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Research Paper

STUDY AND PERFORMANCE ANALYSIS OF GAS TURBINE COMBUSTION CHAMBER AND IMPROVING COMBUSTION EFFICIENCY BY USING CERAMIC COMPOSITE MATERIAL COATING

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Combustion chamber with ceramic material coating is defined as the process of alternating the material concept toget high combustionefficiency. The aim of ceramic chamber coating is to develop high combustion with engines designed to advanced material concept substantially during various combustion conditions. Gas turbine combustion chambers can be generally classified as Can, Annular, Can Annular, etc. Most of the Gas turbine combustion chamber concepts are based upon size and injector position, chamber material but till now not implemented on ceramic materialcoating, ceramic material include the combined material. There is few researches being carried in combustion chamber with new concept. Here, in our concept, the ceramic material (silicon carbide (SiC)) is used in combustion chamber to coat for conventional chamber material to get high temperature combustion exit gas and to get high thrust. In this project, the combustion chamber with ceramic material coating is designed by using CATIA. In order to predict the chamber with ceramic, the numerical analysis of ceramic chamber coating by using ANSYS. The increment of combustion efficiency will be expect by using ceramic combustion chamber coating in gas turbines, which means get more Thrust.

Keywords: Combustion efficiency, ANSYS, Combustion chamber, Thrust

INTRODUCTION

This development of the gas turbine combustion chamber as an aircraft and power plant has been so rapid development has been increased gradually in early to years. The challenges in designing high performance combustion systems have not changed significantly over the years, at present ceramic composite material (SiC) used as protective coating of element of aircraft gas turbine

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combustion chamber, hypersonic technology products, where the acute problems of protection structure at high temperature in on oxidizing environment. ceramic material combustion chamber coating (SiC) used to develop the small amount of thrust.

