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Analysis of Annular Combustion Chamber of Jet Engine with Methane as Fuel

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***Abstract*: Numerical investigation of combustion effectiveness and properties of methane air mixture is tested in gas turbine annular type combustor through three dimensional computational fluid dynamics by using ANSYS CFX 14.5. In this study we designed two models of combustors. Using modified (with vanes) and basic model we compared the performance and efficiency of combustors. By providing vanes we can increase the air resident time in the combustor with helps to increase the output energy. Here we compare the properties like temperature, pressure, velocity and emission mass fractions.**

***Keywords*: Gas turbine combustor, ANSYS 14.5, Computational fluid dynamics.**

1. Introduction

Gas turbine engines are mainly found in the modern world to create the charged power or thrust, they are called permitted generate thrust for aircrafts mostly. The combustor is among the right elements of turbine engine; we have different levels in gas turbine engine. In this scholarly study we handle combustion stage or combustion chamber. In this stage the energy is put into the engine in the kind of heat and it can help to rotate the multistage turbines to create power to operate the compressor etc. the primary goal of the combustor is to create it with low emissions. Stream field in the combustion is normally the principle part which needs to be studied and analyzed both in academics and industries, it gets the commercial importance to investigate and predict at several phenomena during combustion. Gas turbine combustor needs to be designed and developed to meet many mutual conflicting design requirements i.e., High combustion performance over a broad operating envelope, Low NOx emissions, Low smoke, Low flame balance limits, Good beginning properties, Low pressure drop and enough cooling air to keep low wall temperature amounts with structural resilience. Numerical simulations on combustor stream fields had become unavoidable method to accelerate the look modifications which have the very best efficiency and also to optimize their performances. Numerical calculations over the program also facilitates the understanding and visualization of physical phenomena which costs high or frequently inaccessible by experimental method. The usage of CFD codes to predict the stream areas with in a gas turbine combustor provides been motivated for most studies. In this work 3d turbulent fluid flow evaluation is carried out through the use of swirl stabilized gas turbine combustor model with compressible CFD computations had been performed using ANSYS CFX employing k-ἐ turbulence model for closure and eddy dissipation model for combustion. In this function we analyzed the various properties over basic combustor style and modified combustor style with Methane-Air mix at same input conditions.

2. Geometry

Here we considered the predicted geometry to analyze the stream. Create four circles of radius 30, 37, 43 and 50. By creating surface using two circles inlet area can be created and by extruding 15 units two cylinders. At first the surface has to be created and by using fuel inlet lines the surface created can trimed.

3. Meshing and boundary conditions

A. Meshing

The partial differential equations which give solutions for fluid flow and heat transfer is not simple. To achieve solution domains are spitted into subdomains. The governing equations are then discretized and solved inside each subdomain. For this thesis work mesh adaption has done with tetrahedral and prism elements at boundary layer. Meshing for this geometry is done in ICEM CFD.

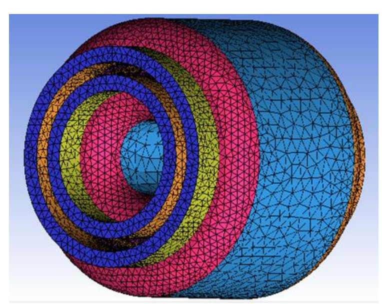

Fig. 1. Basic annular type

B. Eddy dissipation combustion model

In Eddy Dissipation Combustion chemical reaction takes place very fast in molecular level relative to transport processes

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to the flow. When reactants mix at lower molecule level, instantaneously form products. The model assumes reaction rate is directly proportional to time required to mix reactant. In case of turbulent flow reaction rate is directly proportional to Kinetic Energy and Kinetic dissipation. In this model mixing rate is dominated by eddy properties.

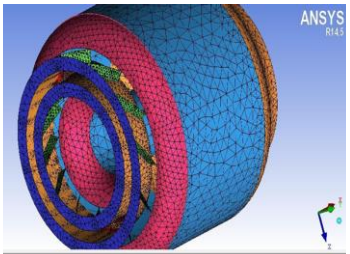

Fig. 2. Modified annular type

C. Boundary Conditions in ANSYS CFX-Pre

Inlet Air Temperature 300K and fuel inlet velocity 10m/s
Test 1- Air inlet velocity at 20m/s
Test 2- Air inlet velocity at 30m/s

4. Results and Discussions

A. Inlet air stream lines for both basic and modified combustors

Below figures shows how the stream lines are formed along the combustor at same air velocity.

