Thermal Efficiency of Domestic LPG Stove Using Different Design of Burner Heads on CFD fluent

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Abstract- *The objective of this paper is to numerically study the flow feature and combustion phenomena of an energy-saving cooking burner using three-dimensional computational fluid dynamics (CFD). Combustion temperatures were experimentally and numerically investigated in order to not only validate the CFD model, but also describe the combustion phenomena. LPG cooking burners are widely used as domestic heating appliances because of convenience and safety. In view point of energy saving and pollutant emission control, improvement of thermal efficiency is the most important research topic.*

Key Words: computational fluid dynamics (CFD), emission control, improvement of thermal efficiency

Introduction- Combustion is the most important processes in engineering, which involves turbulent fluid flow, heat transfer, chemical reactions, transfer of radioactive heat, and other physical phenomena and chemical complexes. Typical engineering applications include internal combustion engines, combustion power plants, boilers ovens, etc. It is important to study the various modes of combustion occurring in these instruments, chemical kinetics involved, temperature and velocity of the flame, mass flow of fuel etc. Improvise the operation of these facilities and to maximize efficiency. Different combustion modes are premixed combustion, combustion and diffusion combustion in mixed mode.

Figure 1 Stove

1. Programmable controls

Many gas stoves come with at least some modern programmable controls to make handling easier. LCDs and other complex cooking routines are some of the standard features in most basic models and high-end manufacturing. Some of the other programmable controls include pre-heating precise, automatic pizza cook timers and others.

2. Safety factors

Modern gas stove ranges are safer than older models. Two of the major security problems with gas stoves are security checks for children and accidental ignition. Cooking gas tables of some buttons that may even be accidentally activated with a slight bump.

Objective

Consumption Quick fuel causing energy crisis, so experiments were conducted to reduce fuel consumption in gas stove by changing the angle of the port in and out of a gas stove so that the gas should be flowing and enough area must provide for the gas to be burned that enhances thermal energy.

Methodology

1. **CAD Modeling-** The creation of CAD models using CAD tools to create the geometry modeling NX part / assembly.
2. **Meshing -** cross-section is a basic operation in CFD. In this operation, the CAD geometry discretized to a number of expansive bit Element and the hub. The game plan hubs and components in space in a lawful manner is called networking. Examination-term accuracy and rely on the cross-sectional size and introductions. With the expansion in cross-sectional size (expand there. Component) CFD Reduce speed but gains precision examination.
3. **Governing Equation-** Oversee the conditions used is 2-dimensional Navier-Stokes condition and development of the following conditions are not exactly compressibility stream Mach number 0.3, the effects of compressibility stream wind currents are not considered further in this examination dealt with as an incompressible flow. The entire structure was taken as

a model of climate hood for recreation CFD computing space. The boundary conditions shown on the front and rear surfaces veil climate models about the direction of flow.

The basic steps to perform CFD analysis:

1. Pre-processing:

a. CAD Modeling -The creation of CAD models using CAD modeling tools to create the geometry of a part / assembly that we want to perform FEA. CAD models may be 2D or 3D.

b. Meshing- Meshing is an important operation in the CFD. In this operation, the CAD geometry discretized to a large number of small Element and node. The setting of nodes and elements in space in an appropriate manner so-called mesh. Accuracy analysis and duration depending on the mesh size and orientation. With the increase in mesh size CFD analysis speed decreased but increased accuracy.

Boundary Conditions- Determining the desired boundary conditions for the problem of speed, mass flow rate, temperature, heat flux, etc.

Solution:

1. Methods of solution- Choosing a solution method to solve the problem that the first order, second order

2. **Solution Initialization:** initialized solution to obtain an initial solution to the problem.

Post Processing- To view and interpretation of results. The result can be viewed in various formats: chart, values, animation etc.

Results

Study-1 C_3H_8

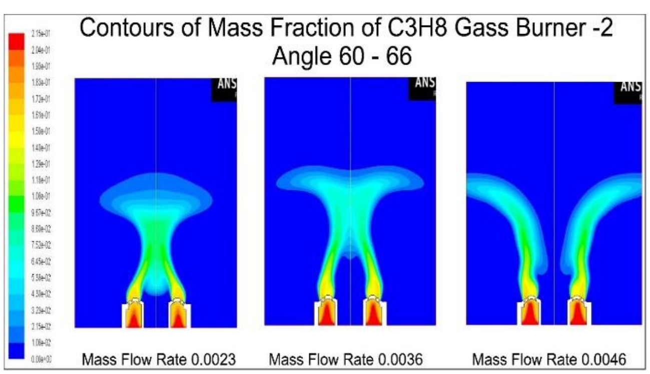
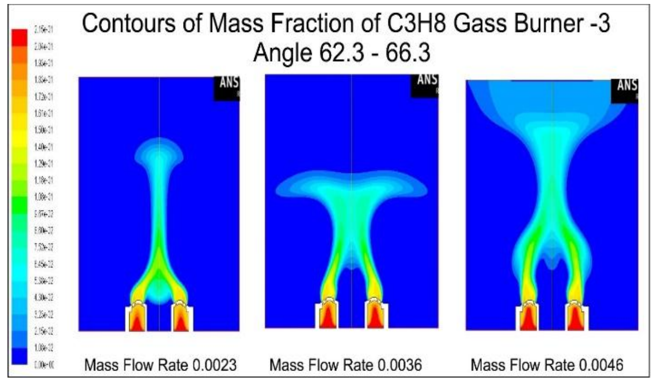