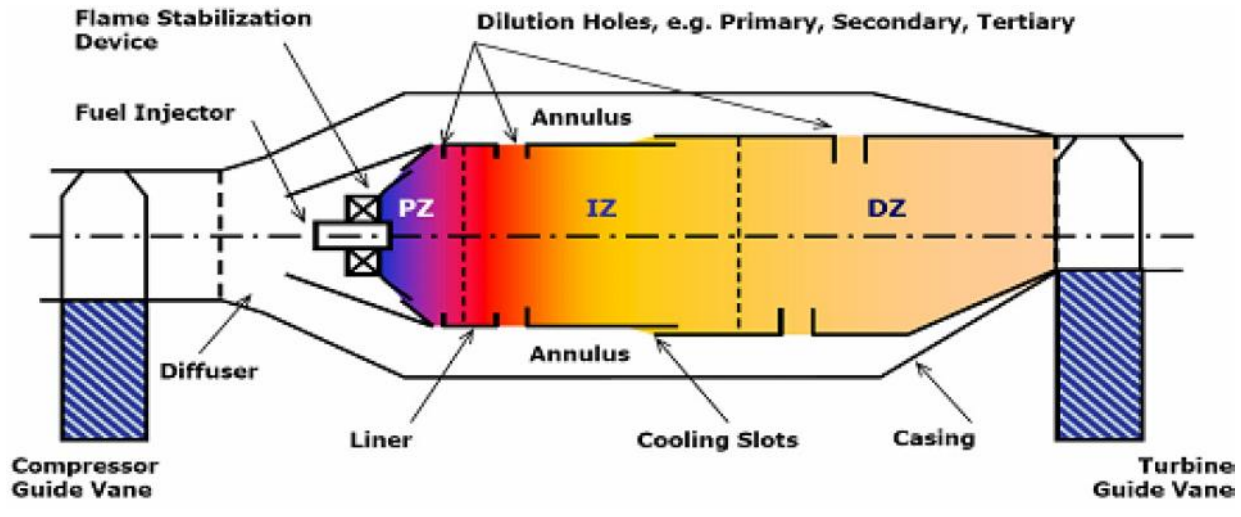
PRINCIPLES OF JET PROPULSION

The basic principle of the propulsion of aircraft is fairly simple. Newton's third law of motion, when broken down to its simplest form states, "to every action, there is equal and opposite reaction". What that means is, if you push on something that something will push back at you. In this same way propulsion formed, the 'body' is atmospheric air that is caused to accelerate as it passes through the engine. The force required to give this acceleration has an equal effect in the opposite direction acting on the apparatus producing the acceleration. A jet engine produces thrust in a similar way to the engine/propeller combination. Both propel the aircraft by thrusting a large weight of air backwards one in the form of a large air slipstream at comparatively low speed and the other in the form of a jet of gas at very high speed.

COMBUSTION CHAMBER

The combustion chamber (Figure 1) has the difficult task of burning large quantities of fuel, supplied through the fuel spray nozzles, with extensive volumes of air, supplied by the compressor and releasing the heat in such a manner that the air is expanded and accelerated to give a smooth stream of uniformly heated gas at all conditions required by the turbine. This task must be accomplished with the minimum loss in pressure and with the maximum heat release for the limited space available. The amount of fuel added to the air will depend upon the temperature rise required. However, the maximum temperature is limited to within the range of 850 to 1700 °C. by the materials from which the turbine blades and nozzles are made. ssThe air has already been heated to between 200 and 550 °C. by the work done during compression, giving a temperature rise requirement of 650

Figure 1: Combustion Chamber



to 1150 °C. from the combustion process. Since the gas temperature required at the turbine varies with engine thrust, and in the case of the turbo-propeller engine upon the power required, the combustion chamber must also be capable of maintaining stable and efficient combustion over a wide range of engine operating conditions. Efficient combustion has become increasingly important because of the rapid rise in commercial aircraft traffic and the consequent increase in atmospheric pollution, which is seen by the general public as exhaustsmoke.

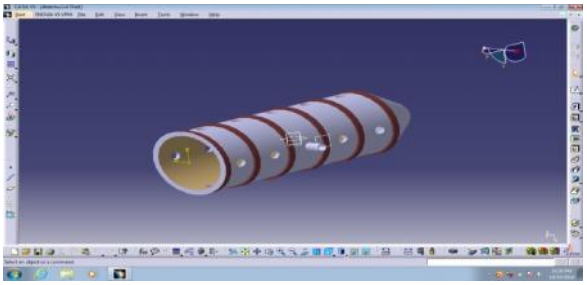
MODELING PROCESS

Ceramic coating combustion chamber is an advanced modeling apart from the combustion chamber. The chamber is designed according to the same principle of combustion. We look the studies of these combustion chamber and compared that ceramic coating combustion chamber is the best and designed it in CATIA software.The full design of Electromagnetic plasma arc propulsion system is shown in Figure 2.

Table 1: Specifications

S. No.	Parts	Dimensions (mm)
1.	Combustion chamber entering diameter	150
2.	Width	485
3.	Outer Diameter	288
4.	Primary and secondary zone holes	10

Figure 2: Ceramic Coating Combustion Chamber



ANALYSIS PROCESS

Ceramic coating combustion chamber flows are practically done through flow analysis techniques. These process can be done through flow analysis in ANSYS software. ANSYS is the best analysis software for the Ceramic coating combustion chamber because the accuracy of the flow as shown the maximum percentage. All the difficult processes are done through ANSYS , because in our analysis we are convert flow velocity into temperature load.