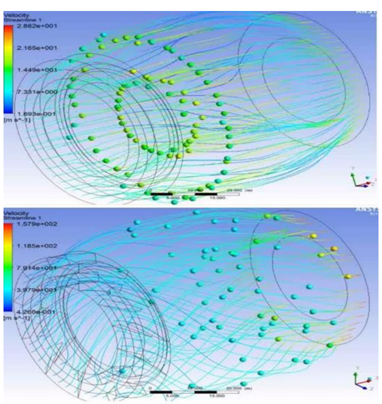

Fig. 3. Stream line view

Test 1- Air inlet velocity at 20m/s

Basic Annular combustor without vanes and Modified annular type with vanes.

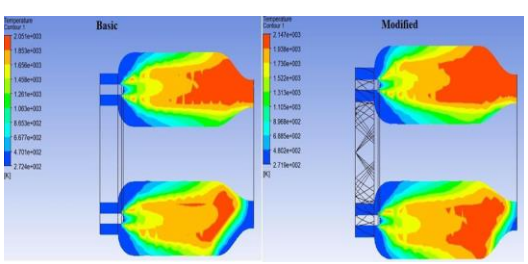

Fig. 4. Temperature distribution at air velocity 20 m/s

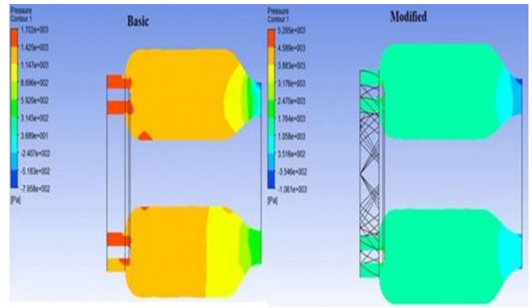

Fig. 5. Pressure distribution at air velocity 20 m/s

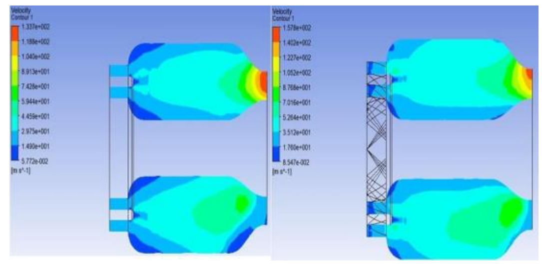

Fig. 6. Velocity distribution at air velocity 20 m/s

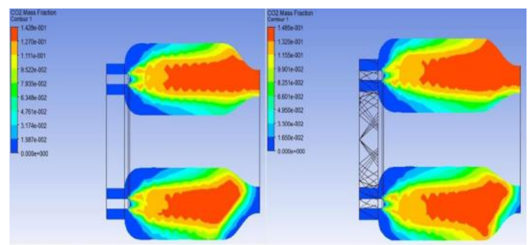

Fig. 7. CO_2 Mass fraction variation at air velocity 20 m/s

Test 2- Air inlet velocity at 30m/s

Basic Annular combustor without vanes and Modified annular type with vanes.

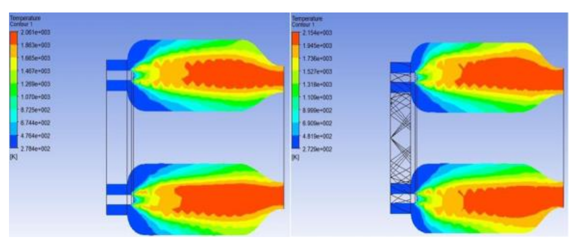

Fig. 8. Temperature distribution at air velocity 30 m/s

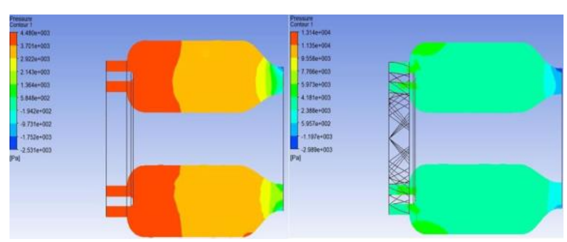

Fig. 9. Pressure distribution at air velocity 30 m/s

5. Conclusion

The design of Annular-type combustion chamber, modified

Annular -type combustion chamber geometry and numerical investigations is carried out. The k-ε model used for analysis and also the mean temperature, reaction rate, and velocity fields are almost insensitive to the grid size. For methane as fuel and with initial atmospheric conditions, Temperature profiles shows increment at reaction zones in modified combustor when compared to basic. In modified Annular -type combustion chamber clearly shows that temperature, velocity profiles increases. The time for combustion is increased by installing vanes in the combustion chamber. At 20m/s Air inlet velocity, velocity is increased by 19% and pressure is decreased by 53% in modified combustor, at 30m/s, Velocity is increased by 14% and pressure is deceased by 48%. Coming to temperature only 4% increment is occurred in modified combustor in both air inlet velocities.

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