Design and Analysis of Annular Combustion Chamber With Swirl For Better Efficency

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Abstract- *Design of an annular combustor is considered as a major factor for this project. An analytical approach is used to calculate the values for the annular geometry. The various dimensions of the combustor are calculated based on the different empirical formulas. CATIA V5R20 software is used to design and generate the combustor model which is incorporatedwithdifferenttypesofswirlandtheanalysisofthecom bustoristobeperformedintheANSVSsoftware. The pressure drop variation is to be studied for various models designed with different swirltypes.*

Keywords- Annular combustor chamber, swirl, engine efficiency

I. INTRODUCTION

Gas turbines are in the stage of constant improvement and development to make it essential to operate over a wide range of operating conditions. Thus, the design of combustion chamber of the gas turbine plays a major role inthe stable operation of the gas turbine. Thus, the annular combustor design is undertaken. Modern trend proves the annular combustion chamber design to be highly efficient design. Thus, the annular combustor design is undertaken in this work for the purpose of understanding the pressure drop study in the combustor and to get the optimized design. Conventional gas turbine consists of an inlet diffuser, fuel injectors, Swirler and three combustion zones namely, primary, secondary and dilution zones. Basically, the design of the combustor involves empirical relations and numerical modelling of the design. The purpose of the design is to obtain an acceptable solution over a wide range of design challenges. The challenges that are considered during the new design of the combustor is the combustion efficiency, pressure drop, limitations of the combustor, interaction of the combustor with components like turbine and compressor and the different types of fuel that can be used in the engine

II. METHODOLOGY

The designing of annular combustor is based on a simple empirical methodology. And then the swirl types are designed based on the ideology of design from the literature survey

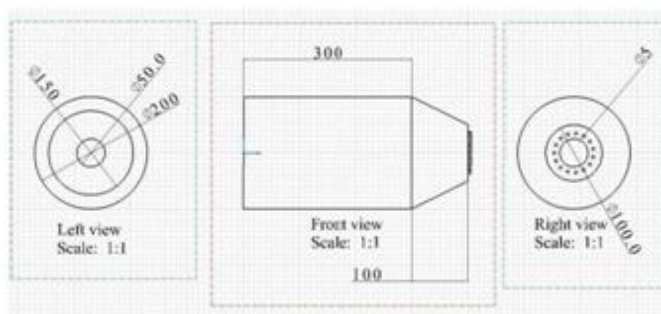

Figure .1 Drafted diagram of the annular combustor

CATIA MODELLING

The basic model comprises of 15 injectors each of 5mm diameter placed inside concentrically. And 30 ignition coils were also incorporated inside themodel. The drafted and the wireframe view of CATIA diagram of the annular combustor has been shown in figure.2

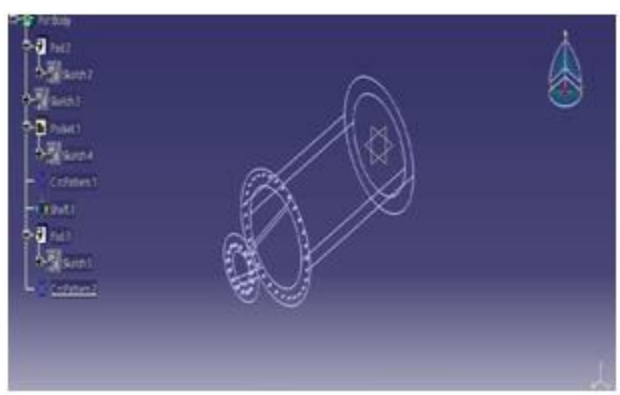

Figure 2. Basic annular combustor

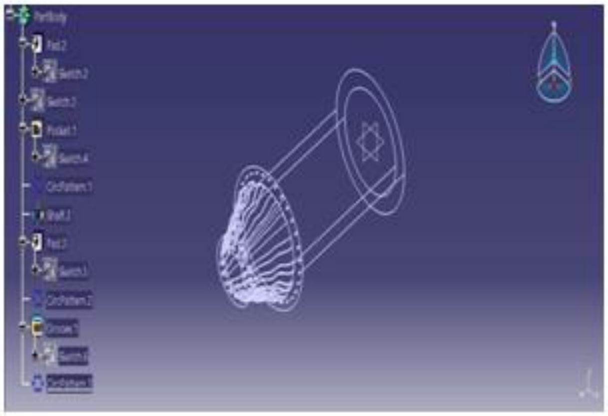

Figure -3 Annular combustor with flat swirl.

The flat swirl is incorporated with basic model of the annular combustor. The flat swirl incorporated with the annular combustor model shown in f

Table -1 Specification of flat type swirl

CONTENT	VALUE
Number of lines	15
Vane width	2.30 MM
Swirl angle	45°
Number of instance	15

The curved type of swirl is designed with three zones inside basic annular combustor model.