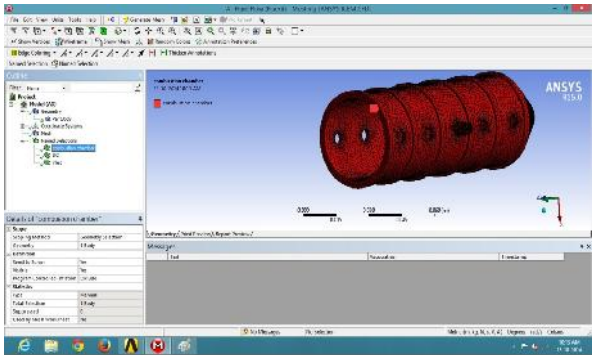
MESHING

The entire structure over the combustion chamber was meshed with Triangular mesh with an interval of 0.03. Triangular meshing was chosen because it was finer over the difficult

Table 2: Boundary Conditions

S. No.	Conditions	Value
1	Mass flow rate of Air (Kg/s)	5
2	Chamber inlet temperature (°C)	1130

Figure 3: Grid Structure of Ceramic Coating Combustion Chamber



regions when compared to the hexagonal mesh and it is shown in Figure 3.

ANALYSIS PROCESS

The temperature contour of the ceramic coating combustion chamber as shown in figure 4 . This system analysis done by ANSYS software. Here the red colour indicate high temperature value and blue colour indicate low temperature value. We can identified from figure the temperature value is less in inlet section when compared to the exit chamber. Because principle of combustion, the inlet section (or) chamber inlet have less temperature and exit section (or) chamber exit have more temperature. Here in this analysis we are used ceramic coating in inside surface of chamber and this coating thermal conductivity is less when compared to conventional once, so here heat transfer rate is low and the combustion efficiency is automatically increased. So the temperature is low in inlet section than exit section and the temperature is more in exit section than inlet section.

RESULTS AND DISCUSSION

We are calculated chamber parameters for ceramic coating combustion chamber. Also compare chamber parameter with conventional chamber and that is listed below.

Figure 4: Temperature Contour of Ceramic Coating Combustion Chamber

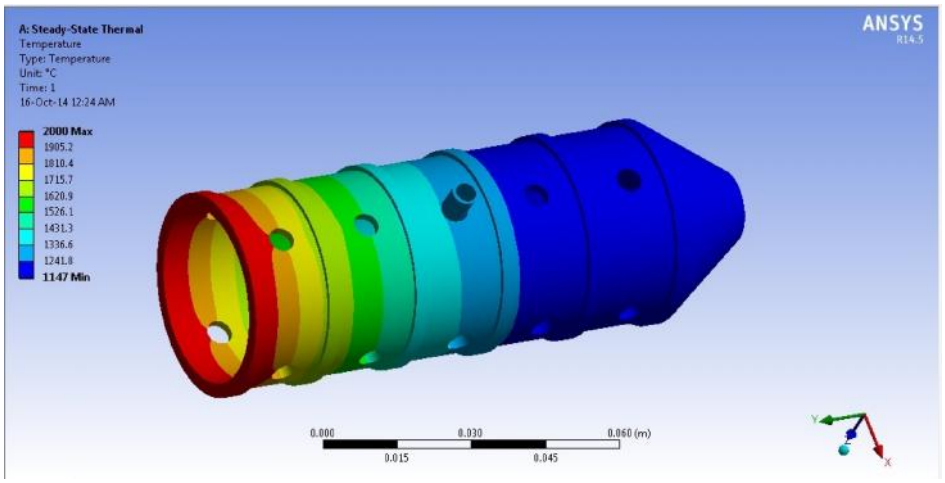
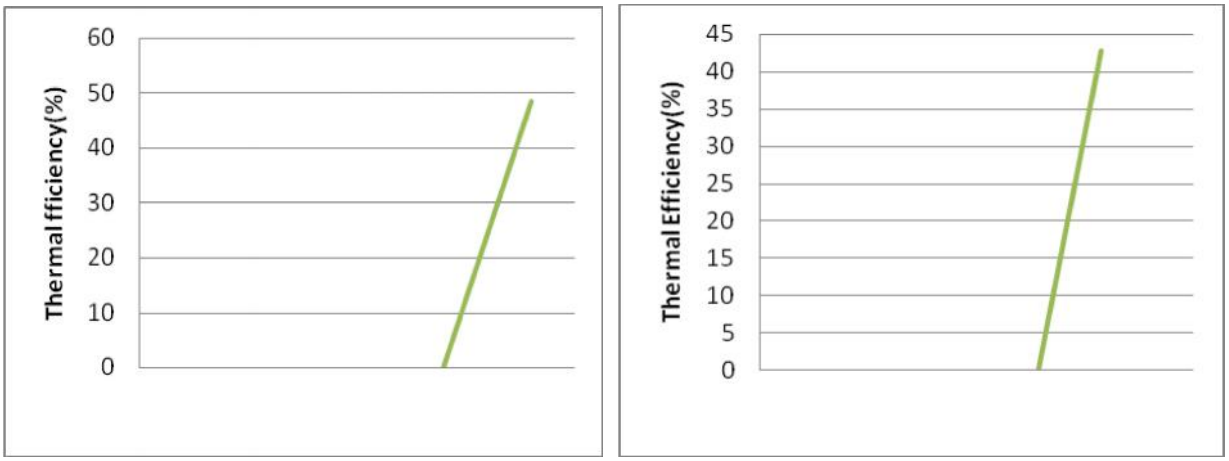


