THERMAL ANALYSIS OF GAS TURBINE ROTOR BLADE USING FINITE ELEMENT ANALYSIS

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ABSTRACT

In the mechanical design constituent, numerical simulations method is mostly used for design instauration (or modification) and design optimisation. In the nowadays aim of work the first stage rotor leaf sword of a two-stage gas turbine has been analyzed for steady state thermal using ANSYS 16.2 an attempt has been investigated the effect of temperature on the turbine blade. A steady state thermal analysis has been carried out to investigate the focal point of the temperature flow rate which is been develops due to the thermal loading. An attempt is also made to suggest the best material for a turbine blade by comparing the results obtained for three different stuff such as Copper, Titanium and Nickel that has been considered for the analysis. The blade is modelled with SolidWorks 2015. The geometric model of the blade profile is generated with mathematically and extruded to get a solid model. In this work after finding the suitable materials, the analysis of different diam of hole also investigated. For different hole diameter, it has been pointed out that if the diameter of the hole is increased gradually with the constant number of holes, then the maximum temperature value and the total heat flux distribution decreases, then it grows again. Therefore, this present work the suitable diameter of hole also has been suggested for better performance in future.

Keywords: Open Ground Storey, Bare frame, Infill Frame, STAAD.Pro, Response Spectrum Analysis, Base Shear, Deformation, Base Moment.

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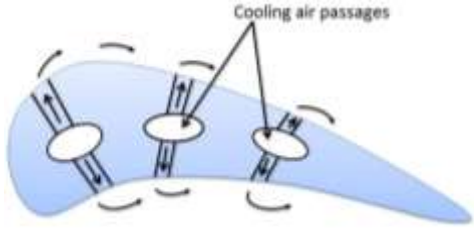
1. Introduction

The gas turbine obtains its energy Eventually Tom's perusing using the vitality for blazed gasses and the air which may be toward high engineering Also weight Toward growing through those a few rings of settled Furthermore moving blades, will get a high point about request of 4 with 10 bars from claiming attempting liquid which is vital to development a compressor may be needed.

Film cooling (also called slim novel into a film cooling), a generally utilized type, considers higher heat exchange rates over Possibly convection and impingement cooling. This strategy comprises from claiming pumping the cooling let some circulation into of the blade through different little gaps in the structure. A slim layer (the film) for cooling air is at that point made on the outer surface of the blade, decreasing those heat exchange starting with fundamental flow, whose temperature (1300–1800 kelvins) camwood surpass those softening point of the blade material (1300–1400 kelvins). The air gaps camwood makes over a lot of people different blade locations, yet all the they are A large portion frequently along the heading edge.



2.

Fig 1. Film or thin film cooling

An open ground storey building, having only columns in the ground storey and both partition walls and columns in the upper storeys, have two distinct characteristics, namely:

(a) It is relatively flexible in the ground storey, i.e., the relative horizontal displacement it undergoes in the ground storey is much larger than what each of the storeys above it does. This flexible ground storey is also called soft storey.

(b) It is relatively weak in ground storey, i.e., the total horizontal earthquake forces it can carry in the ground storey is significantly smaller than what each of the storeys above it can carry. Thus, the open ground storey may also be a weak storey.

3. Problem Identification

Gas turbine need aid utilized extensively for airplane propulsion, land-based energy era and mechanical requisition. Warm effectiveness Furthermore control yield of gas turbine increments with expanding turbine rotor bay temperature. Those current rotor bay temperature level in propelled gas turbine is a wide margin over the softening point of the blade material.

Therefore, alongside high engineering development, complex publicizing cooling plan must be created to nonstop sheltered operation of gas turbine with high execution. From the identification of above problem, the main objective of the work is to minimize the losses due to thermal losses and improve the design against in this field. In this work the design is modified and material can be varied.

4. Methodology

Internal cooling of blades can be achieved by passing cooling air from the air compressor through internal cooling passages from hub towards the blade tips. The internal passages may be circular or elliptical and or distributed near the entire surface of blade. In this chapter will discussed with the mathematical modeling of object as well solving method of the object

Table 1. Value of first stage rotor blade profile [14]

Sr. No.	Symbol	Value	Unit
1	U_{m1}	343.8615	m/sec
2	α_{2r}	65.5731	Deg
3	β_{2r}	45.2708	Deg
4	α_{2t}	63.5179	Deg
5	β_{2t}	34.9727	Deg
6	α_{3r}	39.3237	Deg
7	β_{3r}	63.3089	Deg
8	α_{3t}	35.7720	Deg
9	β_{3t}	64.0034	Deg
10	θ_{2r}	40.2708	Deg
11	θ_{2t}	449727	Deg
12	h_{S1}	0.0595	m
13	h_{R1}	0.0826	m
14	n_{S1}	124	Blades
15	n_{R1}	92	Blades
16	W_{R1}	0.0275	m
17	t_{R1}	0.0129	m

3.1 Modeling of Gas Turbine Blade

In this work the 3D model of turbine blade with hub was done in two stages in Solid Works 2015. First for creating the 3D model of the turbine blade, key points were created along the profile in the working plane.