Table-2 Specification of 45° curved type swirl

CONTENT	VALUE
Number of vanes	15
Vane width	1.20mm
Swirl angle	45°
Number of instances	45

The 45° curved swirl incorporated with annular combustor is shown in figure 4

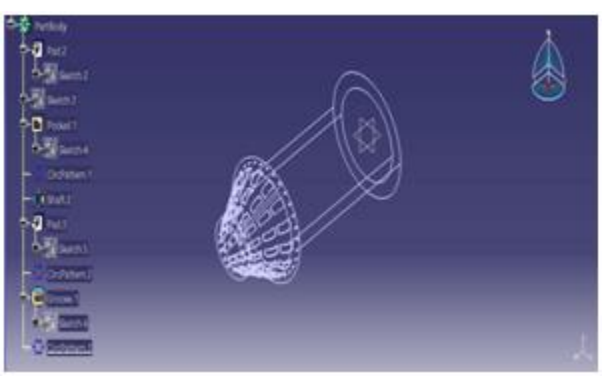

Figure -4 Annular combustor with 45° curved swirl

Table-3 Specification of 50° curved type swirl

CONTENT	VALUES
Number of vanes	15
Vanes width	2mm
Swirl angle	50°
Number of instances	45

The 50° curved swirl incorporated with annular combustor is shown in figure 5.

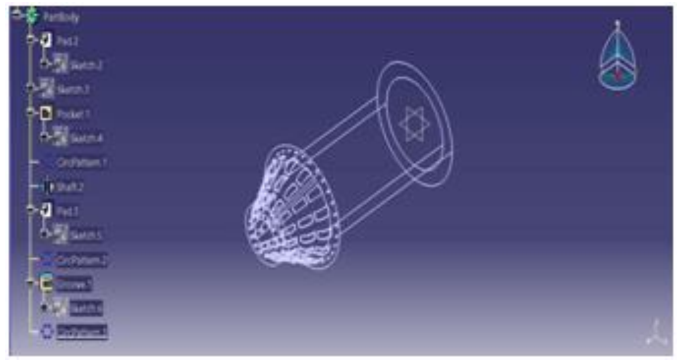

Figure -5 Annular combustor with 50° curved swirl

III. MESHING

The various types of model designed were then imported into the design modeler of the ANSYS 16 workbench and the fine meshes which could yield on optimized result were generated.