Table 3: Comparison of Combustion Chamber

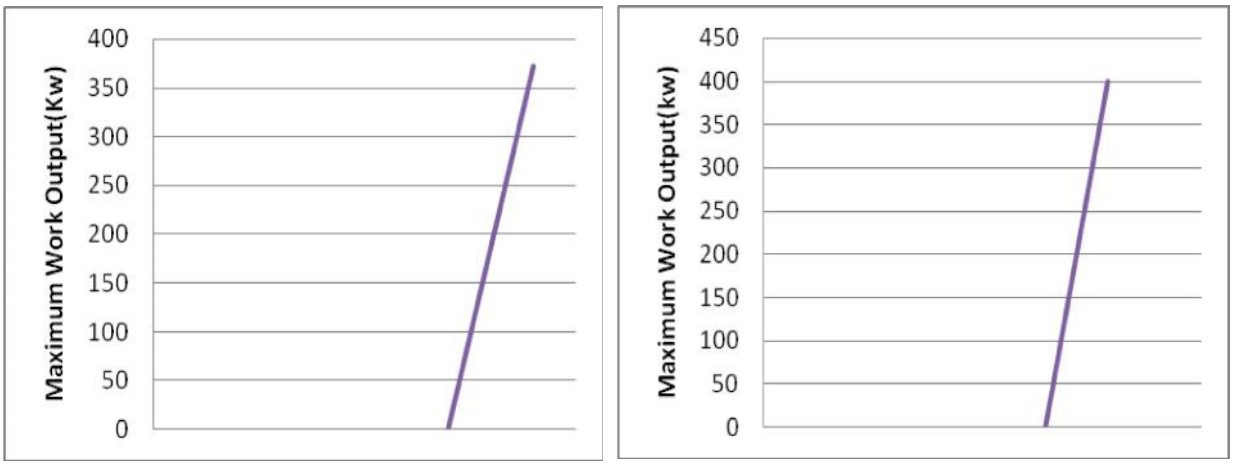
Ceramic Coating Combustion Chamber		**Conventional Chamber (Nickel Based Combustion Chamber)**	
Performance	**Value**	**Performance**	**Value**
Thermal Efficiency (%)	48.5	Thermal Efficiency (%)	42.7
Maximum Work Output (Kw)	372	Maximum Work Output (Kw)	400
Heat Rate	0.023	Heat Rate	0.028
Specific Fuel Consumption (s^{-1})	0.00198	Specific Fuel Consumption (s^{-1})	0.00225
Combustion Efficiency (%)	70	Combustion Efficiency (%)	65

We are plotted thrust graph for ceramic coating combustion chamber and conventional combustion chamber and also the graph shown below. The graph indicate the ceramic coating combustion chamber produce combustion efficiency in linearly, after combustion efficiency suddenly increases. The conventional combustion chamber Produce thrust linearly, but produce rate of combustion efficiency is low than ceramic coating combustion chamber as shown in Graph 5. We are plotted combustion chamber parameters graph for ceramic coating combustion chamber and conventional combustion chamber and also the graph shown below. Identified from graph ceramic coating combustion chamber parameters are produce linearly, after parameters are suddenly increases. The conventional combustion chamber parameters are produce linearly, but produce rate of parameters are low than ceramic coating combustion chamber as shown in Graphs 1, 2, 3, 4 and 5.

