Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 6, June -2017

NUMERICAL SIMULATION OF TUBULAR TYPE COMBUSTION CHAMBER WITH HYDROGEN, METHANE AND SYNGAS

[1]Thakur. A.S., [2]Prajapati S,

[1]*M.Tech. Student, Parul Institute of Engineering and Technology -Vadodara,*
[2]*Asst.professor Mechanical Dept. Parul Institute of Engineering and Technology -Vadodara,*

Abstract :- *The burning council of gas turbine unit is a standout amongst the most basic parts to be planned. Looking over writing uncovers that the outline approaches for burning chamber are accessible in a discrete way and there exist a need to order this data and advance a deliberate plan system for ignition chamber. Also in ignition handle nitrogen in fuel and noticeable all around responds with oxygen at high temperatures to frame different oxides of nitrogen altogether called NO_X. Petroleum product control plants are the second biggest producer of NO_X. This is a dangerous toxin making visual and respiratory issues. Likewise NO_X consolidates with water to frame corrosive rain, brown haze, and ground ozone. The present work is an endeavor towards getting such gas burning chamber running on various fuel extent to get least NO_X. In this venture outline and reenactment of smaller scale gas turbine with hydrogen, methane (CNG) and syngas yielding change in yield of emanation and to acquired change in leave pipe gas temperature.*

Keywords *Combustion Chamber, Gas Turbine,Equivalence Ratio,Air Fuel Flow Rate, Stoichiometric Ratio.*

I. INTRODUCTION

As gas turbine innovation progresses into 21st century; burning designers are confronted with the difficulties of accomplishing of higher pressure proportions, higher turbine gulf temperature in gas turbines. In the meantime, as enthusiasm for toxin outflows from gas turbine expands, burning designers are additionally required to consider new means for poison lessening. A specialized talk on ignition innovation status and requirements will demonstrate that the exemplary obstacles that have hampered advance towards close stoichiometric burning still exist. Temperature rise, blending, liner cooling, dependability, fuel impacts, temperature profile control and outflows keep on confronting the mechanical originators with a plenty of building quandaries and exchange offs. Moreover, new materials, for example, fired grid composite are presently being fused ahead of time outlines.

II. PROBLEM STATEMENT

Coal is the main regular asset and petroleum product accessible in plenitude in India. Subsequently, it is utilized broadly as a warm vitality source and furthermore as fuel for warm power plants creating power. Control era necessity has been expanded in late decades to take care of the demand of expanding populace in India. The vast majority of the power, around 70% of aggregate is created by coal-based warm power plants. High review quality coal is utilized by the metallurgical business. So coal provided to warm power plant is of low quality. Coal is the principle source utilized as fuel vitality is changed over into helpful warmth vitality in warm power plant which produces most noteworthy condition and wellbeing concerns. Burning of coal at warm power plants emanates mostly carbon dioxide (CO_2), sulfur oxides (SO_X), nitrogen oxides (NO_X), CFCs particulates, for example, fly slag and Suspended Particulate Matter (SPM). High fiery remains content in Indian coal and wasteful burning innovations add to India's emanation including gasses that are in charge of the nursery impact.

III. AIM OF THE STUDY

The main aim of the study is to simulate tubular type combustion chamber with different proportion of fuel, stoichiometric ratio. And to obtain comparison to yield efficient and least emitting composition pollutants

IV. OBJECTIVE OF STUDY

- To elevate fuel extent to ideal high vitality rate and in the meantime eco-accommodating.
- To fuse the composed ignition chamber in Gas Turbine Engine.

