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Simulation of gas turbine blade for enhancement of efficiency of gas turbine using ANSYS

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Abstract: *As day by day population of the world is increasing and our resources are frequently reducing hence to meet this demand of the world of energy we have to move to a device which have a maximum efficiency for the condition turbo-machinery are better suited machines having a good efficiency, in which a Gas turbine is best example of turbo- machinery Turbine is the part of gas turbine which provide the power to compressor to run or provide power to external source from where energy can be extracted by attaching alternator in the shaft of Gas turbine. As in earlier a lot of work have been done by the researcher to increase the efficiency and standard of Gas turbine by the method of film cooling, coating, and curvature of blade to protect the blade from high temperature of 1200 C° inside the Gas turbine to increase the life of blade without considering about the efficiency of the engine As in this work is to enhancement of efficiency of Gas turbine. Gas turbine blade is very important component of engine as they are attached to both turbine or compressor and turbine provide energy to compressor hence the turbine blade are more important component to enhance the efficiency which will be analyzed on the basis of blade height area of fluid flow , area of blade thickness and angles . This simulation is based on the define value of temperature pressure density of fluid and solid used in blade construction will be meshed in ANSYS and calculation on the basis of FEM and the result from this calculation over the temperature and fluid flow inside the gas turbine of different number of blade is studied will be compare to reach high efficiency point. By determent these value output is formulated on graph chart and will be studied and result obtain*

Keywords: *Cp specific heat, C camber length, LE Leading edge ,TE trailing edge , (C/S) Solidity, R1 inlet of blade , Pitch Cord Ratio (S/C),S2 inlet of shroud ,S1 inlet of hub ,T temperature ,kg/s mass flow rate*

I. INTRODUCTION

Velocity of gases increases or decreases due to blade attached to its components' turbine, compressor or several other devices such as regenerator economizer etc. Gas turbine is classified into three categories by number of shaft. Gas turbine is a machine which has a shape of a long cylinder attached with tricone at the end. They have higher efficiency or power /weight ratio compared to other turbo-machinery or internal combustion engines. Gas turbine has very few moving parts which mean they are more reliable than other turbo machine. Gas turbines are easier and cheaper when it is installed in a power plant. For the instalment of Gas turbine in power plant , installation can be completed in a period of about 400 days which is less than nuclear power plant takes 1900 days, coal plant takes 1200 days .This is factor by gas turbine is getting more attention in some nation. They are easily operated and provide power to industries by the help of generator attached to the shaft of Gas turbine and are also providing power to boats aircraft cars etc and are replacing other cycle engine as they are more economical. Siemens turbines are of about 90 % efficiency and total efficiency of this turbine is 45 % is utilized by the industries or other respective field. By combining two different type of turbine the efficiency can be increased. Gas turbine efficiency is based on brayton cycle and is calculated on this value of assumption. Gas turbine has compressor, turbine and combustion chamber attached to shaft. The main part of turbine and compressor are blade attached to them , blades are attached in compressor and turbine in opposite direction to each other , hence blade is major part of Gas turbine engine as by changing blade geometry efficiency can be increased in the engine.

II. Blades

Blades are attached to hub in meridian manner to withstand heat and forces, stress. Turbines are of also two types radial and axial turbine .Compressor and external machine for output get power from turbine only