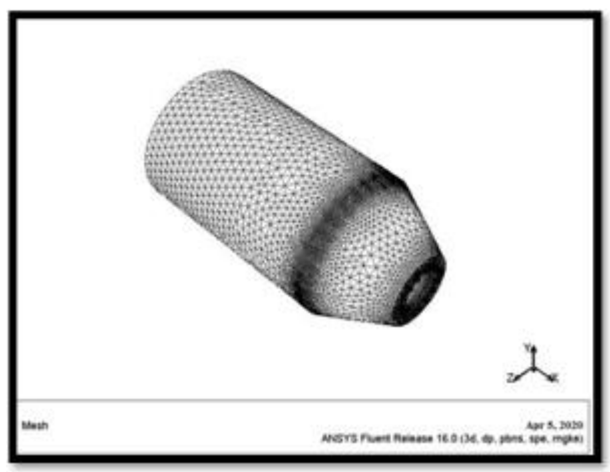

Figure -6 Tetrahectral 3D MESH generated for annular combustor

IV. RESULTS AND DISCUSSIONS

4.1 Basic annular Combustor model

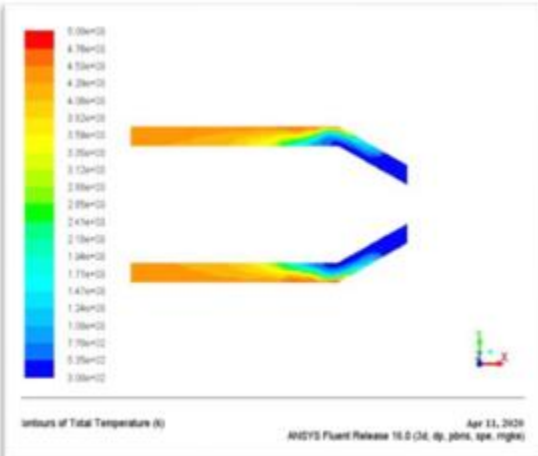

Figure -7 Total temperature contours of basic annular combustor model

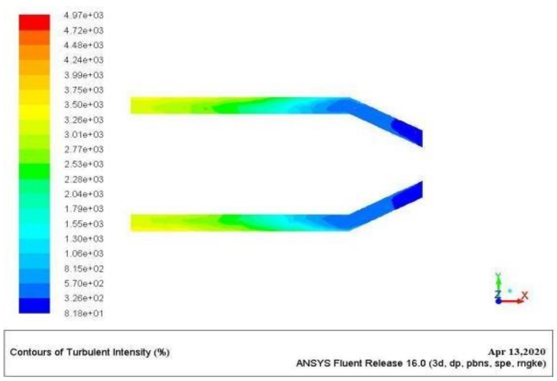

Figure -8 Turbulent intensity contour of basic annular combustor model

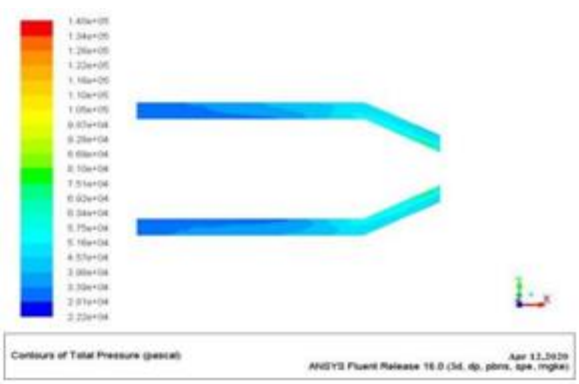

Figure -9 Total pressure contour of basic annular contours model

4.2 Annular combustor model with flat swirl

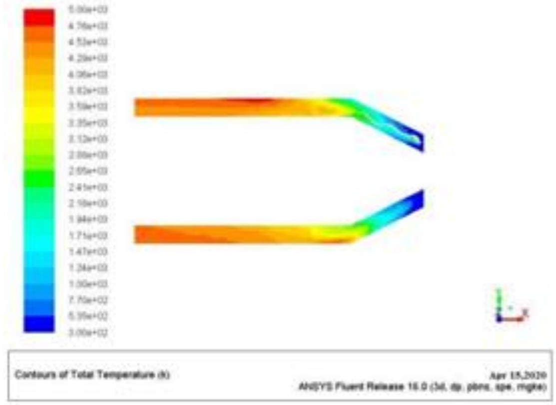

Figure -10 Total temperature contour of annular model with flat swirl.

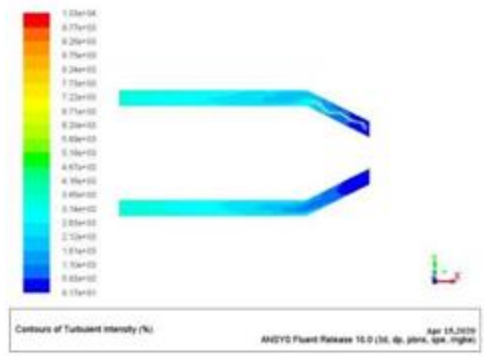

Figure -11 Turbulent intensity contour of annular combustor model with flat swirl.

4.3 Annular combustor model with curved 45° swirl

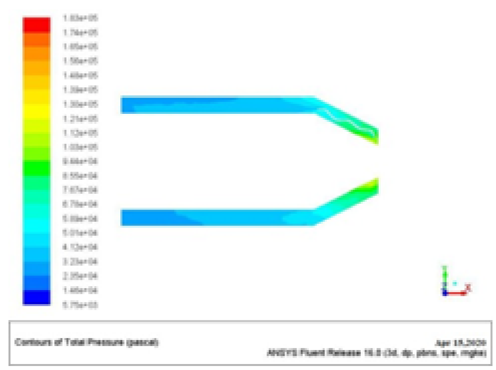

Figure-12 Total pressure contour ofannular combustor model with flatswirl.

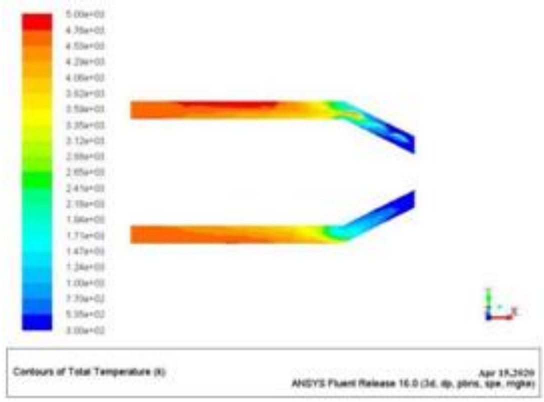

Figure-13 Total temperature contour ofannular combustor model with 45°swirl.

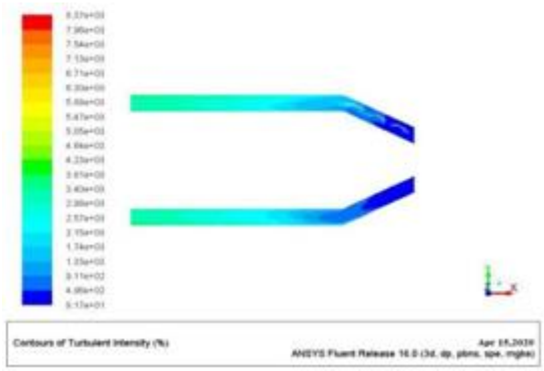

Figure -14 Turbulent intensity contour ofannular combustor model with curved 45°swirl.