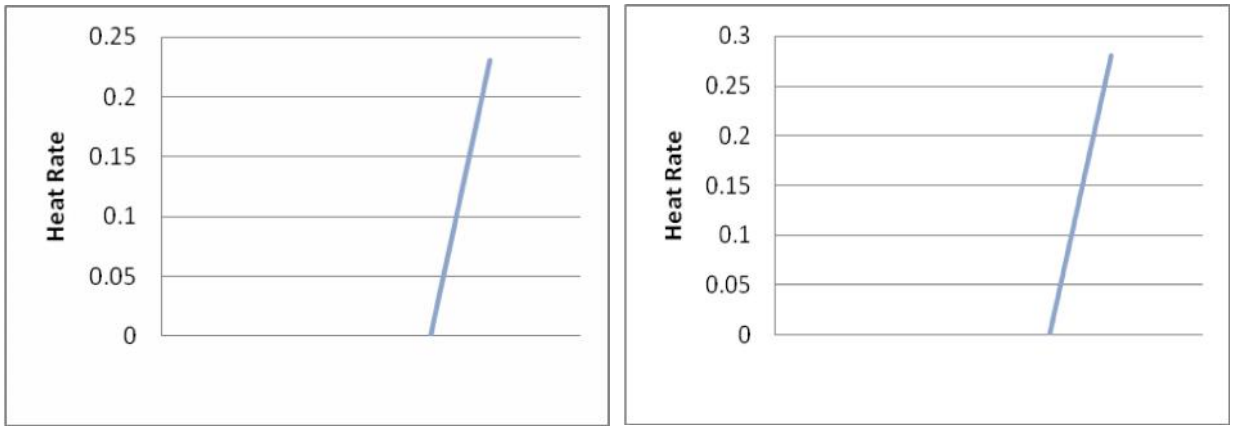
Graph 1: Comparison of Graph of Thermal Efficiency



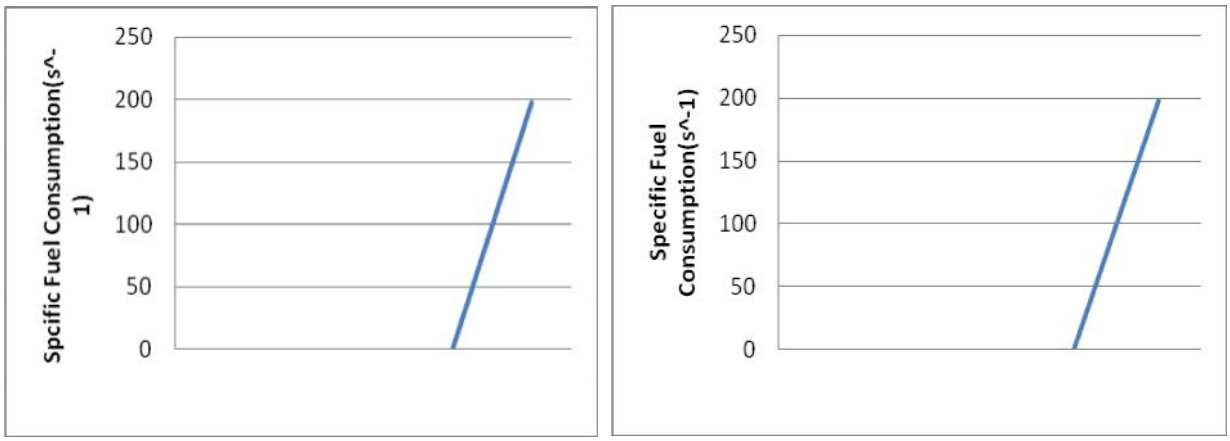
Graph 2: Comparison of Graph of Maximum Work Output