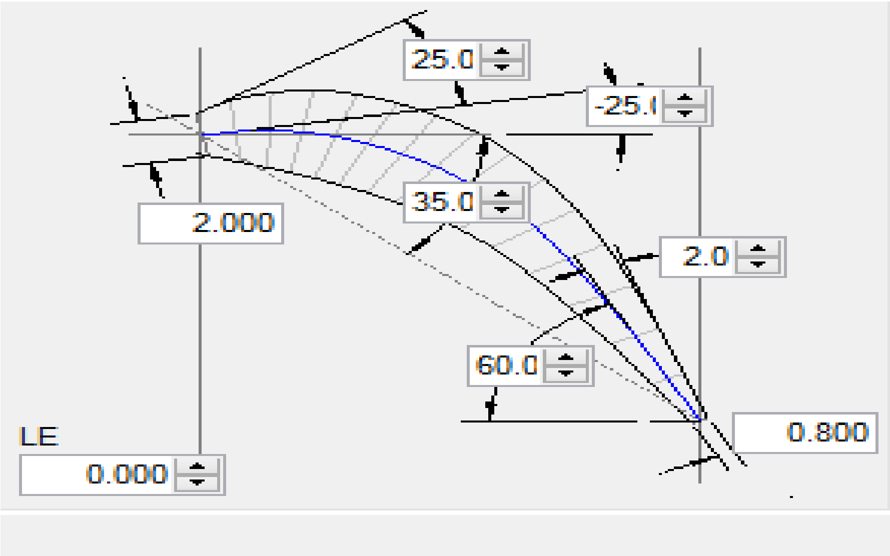


Fig 1 Sketch of blade of type 1

The blades of gas turbine are attached to compressor and turbine. The blades are part of Gas turbines which are providing gas. They receive all the time heat in spite of that blade have to produce power to compressor or turbine for outcome by exerting a high stress on their part. Blade of turbine can be divided on the basis of leading and trailing edge geometry in the form of

1< Edge, 2< Ellipse shape , 3< Cut of type

III. Methodology 1

Design of turbine blade with having LE Pitch = 7.46518 mm and TE Pitch(S) = 7.70221 mm and Airfoil Area = 131.637 mm², Camber Length = 43.3695 , Cord Length (C) = 39.2005 , Meridional Length (M) = 31.144mm, Stagger Angle = 37.4°, Solidity (C/S) = 5.08951° Pitch Cord Ratio (S/C) = 0.196483 LE Thickness = 1.94059 mm, TE Thickness = 0.800947 mm and these are the value of size for this turbine blade and for this thesis many blade design were model to check the correct value to suit the turbine After modulating a 2 dimensional model of blade of length 40 mm then a height of according to shaft diameter blade length were made and the blade design of 3 model were drafted in cad

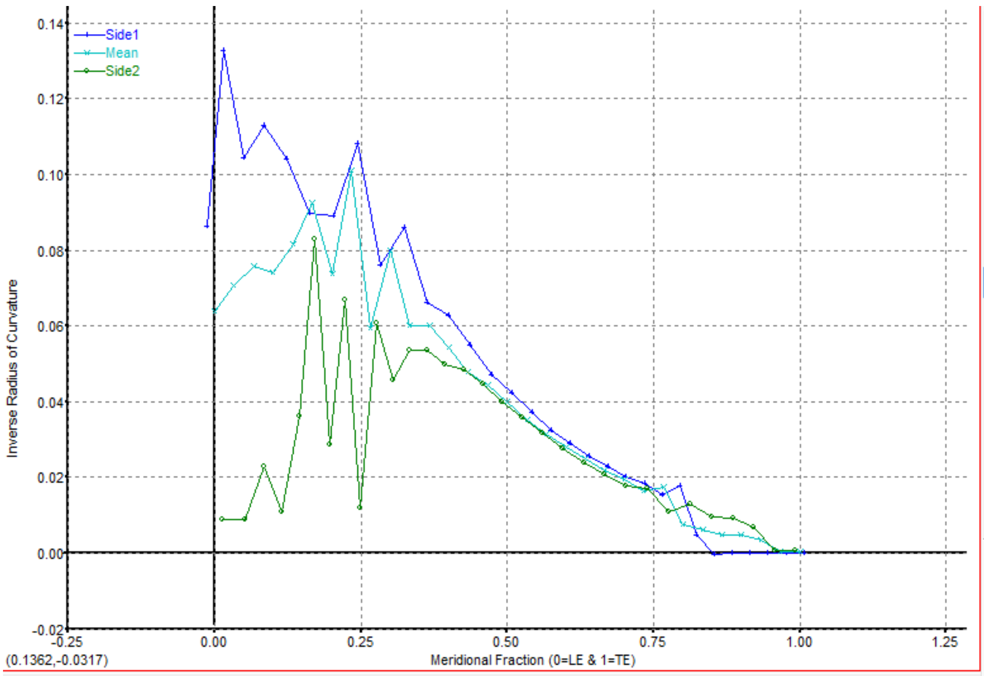


Fig 2 the graph variation of radius at two side of blade

On the basis of graph of figure 2 showing blade location thickness aerofoil area the blade model is design for this report after designing of blade then they are ready to attached in turbine then they are attached in shaft so that they can for series of blade in circular manner

