Optimization Of Turbine Blade With Different Thickness Of TBC Material

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***Abstract*—Turbine blades are the intrinsic parts of energy generation segment because they work in rough conditions. Therefore, it is necessary to increase turbine blade performance to prevent additional expenses of maintenance and repair of component. There are discrete ways to enhance gas turbine blades performance such as using a high strength supper alloy, reduce blade temperature generate during process use of inter-cooling supply line. TBC coating apply on blade surface usually with air plasma spray (APS) coating technique and occupy blade body to protect it from high range temperatures. Effects of different TBC's materials and Their thickness on heat transfer between jet steam and blade body is studied. YSZ as TBC perform as protecting insulation layer that increases the temperature gradient between the steam and blade body. For this purpose turbine blade model is design using solidworks 3d modeling software and Finite Element analysis software is used for the ANSLYSIS of the Blade. Material properties are taken as temperature dependent and boundary conditions were applied as heat transfer coefficient. Different Thickness of TBC Material are coated and analyzed for Heat Transfer Rate and Life of the blade.**

Keywords-**3D modeling ,Alloys, TBC and steam Turbine.**

I. INTRODUCTION

Turbine perform important role in power plants industries. blades of gas-steam turbine work in an aggressive environment, which causes to formation of mechanical stresses and destructive thermal stresses. Turbine enigne performance get affected by unpleasant defect in blade. Research studies show that countless gas turbine are damaged due to cracking of TBC layer a blade body process to oxidation and corrosion occurs which result in to turbine blade failure. Thermal stress is one of the influencing parameters known in turbine blades design, which is dependent to the temperature division, so to improve ability of turbine blade to withstand against temperature effects is challenging work for engineers. Thermal Barrier Coatings(TBC) performs the important function on isolate components such as gas-steam turbine and aviation engine parts operating at elevated temperatures. thermally accumulated metallic components deposited by Thermal barrier coatings(TBC) layer , in gas turbine as instance. thermal conductivity is categories feature of TBC's. The coating generate unsustainable temperature gradient when exposed to high heat flow. By using TBC as layer increase temperature resisting capacity of the process by blade and that help to improve efficiency. Studies show's use of super alloys, heat reducing Methods and thermal barrier coating (TBC) layer on component are important factors, that help to increase blades life and overall turbine efficiency. TBCs have been introduced and applied during the past few period of year, to protect blade surface against high temperature and increase its life. In this Project Objective is to enhance the working Life and field Performance of the turbine blade using different Thermal Barrier Coating materials with different Thickness. Brodin H., Jinnestrand M. ,Johansson S. and S jöström S [1] Author worked on a prediction of fatigue life of model has been used based on a Paris law-approach. Model in physical manner sense that it takes the local stress-state (from thermal and mechanical loading) into consideration. By design calculation of energy extraction rate at the crack blade tip and allowing for mode mixity. Nitin P. Padture, Maurice Gell, Eric H. Jordan [2] A review is presented on thermal barrier coatings(TBC) for the application of Gas-steam Turbines.TBC using electron micrograph (SEM) of an electron-beam physical-vapor(EB-PVD) is material powder form deposite as TBC on surface. The obtained results included the turbine blade with internal hollow pocket for air-cooling purpose, whereas the outer side high temperature surface is under thermal barrier coated, setting up temperature gradient across TBC layer. A. Ziaei-Asl,M. Tayefe Ramezanlou [3] Blades of the Gas turbine are introduces as the key parts of energy production segment as they work in high rough surrounding conditions. In this paper,combustion gases and blade body heat transfer had been studied on the different TBC thickness.

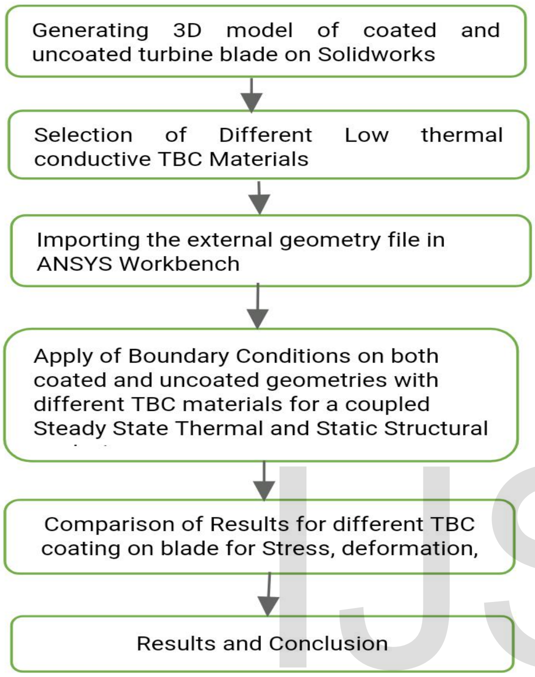


Fig. 1. Overall methodology

I. Experimental Details and Measurement

A single Turbine blade is selected of GER3808C with dimensions referred from US Patent no. 6,461,110. Analysis results performed for single blade reflects complete symmetry of the Turbine.

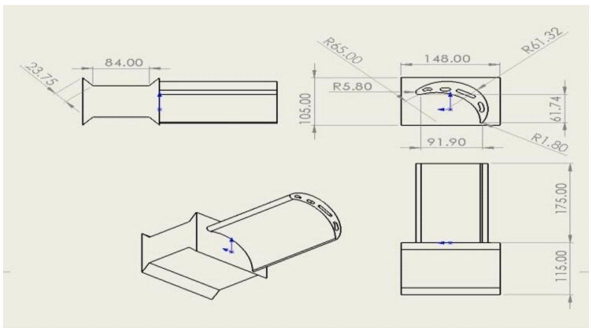


Fig 2: Detail drawing of the Blade

Following boundary conditions are assume to study the behavior of Turbine blade.

