# Adjustable Holes and Temperature Distribution Effect on Rotor Blade

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***Abstract*— Gas turbines have an important role in electric power generation. Turbine blades are the most important components in a gas turbine power plant. Turbine blades are mainly affected due to static loads. Also the temperature has significant effect on the blades. In this paper the second stage of axial-flow gas turbine rotor blade with holes is created in Solid Works software and design calculation is computed by MATLAB software. The temperature distribution effect on second stage rotor blade with holes is analysed from ANSYS 14.5 software. Three different models with different number of holes (5, 9 and 13) were analyzed to find out the optimum number of holes for good performance.**

***Keywords*— Rotor blade, Ansys 14.5, Solid Works, Gas Turbine**

## I. INTRODUCTION

Gas turbine technology is used in a variety of configurations for electric power generation. The gas turbine in its most common from is a rotary heat engine operating by means of series of processes consisting of air taken from the atmosphere increase of gas temperature by constant pressure combustion of the fuel the whole process being continuous.

A gas turbine is a device designed to convert the heat energy of fuel into useful work such as mechanical shaft power. The gas turbine power plants can be classified into two categories. These are open cycle gas turbine power plant and close cycle gas turbine power plant.

The simple open cycle gas turbine is suitable for industrial gas turbine. The turbine is a rotary mechanical device that extracts energy from a fluid flow and converts into useful work. The gas turbine obtains its power by utilizing the energy of burnt gases and the air which is at high temperature and pressure.

A schematic drawing of a simple open cycle gas turbine is shown in figure 1. The simplest arrangement of gas turbine consists of a compressor, combustion chamber and turbine directly connected to the generator.

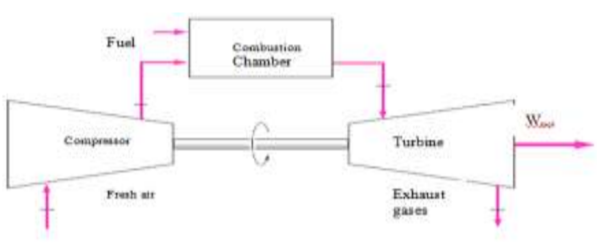


Fig.1 Simple open cycle gas turbine

## II. MATERIAL AND METHODS

In this work, the temperature distribution of the gas turbine rotor blade is made of structural steel was carried out.

Table 1 shows the properties of structural steel.

TABLE I

Material Properties of Structural Steel

| Material Properties | Magnitudes |
|---|---|
| Density | 7850kg/m$^3$ |
| Modulus of elasticity | 110GPa |
| Poisson's ratio | 0.30 |
| Thermal expansion coefficient | 2.2e-5/k |
| Maximum Allowable Temperature | 2300 °K |
| Thermal conductivity | 9.6W/m °K |

The holes on the blade tip are arranged on the mid camber line of the blade tip section. Turbine second stage axial blade chord length is 64.5mm and cooling passage diameter is 1.4mm. It is shown in Figure 2, the blade consisting of 5 holes, in Figure 3, the blade consisting of 9 holes and in Figure 4, the blade consisting of 13 holes.

Fig2. Turbine second stage rotor blade with 5 holes

Fig3. Turbine second stage rotor blade with 9 holes

Fig4. Turbine second stage rotor blade with 13 holes

## III. ANALYSIS

Turbine second stage rotor blades have three different holes configuration. The temperature distributions on the rotor blades are calculated and applied in ANSYS 14.5. The temperature distribution for turbine second stage rotor blade (with five blade holes) is illustrated in Figure 5. The highest temperature on the rotor blade is 1607°K while the maximum allowable temperature of the rotor blade material is 2300°K. The rotor blade (with five blade holes) will work safety at this temperature.

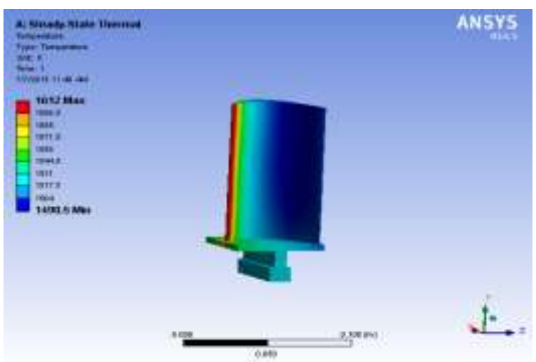


Fig 5. Temperature Distribution of Turbine Second Stage Rotor Blade (with five blade holes)

The temperature distribution for turbine second stage rotor blade (with nine blade holes) is illustrated in Figure 6. The highest temperature on the rotor blade is 1594°K while the maximum allowable temperature of the rotor blade material is 2300°K. The rotor blade (with nine blade holes) will work safety at this temperature.

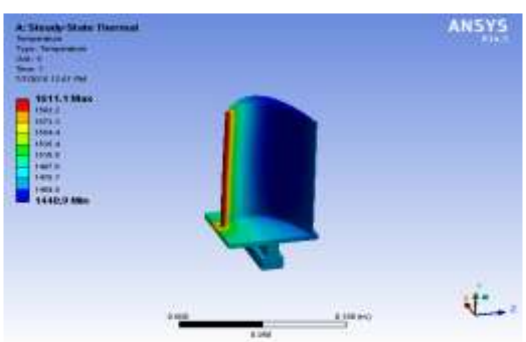


Fig 6. Temperature Distribution of Turbine Second Stage Rotor Blade (with nine blade holes)

The temperature distribution for turbine second stage rotor blade (with thirteen blade holes) is illustrated in Figure 7. The highest temperature on the rotor blade is 1584°K while the maximum allowable temperature of the rotor blade material is 2300°K. The rotor blade (with thirteen blade holes) will work safety at this temperature.

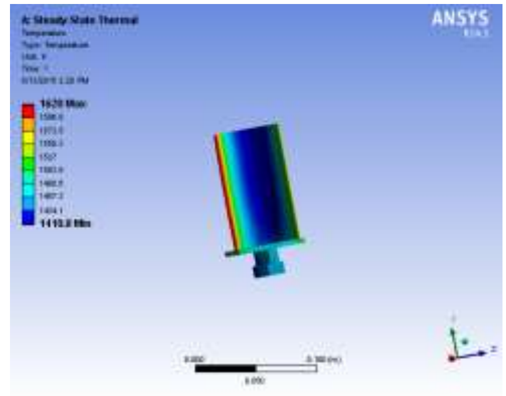


Fig7. Temperature Distribution of Turbine Second Stage Rotor Blade (with thirteen blade holes)

## IV. RESULTS AND DISCUSSION

The finite element thermal analysis of gas turbine rotor blade is carried out using ANSYS 14.5 software. The temperature has a significant effect on the overall turbine blades. The temperature distribution is analyzed for three different the number of holes. The analysis results of the temperature distribution of the three different the number of holes are not exceeded the allowable temperatures. The maximum temperatures of turbine second stage rotor blade (with 5, 9, and 13 holes) are 1607°K, 1594°K and 1584°K. The turbine second stage rotor blade of maximum temperature value is observed at the rotor blade with 5 blade holes. According to the finite element thermal analysis, the turbine second stage rotor blade (with 13 holes) design is optimum.

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