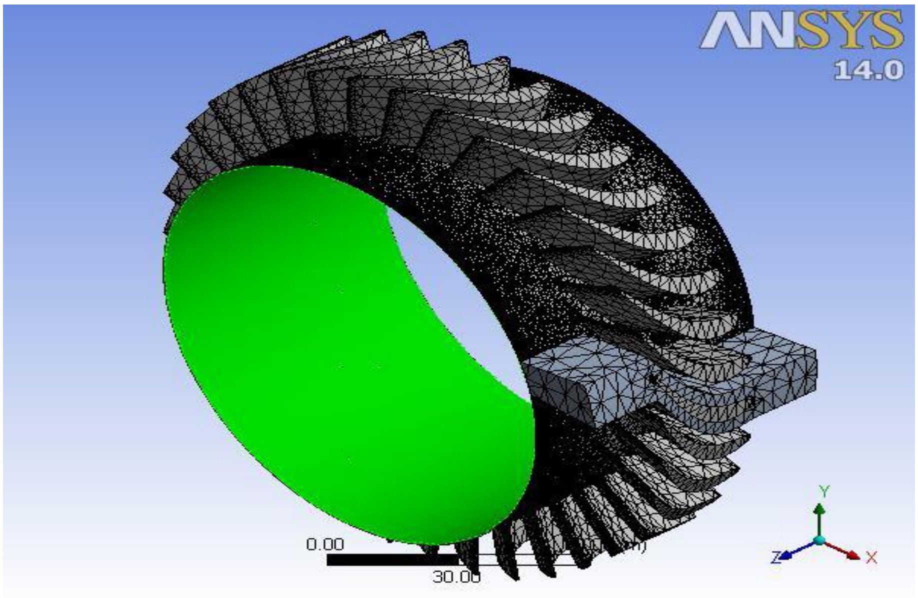


Fig3.12 showing mesh model of turbine blade attached to hub

Meshing is the first pre processing stage in ANSYS analysis. Meshes are done on the model to substitute the values of input parameter. Meshing in thesis is done by defining this model in to geometry and then the fluid flow region of one blade is define as body is symmetry not necessary define all the blade, by meshing fluid flow and heat transfer are based on differential equation, in order to analyze fluids and heat flow nodal point are split into hexahedral mesh. Continuity equation all around nodes of model will be put in the entire flow region by creating mesh

domain	Nodes	element
R1	15916	13378
S1	12880	11286
S2	4480	3654
Total	33276	28309

Table 3.1

IV. Methodology 2

The blade which is generated in CAD transported to software ansys of fluent where the flow of fluid will be analyzed and design of blade with hub of turbine for 3D design is processed for solving first step is to check the mesh quality and the model is again meshed for solution

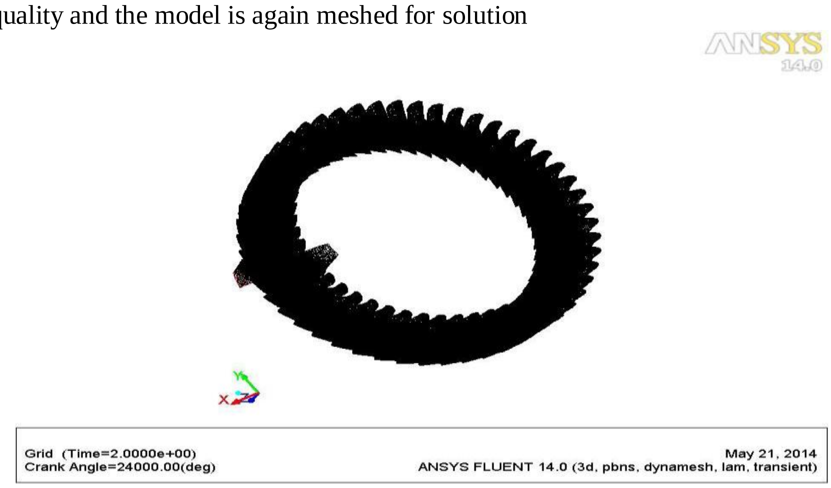


Figure 4.1 mesh design of turbine blade

Fluid which will flow in the Gas turbine is define and the and the radius and height is according to hub diameter is set and all this solution are based on Navier stroke equation by keeping gravitation force on the blade and the fluid which are flowing are acetylene air acetone etc are define for analysis with their density thermal conductivity and many other input are define to solve the result the blades are calculated in the dynamic mode and mesh is again update which are based on