- Steam Temperature- 500 C
- Convective heat transfer coefficient:- 200 w/m2k
- Thermal conductivity of Structural Steel:- 60.5 w/mk
- Impact Pressure on Turbine blade- 120 bar
- Power generation capacity- upto 30mw

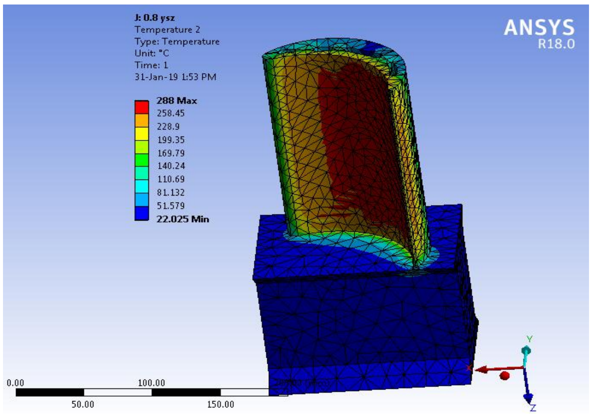
Properties	Y-PSZ	YSZ	Alumina	Zirconate
Density (kg/m3)	6030	5850	3980	6050
Elastic Modulus (GPa)	210	40	413	156
Ultimate Tensile Strength (MPa)	2500	1630	665	48
Poisson's Ratio	0.23	0.21	0.33	0.28
Coefficient of Thermal Expansion (1/ C)	$10.0x10^{-6}$	1.07e-5	1.09e-5	9.7 x10-6
Thermal Conductivity(W/m C)	2.2	2.12	4	2.15

Fig.3. Properties of material

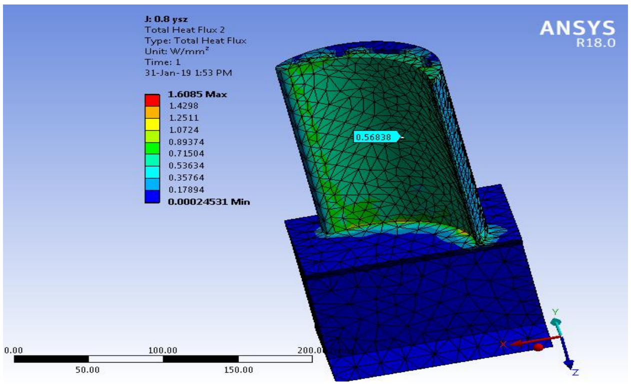
Thickness	0.2mm	0.4mm	0.6mm	0.8mm	uncoated
Surface Temprature (C)	425.5	365.22	322	288	500
Heat Flux (W/mm2)	0.9747	0.86113	0.7249	0.5683	1.3014
Stress (Mpa)	220.1	227.35	229.03	152	1308.1
Deformation (mm)	0.9228	1.2323	0.6641	1.3425	1.1313

Fig.4. Material Properties of TBC coated blade with YSZ

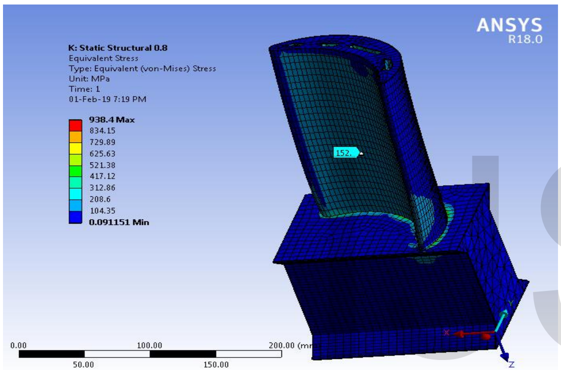
Simulation results for 0.8 mm YSZ Coating:



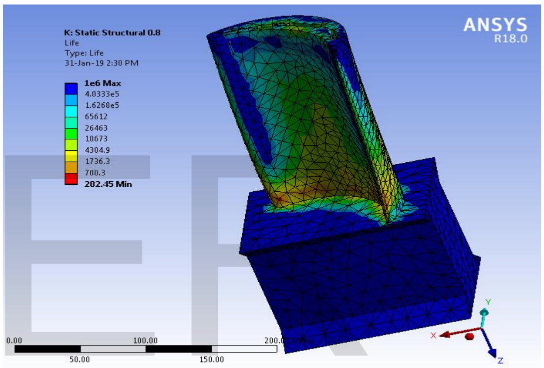
Temperature Distribution for given Conditions.



Total Heat Flux for given Conditions



Equivalent Stresses for given Condition



Total life for given Conditions.

II. TABLE OF RESULTS

Parameters	Uncoated	0.8 mm TBC YSZ
Surface Temperature (C)	500	288
Heat Flux (W/mm2)	1.3014	0.56838
Stress (Mpa)	1308.1	152
Fatigue Life (overall)	1x10^5	4.03x10^5

III. CONCLUSION

The comparative simulation results prove that application of YSZ TBC coating on turbine blade has resulted in significant reduction in different parametric values. Application of YSZ TBC material has significantly controlled the direct heat interaction with to the turbine blade and therefore enhanced the fatigue life of the turbine blade. This further improves the performance of the turbine and improves the efficiency of power plant. TBC coating of increased thickness i.e. 0.8 mm can further enhance multiple life parameters of the steam turbine.

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