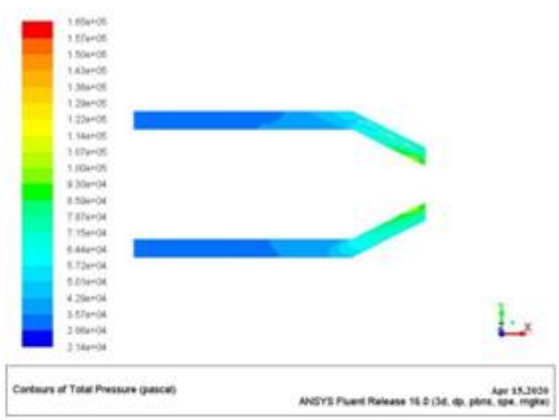

Figure-15 Total pressure contour ofannular combustor model with curved 45°swirl.

4.4 Annular combustor model with curved 50' swirl

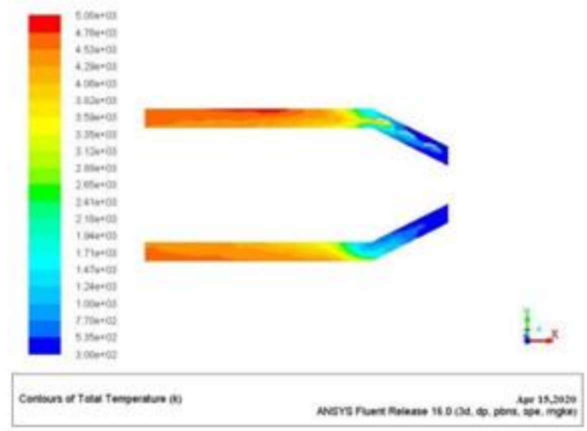

Figure-16 Total temperature contour of annular combustor model with 50° swirl.

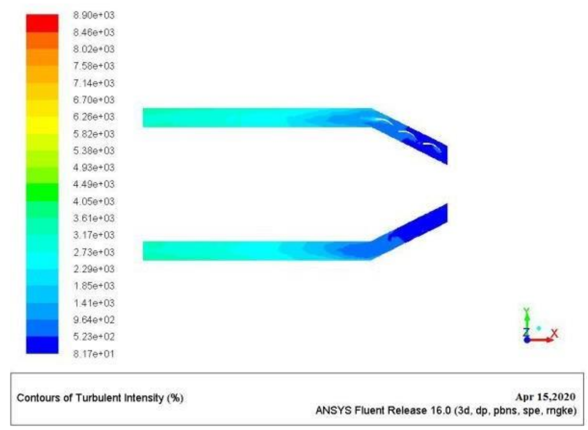

Figure -17 Turbulent intensity contour of annular combustor with 50° swirl.

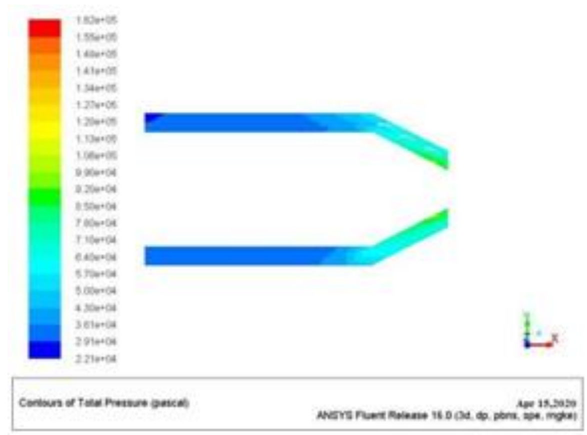

Figure-18 Total pressure contour of annular combustor with curved 50° swirl

V. CONCLUSION

CFD analysis of the various models have beencarried out and the following are the conclusions that can be drawn from this study

- CFD codes can be effectively used for analyzing and estimating flow field generated by different types of models created.
- The Curved Vane Swirl produced better recirculation zone than the other types and there by, increases the level of turbulent kinetic energy.
- For a given angle, Curved Vane Swirls passed more mass flow due to less blockage (flow separation avoided).
- The flow is effectively turned by the Curved Vane Swirls, which resulting in better recirculation zone and improved mixing in the gas turbine combustion chambers.
- The Flat Type also produces considerable amount of recirculation zone and allow for improved mixing.
- Most of the gas turbines also prefer the use of Flat Type Swirl as it is easy for construction and can be easily computed in CFD.

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