- **Smoothing**: This enables to calculate the mesh of blade on the basis of diffusion method
- **Layering:** Layer of mesh are added or removed the cell by moving toward adjacent layer
- **Remeshing:** by this model is again meshed For setting up reference quality for computing the result geometry reference value are specified taking hub as value from where value is calculated area $1m^2$, density $1.252 kg/m^3$ enthalpy 0 length 39.37 mm temperature = 300 k with value 1 m/s and specific heat Cp =1.4

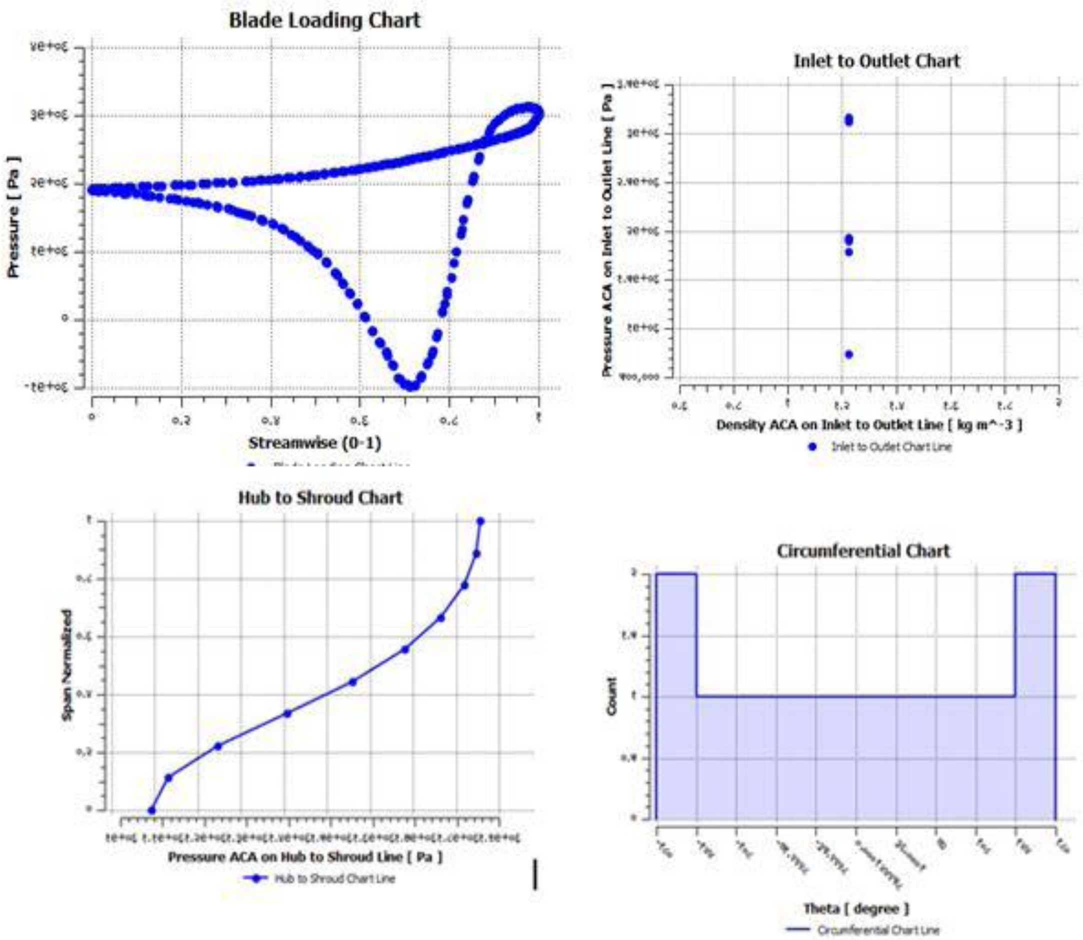
Then the parameters are set to solve the equation by the following way