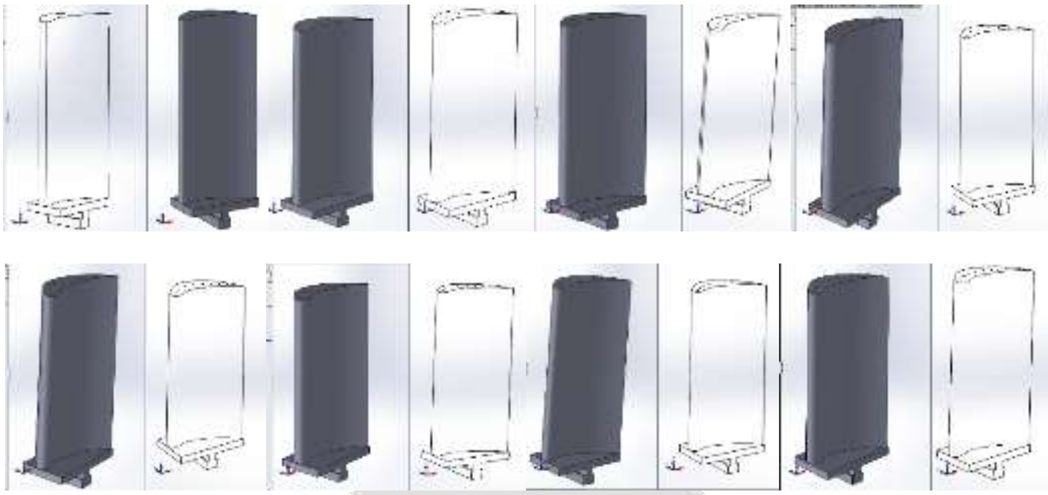


Fig 2. 3D view of first stage turbine rotor blade profile without and with holes (6-12 holes)

5. Results and Discussions

In this chapter are discussing about the thermal effect in gas turbine rotor blade without and with holes i.e. 6, 7, 8, 9, 10, 11, and 12 considerations. The objective of the present work is to find the optimum number of holes, material and diameter of hole for gas turbine rotor blade for better performance.

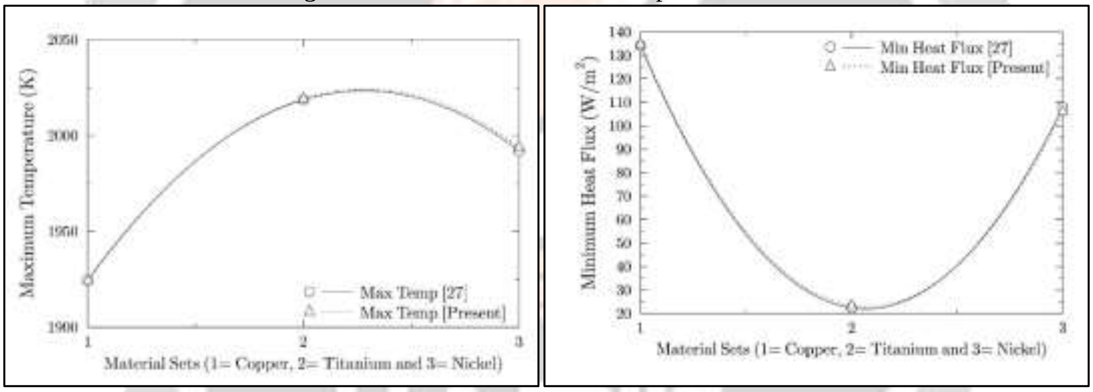


Fig 3. Validation graph of the model for maximum temperature in different material sets