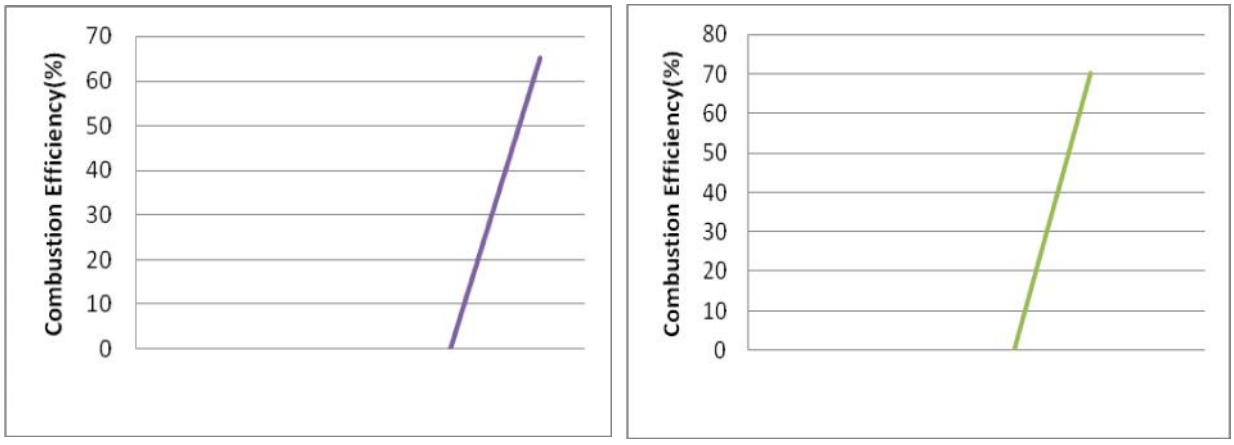
Graph 3: Comparison of Graph of Heat Rate



Graph 4: Comparison of Graph of Specific Fuel Consumption



Graph 5: Comparison of Graph of Combustion Efficiency



CONCLUSION

The Ceramic material coated combustion chamber, Aircraft Industries and Laboratories because it will give more combustion efficiency. Here ceramic coated combustion chamber produced the more thrust at the same time combustion chamber life increased. If this combustion chamber was implemented small amount of thrust increased then compare to conventional combustion chamber. The ceramic material cost is less. This combustion chamber of conventional model may use in Laboratories and especially large aircrafts. Because of this system produce more combustion efficiency and life. If we are implement this system in future for Large efficiency, we can develop our country Gas turbine combustion chamber Research field when compared to other countries combustion chamber Research field and also we can face and overcome the combustion chamber efficiency Problems during combustion.

REFERENCES

1. Cao Q, Vassen R and Stover D (2004), "Ceramic Materials for Thermal Barrier Coatings", *Journal of European Ceramic Society*, Vol. 24, pp. 1-10.
2. Chan S H and Khor K A (2000), "The Effect of Thermal Barrier Coated Piston Crown on Engine Characteristics", *Journal of Materials Engineering and Performance*, Vol. 9, No. 1, pp. 103-109.
3. Metin Gumus and Mehmet Akcay (2010), "Thermal Barrier Coatings for Diesel Engines", November 19-20.
4. Pedaprolu Venkata Vinod, Seshaiah T and Victor Babu T (2012), "The Design and Analysis of Gas Turbine Blade", Vol. II, No. I, pp. 136-138.
5. Rimrott F P J (1989), *Introductory Orbit Dynamics*, Vieweg, Wiesbaden.
6. Sovey J S and Mantenieks M A (2007), "Performance and Lifetime Assessment of Magneto Plasma Dynamic Arc Thrashers Technology", *Propulsion Power*.
7. Sravavana Kumar P and Punna Rao P (2013), "Design and Analysis of Gas Turbine Combustion Chamber".