- Gradient is set on the basis of heat pressure square cell
- Pressure equation set to calculate pressure at nodes or element of blades
- Momentum is second order upwind
- Energy is second order upwind

All these formulation is based on first order equation For up and down in the value in calculation the relaxation of 0.3 in pressure, $1 kg/m^3$ in density, energy 1 moment0.7 is taken into consideration for calculation For solution to be in perfect result the iteration is set to max 27 in a interval of 1 and Force value area analyses then value are calculated on each nodes of geometry by meshing and the area of blade inflow are calculated

V. Result

FLUID FLOW ANALYSIS OF BLADES Fig result of analysis of fluid flow for blade type 1 In this report more than 30 type of blade were analysed and according to them the value are obtained but only two types blade results

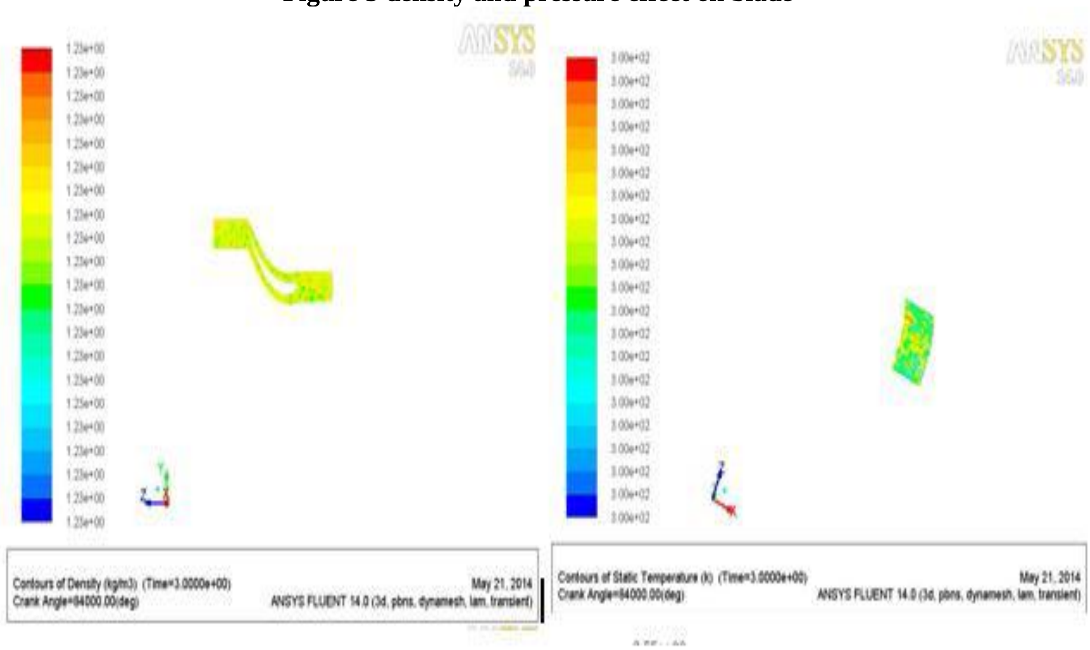


It is mention. Pressure at the blade were calculated and shown on the Graph and density variation according to area are mention

FORCE REPORT
Domain Name: Default Domain
Global Length = 2.3664E-02
Minimum Extent = 2.0757E-02
Maximum Extent = 5.0000E-02
Density = 1.1850E+00
Dynamic Viscosity= 1.8310E-05
Velocity = 0.0000E+00

These are values which are obtained by the analysis of fluid forces at point of blade hub shroud etc