V. DESIGN OF COMBUSTOR CHAMBER

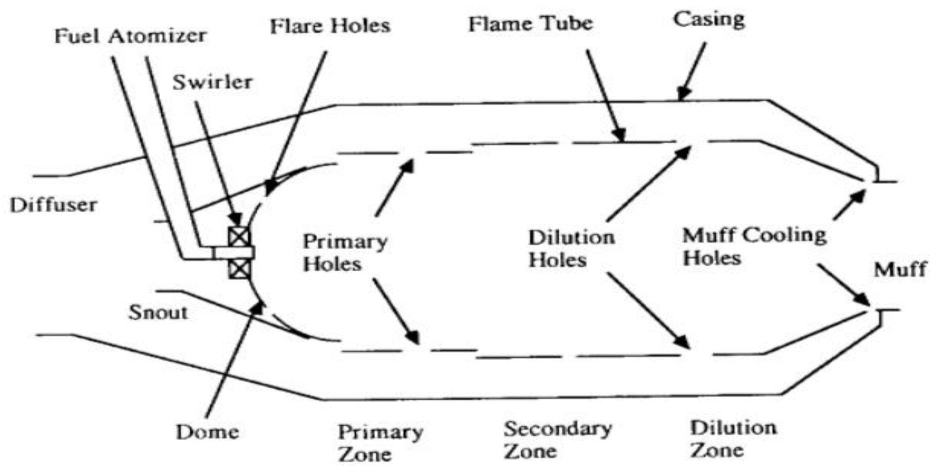


Figure 1 Basic Combustion Chamber

Basic Terminology

There is a need to examine the fundamental combustor chamber wording to comprehend the diverse segments of ignition chamber. Figure 1 is a cross-segment of a non specific dissemination fire burning chamber. The fundamental measurements of the burning chamber are the packaging and liner region.

Design Data

The design data is carried from Kulshreshtha B. (2010). The cycle analysis was carried over equivalence ratio of 0.3, 0.5, 0.7 and 0.9 with fuel methane, hydrogen and syngas at standard stoichiometric condition.

Chamber	Casing Area (m^2)	Liner Area (m^2)	Air admission holes							
			Primary Zone		Dilution Zone		Wall Cooling			
							Primary Zone		Dilution Zone	
			n	d_h (mm)	n	d_h (mm)	N	d_h (mm)	n	d_h (mm)
Tubular	0.0019	0.0014	6	5.98	3	13.07	78	1.83	100	1.32

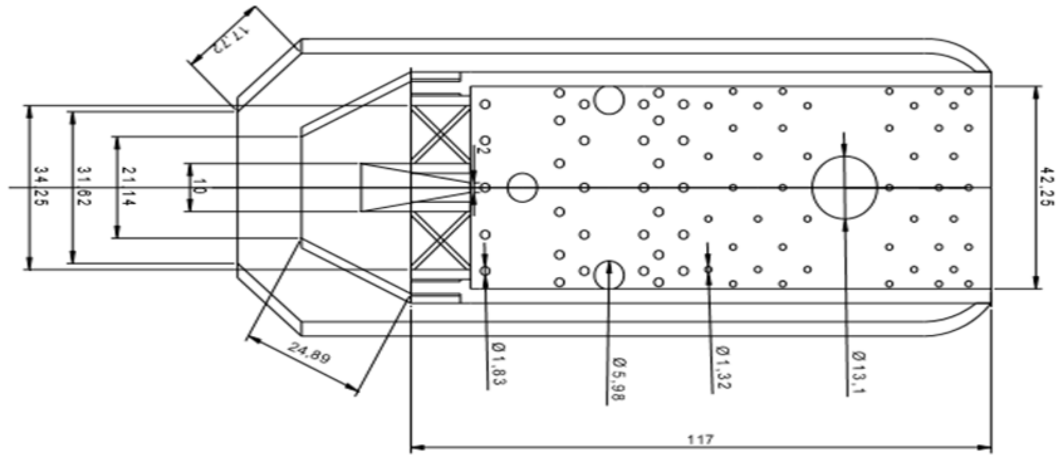


Figure 2 detail drawing of combustor chamber

Case 1 Hydrogen Fuel

Equivalence ratio Ø	Air flow rate	Fuel flow rate
Ø=0.3	0.1028	0.0008
Ø=0.5	0.1028	0.0013
Ø=0.7	0.1028	0.0018
Ø=0.9	0.1028	0.0024

