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‘‘Circumferential Fan Cooling”–Elite in Turbine Life

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Abstract

It is an ever increasing seek for any turbine Industry to come with a technology which is effective over thermal properties. The changeover that we propose, out of which better engineering in turbine cooling can be owned by driving atmospheric air for the process. Any engine efficiency will raise or fall based on its turbine’s ability. The melting temperature of most materials is far less than the design operating temperatures of the gas turbine. In addition to that the rapid spatial variations in temperature within the blade can create thermal stresses which can be in dangerous limits. In order to tackle the problems related to thermal stresses, oxidation and creep which limit the lifetime of turbines, cooling of the blades is required. In the technology that we propose, the HUB of the engine will have the opening for air to enter and additional vacuum is created by circumferentially fixed fans in the interior portion of hollow shaft. The low pressure at the blade tip will automatically deliver the air to the surface through the inner passage in the turbine blades. Our paper also holds the objective way in which the driven air is used for cooling turbine blades and structural design. By our technology we assure turbine life will be beyond imagination.
Circunference;Hallow shaft;Cooling;Efficient.

1. Introduction

Gas turbines plays a vital role in the today’s industrialized society, and as the demands of power increase, the power output and the thermal efficiency of gas turbines must also increase, one method of increasing both the power output and thermal efficiency of engine. In the advanced gas turbine engines of today, the turbine inlet temperature is

as high as15000c, however, this temperature exceeds the melting temperature of the metal airfoils. Therefore, it is imperative that the blades and vanes are to be cooled, so they can withstand these extreme temperatures. Driving air from compressor reduces temperature of turbine blade. But we Indians always have a mentality to utilize each and every part of the engine and hence gas turbine with this technology when combines with the cooling using compressor has its own work and a slight modification in parts while manufacturing holds good and with this new proposed idea, turbine blade temperature can be greatly minimized and it is more efficient in nature.

2. Architecture

The gas turbine cooling system consists of a hub which is directly connected to the hollow shaft which becomes a passage for driving coolant from atmosphere and this passage extends up to turbine blade tip the cross section of gas turbine shown in Fig. 1. When the gas turbine is in ideal condition, the rotor rotates the hub. The hub consisting of air vent drives air and the driven air has to be circulated to turbine blades and hence a mechanism similar pump should take place to drive the air from atmosphere. The principle of driving air inside by creating an empty space inside a hollow shaft is done by aerodynamically designed circumferentially fixed fan. This aerodynamically designed circumferential fan is mounted inside the hollow shaft which rotates along with the shaft thereby creating an empty space which pumps coolant inwards. The coolant air is taken through turbine blade passages by pressure difference.

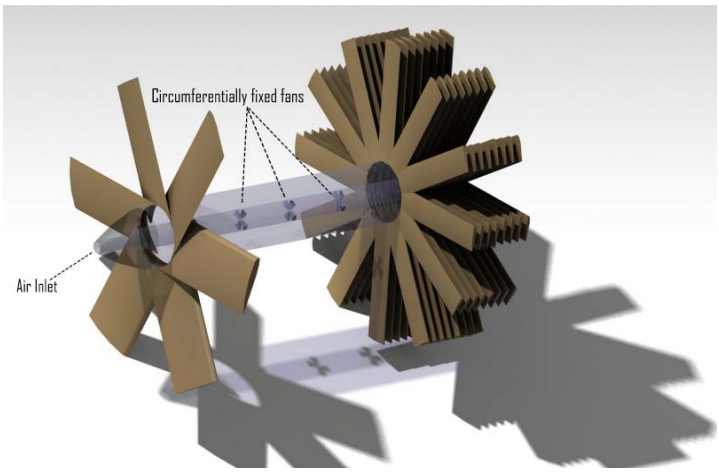

Fig. 1: Architecture of a Gas Turbine Engine Cross Section
(Designed in Cad Software Catia).

It is found that the when a turbine rotates the pressure at a blade tip is far less than that at the blade head hence by law all liquids including air always move from high pressure to low pressure hence coolant passes through the passages of turbine. Removing heat from the turbine blade, on the other side turbine is cooled by compressor action and hence when both the principle coupled together removing major

amount of heat generated which maintains material property and thermal efficiency of gas turbines is greatly increased.

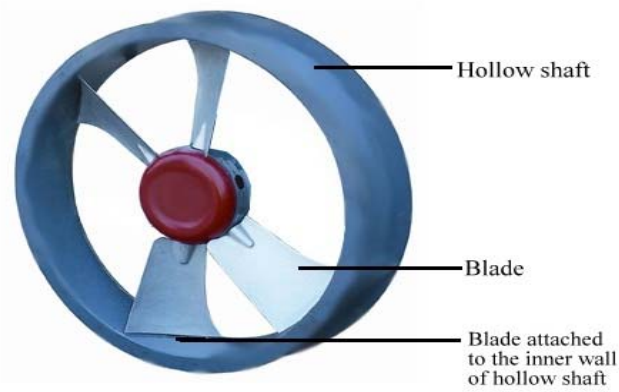

Fig. 1: Architecture Cut Section of Shaft Showing Circumferentially Fixed FAN (Designed Using CAD Software CATIA)

In our case the fan selection plays a major role. It is mandate that the selected fan should pump air from atmosphere and drives it safely without disturbing the setup hence axial type fan is choose in which the air flows in parallel to the shaft thereby removing heat along the flow. Based on the wheel arrangement it is classified into following types

- C-wheel - Blades can be adjusted when running.
- A-wheel - Blades can be adjusted only when the fan is standing still.
- K-wheel - Blades cannot be adjusted.

In our case K-wheel type is used since it is circumferentially fixed perfectly and hence its of one time investment.

Now,

Turbine efficiency=heat removed in turbine by driving air from compressor.

Future,

Turbine efficiency = heat removed in turbine by driving air from compressor + heat removed through circumferential fan technique.

3. Problems Faced

Calculating mass flow rate of coolant air,

Mass flow rate

Mass flow rate is the mass of a substance which passes through a given surface per unit time. It is denoted by symbol $\dot{m}$ Its unit is kilogram per second.

Mass flow rate =$\dot{m}$ = r VA

for ideal compressible gas,

$$\dot{m} = \frac{A\,p_t}{\sqrt{T_t}} \sqrt{\frac{\gamma}{R}}\, M \left(1 + \frac{\gamma - 1}{2} M^2\right)^{-\frac{\gamma+1}{2(\gamma-1)}}$$

Where
A= Area
R= Gas constant
V= Velocity
Tt = Total temperature
r = Density
ϒ= Specific heat ratio
Pt = Total pressure

The known values are substituted in above equation and mass flow rate is calculated.

Vibrations on engine is studied finally and necessary measures to overcome this is executed.

4. Conclusions

Hence thereby when the above proposed technology is introduced in modern gas turbine engine thermal efficiency is greatly increased and definitely as per the title "Circumferential Fan Cooling" is elite in turbines life.

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