Figure 5 density and pressure effect on blade



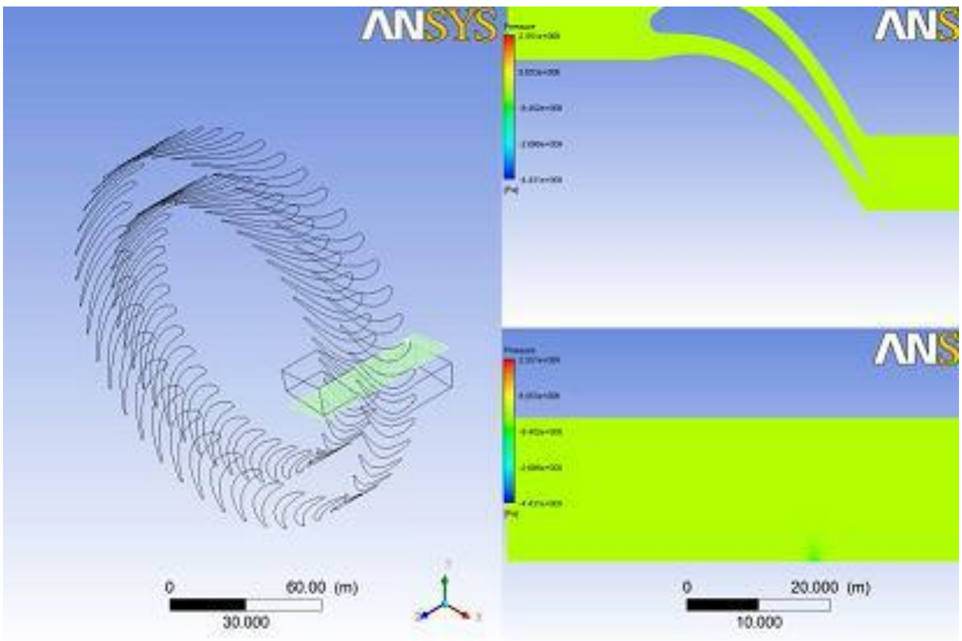


Figure 5 variation of fluid while flowing over blade

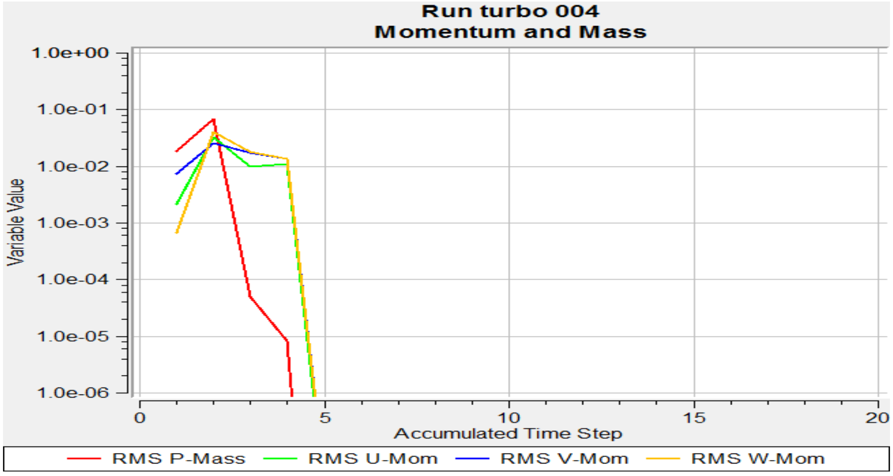


Figure 5 variation pressures, velocity internal energy

VI. Conclusion

On the basis of result obtained from more than 30 types of blade at temperature from 22 °C to 2000 °C of blade having shroud for leading edge and trailing edge different size and shape and the camber length increasing and decreasing value. Flow analysis for blade having blade without shroud results are best but life of blade are shorter than but it will increase the efficiency of blade as flow of fluid inside the turbine having 42 number of blade the pressure are less at leading edge comparisons than trailing edge and less interference of fluid takes place can also enhance the efficiency of turbine. The heating effect of blade is same for all materials are based on density of blade material INCONES 165 having density8400 Kg/m³ is good. The value will also increase when density of material will increase. Shroud will reduce the flow of fluid inside the turbine. Temperature does not show any type variations on the blade geometry until its operating condition or melting point incone165 is best. Forces on the turbine with 42 blades have an effect of maximum 5.00575 E 002 and minimum2.00575 E 02 and dynamic viscosity is also better for more than or less than 42 blades of turbine . Value obtained for 42 number of blade having leading and trailing edge square cut is also less than the elliptical shape blade On the basis of this report the number of 42 blade of turbine having elliptical leading edge and trailing edge the result output of turbine efficiency is better than other.

VII. Future Aspect

With the invention of different type of material having high melting point and thermal conductivities and different density the blade of turbine can be further studied, as the use of turbine is increasing in the industries to because of increasing have maximum efficiency as resources are diminishing day by day.

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