Case 2 Methane Fuel

Equivalence ratio Ø	Air flow rate	Fuel flow rate
Ø=0.3	0.0990	0.0011
Ø=0.5	0.0990	0.0018
Ø=0.7	0.0990	0.0026
Ø=0.9	0.0990	0.0033

Case 3 Syngas Fuel

Equivalence ratio Ø	Air flow rate	Fuel flow rate
Ø=0.3	0.0762	0.0054
Ø=0.5	0.0762	0.0090
Ø=0.7	0.0762	0.0126
Ø=0.9	0.0762	0.0162

VI. NUMERICAL SIMULATION

There are two approaches to break down the ignition chamber numerically. One route is to give enter conditions at gulf and all the air affirmation gaps according to the plan conditions. In any case, in real case, the stream circulation in various zones can't be controlled. This is the greatest downside of giving diverse contributions at various air affirmation gaps. The second method for breaking down the ignition chamber is to give just a single bay at the bay of the diffuser and let the stream isolate without anyone else's input into liner and packaging, and from packaging into various zones through air confirmation gaps and cooling openings. Such condition is the correct imitation of the genuine case experimentation, in which the air is provided at the delta diffuser with known states of weight, temperature and speed, and after that, permitted to separate between the packaging and the liner with fuel infusion at liner section.

Basic assumptions and Boundary conditions

- The ignition chamber is examined by a solitary section at diffuser
- The stream is permitted to partition without anyone else's input into liner and packaging, and from packaging into various zones through air confirmation openings and cooling spaces. Such condition is the correct reproduction of the genuine case experimentation, in which the air is provided at the delta diffuser with known states of weight, temperature and speed, and after that, permitted to separate between the packaging and the liner.
- Majority of the analysts working in the range of computational burning have chosen k – ε model to catch material science of turbulence. The k – ε show under predicts division and is very incorrect with twirling streams and streams with solid streamline arch. In contrast with k – ε, SST k – ω represents the vehicle of the turbulent shear stress and gives very exact expectations of the onset and the measure of stream partition. Additionally, the model can be utilized with coarser close divider work and deliver legitimate outcomes.
- Wall limit condition and warmth misfortune influences the fire structure and expectations of temperature levels in ignition framework. In present case, for the 3D estimations with CFX, the adiabatic framework model is utilized in view of vast mass stream rate of air through annulus which keeps divider cooled packaging about at surrounding temperature.

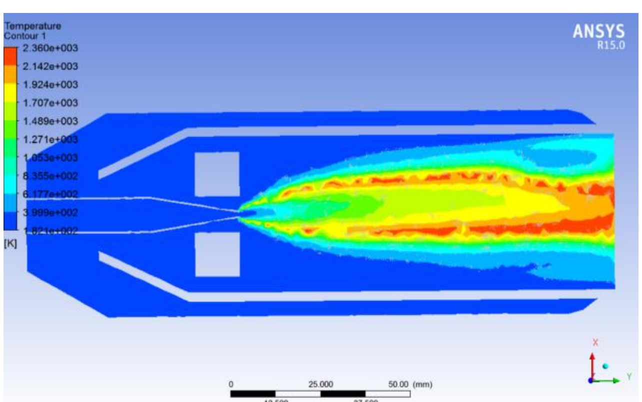
CFD Modeling

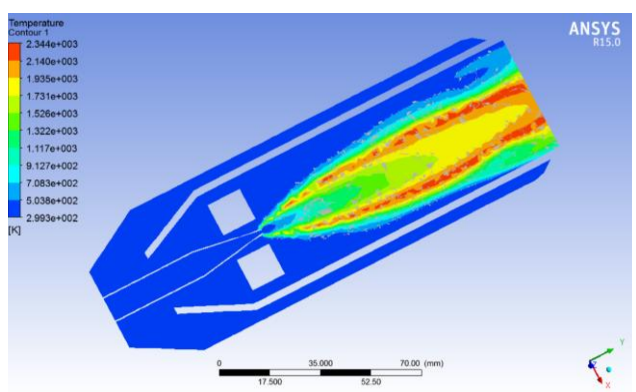
The combustor displaying is completed utilizing whirlpool dispersal show in light of the idea that synthetic response is quick with respect to the vehicle forms in the stream. At the point when reactants blend at the sub-atomic level, they momentarily frame items.

