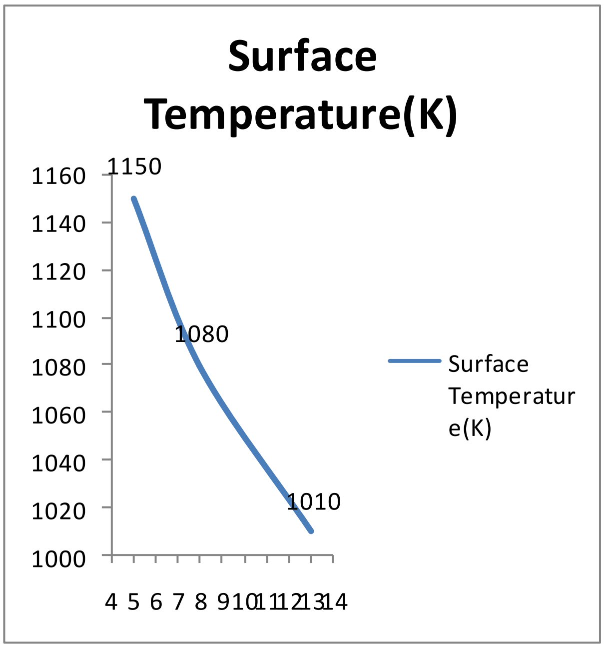
Temperature distribution which is shown in figure varies from from the leading edge to the trailing edge through the blade surface and the variation are linear along the path from both inside and outside of the blade surface. Considerable change is not observed for the first 8 mm length from the leading edge and from where the temperature is gradually decreasing and the next 36mm considerable change occurs and for the next 4mm it is almost constant.

The temperature distribution is also varied for increasing the number of holes. The temperature at the leading edge is lower than the blade consisting of 13 holes by observing results of above models. It can be observed that the temperature near the leading edge is 1010K. It has been reported by narasaraju [1] that the decreasing temperature will lead to lower thermal efficiency. Hence the number of holes is restricted to 13.





CONCLUSION

Gas turbine blade heat transfer analysis is carried out with different models of varying number of holes and varying shape of geometry. It is found that total heat transfer rate is maximum at tailing edge and the temperature of the blade at leading edge is minimum for the blade consisting of 13 holes of elliptical shape.

The thermal Temperature is decreasing linearly from the tip or root of the blade section.

1. For elliptical model temperature distribution is better than circular since surface area is more, convection factor depends on geometry and fluid property.
2. Analysis has been stopped for 13 holes since thermal efficiency of blade decrease if more holes are provided.
3. Better cooling rate has been achieved for 13 holes of elliptical shape
4. Finally based on leading and trailing edge temperature distribution 13 holes ellipse model has been optimized.
5. If more than thirteen hole is taken for analysis blade will loose strength
6. If more than thirteen hole is taken for analysis more air must be drawn
from compressor for cooling resulting in decrease in combustor efficiency
7 Better the cooling rate more the life span of blade
8 Better flying hours of aircraft can be achieved with respect to changing of gas turbine blades.

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