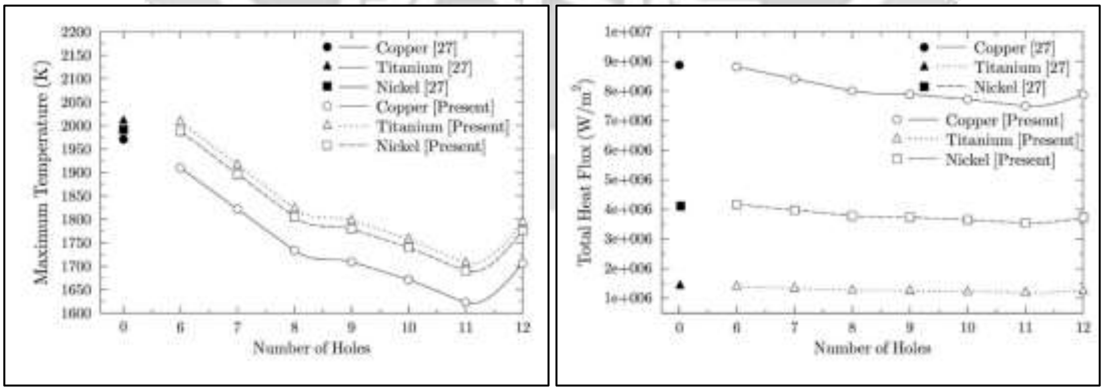


Fig 4. Variation of Maximum temperature and total heat flux in without [27] and with number of holes 0-12 holes [present] in blade profile and different materials

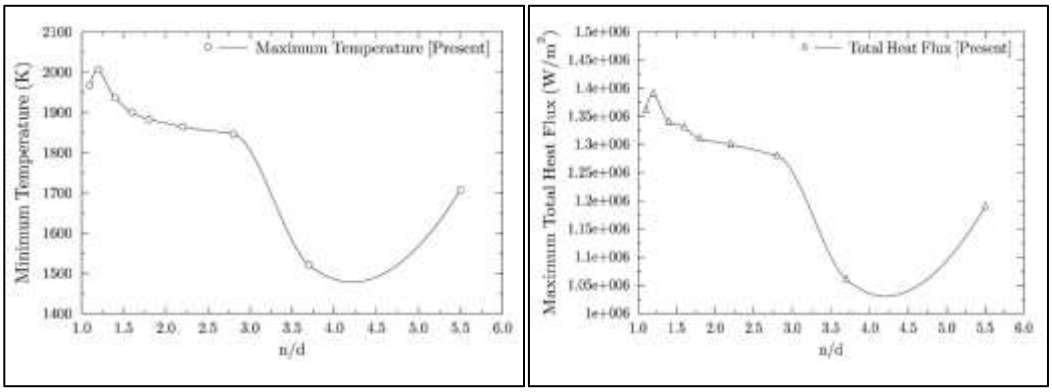


Fig 5. Variation of maximum temperature and total heat flux in blade with respect to n/d (ration of no. of hole and diameter of hole) for titanium material

6. Conclusion and Future Work

Conclusion

This chapter deals with conclusions based on the results and discussions of previous chapter. From this work was following conclusions are drawn:

- From this work, it was observed that the ANSYS 16.2 Software has been quite robust and allowed for this work to find the contribution of hole and their interaction.
- In this work, the finite element analysis is used as a tool and carried out the thermal performance.
- The blade with different number of holes has done with three materials, Copper, Titanium and Nickel.
- In present results it has been concluded after analysis, the maximum temperature of the all three materials are not exceed their allowable temperature as shown in chapter 4.
- The results of total thermal heat fluxes for materials are depend upon the thermal conductivity and convection heat transfer coefficient of the material.
- In this work has been found the steady state thermal analysis result, the total thermal heat flux for titanium is the least value as compared to other holes as well materials.
- So, Titanium material gives better result than the two other materials and another hole's creation in the blade profile.
- These results indicate that the blade with 11 holes will have optimum performance for the prescribed loading conditions.
- In this work, for minimization of losses the diameter of hole also be presented.
- It has been pointed out that if the diameter of the hole is increased gradually with the constant number of holes (n/d= 3.7 or d=3mm), then the maximum temperature value and the total heat flow distribution decreases, then it grows again. Therefore, this present work the suitable diameter of hole 3mm is suggested for better performance in future.

Future Work

There is some future work in on make recognized previously, enhancing those suitable elements about this under work:

- The economic investment worth of effort about configurations if a chance to be functioned out to estimate those particular capital expense and additionally plant capital expense which might assistance on pick setup on the premise about superior effectiveness and particular fill in and also on the expense.
- Exceptional cooling model might a chance to be formed.
- Streamlining about distinctive components about diverse configurations might make endeavored.
- Point by point worth of effort for diverse materials and alloys that might make utilized within gas turbine blade ought to be carried out.
- Different kind of blade cooling systems camwood make investigated will get most extreme effectiveness.
- In future for below 10 storey buildings can be designed without shear wall and for upper 10 storey can apply shear walls.
- In future it should be work in the area of magnification factor (better design less than 2.5).

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