Fluid Model	Thermal Energy
Turbulence Model	SST K-ω
Radiation Model	Discrete Transfer
Nitrogen	Constrain
Combustion reaction	1. Hydrogen 2. Methane 3. Syngas

CFX-RIF Generator was utilized to incorporate 19 reversible responses and 9 species for ANSYS CFX for Hydrogen. The arrangement meeting is judged by the residuals of administering conditions. The outcomes revealed in this paper depend on the criteria that the lingering of every condition ought to be littler than 1.0×10−6. Every reenactment typically takes around 40 CPU hours each.

VII. RESULTS





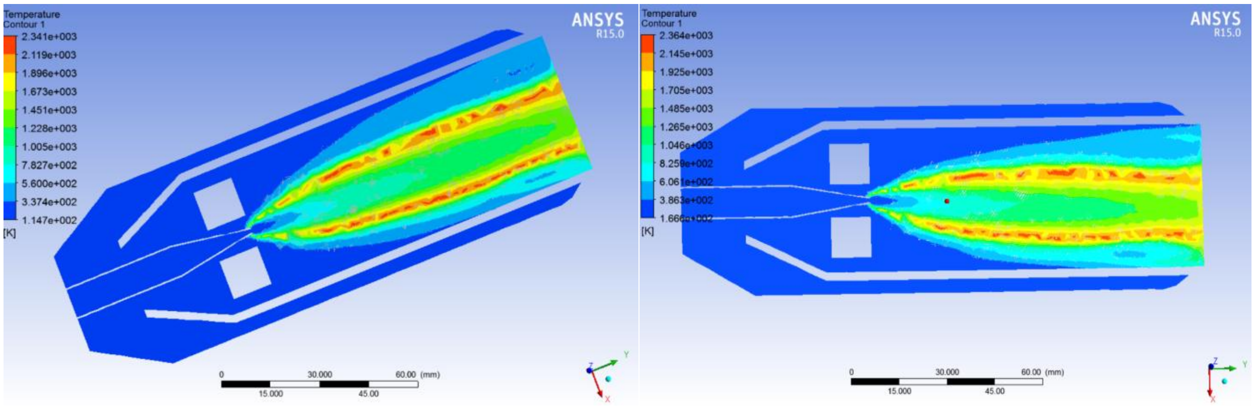


Figure 3 Hydrogen temperature profiles with equivalence ratio 03, 0.5, 0.7 and 0.9.

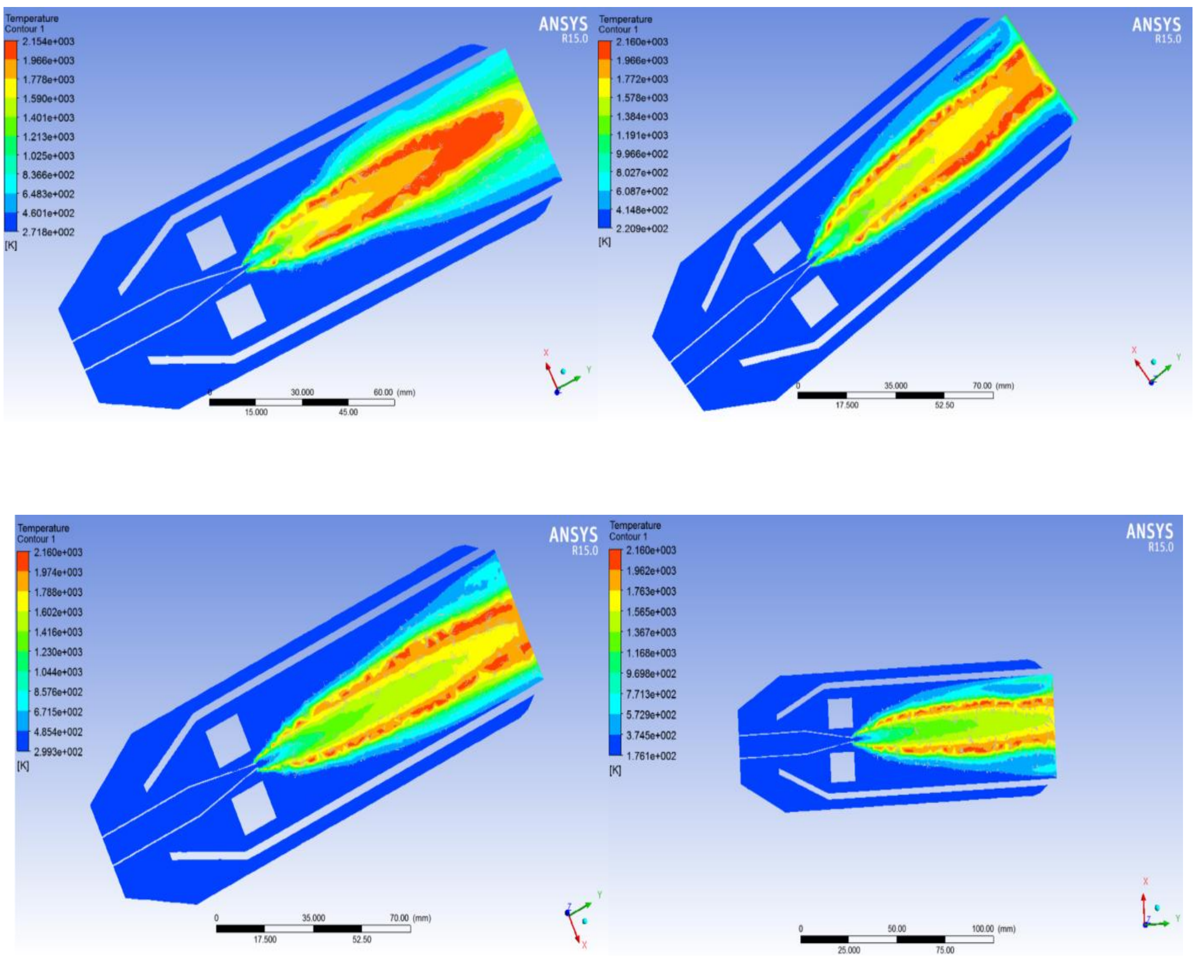


Figure 4 Methane Temperature profiles with equivalence ratio 0.3, 0.5, 0.7 and 0.9.

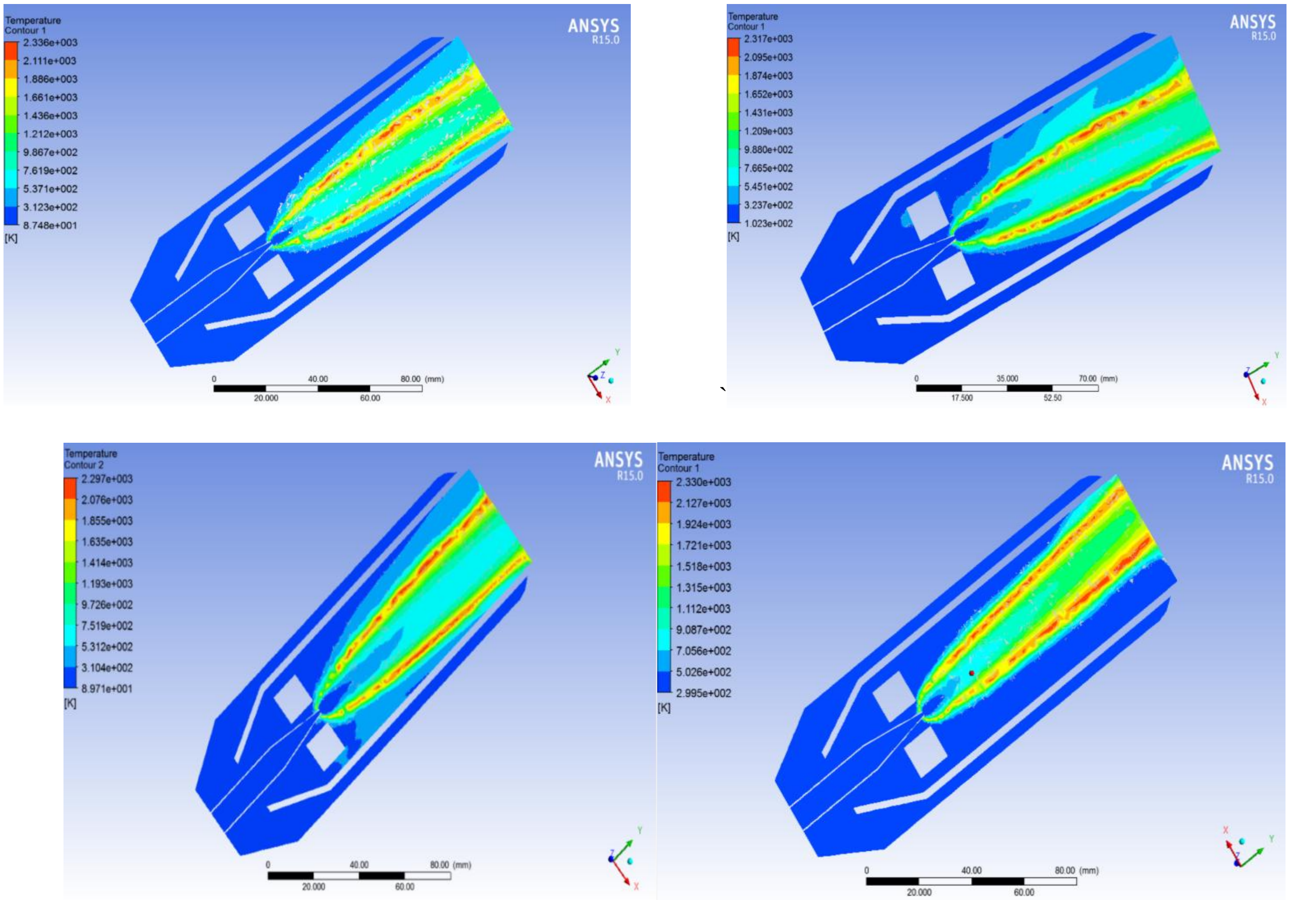


Figure 5 Syngas Temperature profiles with equivalence ratio 0.3, 0.5, 0.7 and 0.9.

VIII. CONCLUSION

The plan of smaller scale gas turbine burning chamber is done utilizing hydrogen as fuel and the outline is then approved utilizing Numerical approach. The subjective and quantitative assention of CFD results proposes that the essential presumptions and limit conditions and additionally the issue definition for CFD examination can be connected to comprehend the stream marvels, temperature shapes and wind current dissemination for ignition chamber.

Higher temperature is gotten in hydrogen case as in most extreme temperature of 2400 K than methane of 2200 K and in syngas of 2100 K. In addition equality proportion demonstrates that higher the proportion less fuel finish burning happens. Since at equivalence proportion of 0.3 max temperature area is more contrasted with max temperature locale of 0.9 comparability in every one of the cases. In this way total ignition or more air is expected to happen.

Temperature at focus line is pattern to consistent. Syngas case indicate least temperature general contrasted with different cases.

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