Figure 2



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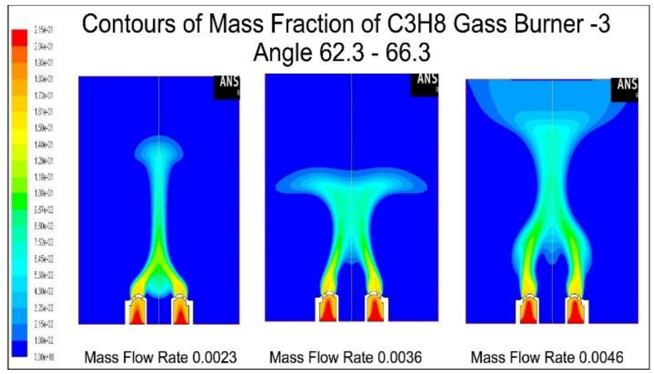
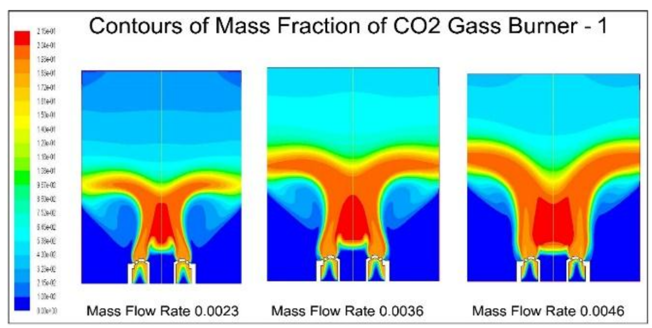


Figure 4

Study-2 CO_2



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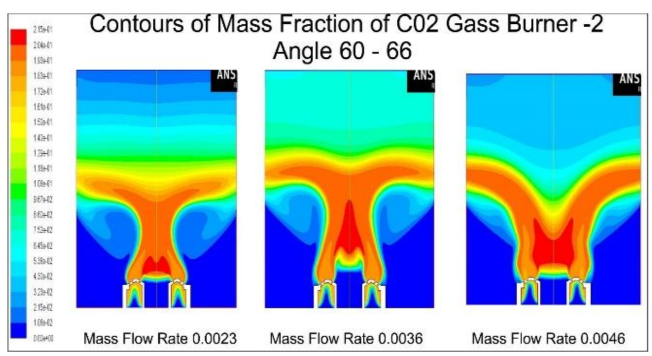

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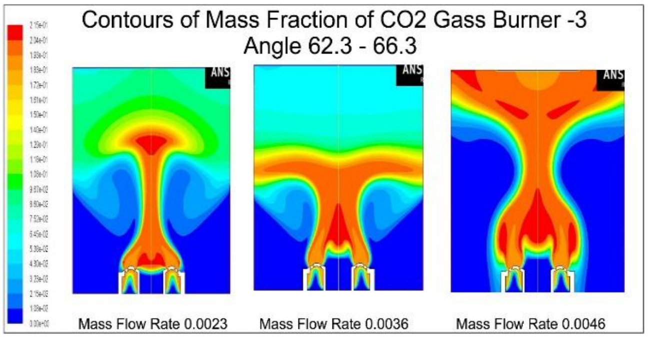
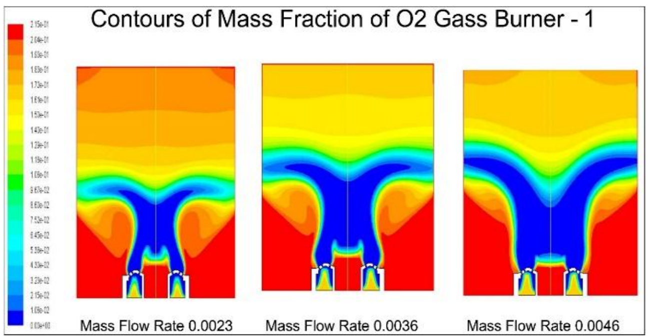


Figure 7

Study - 3 O_2



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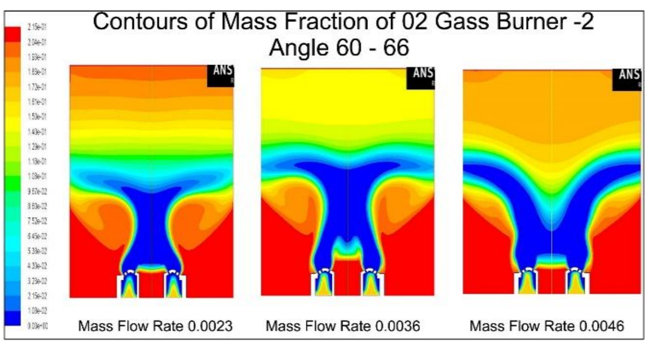

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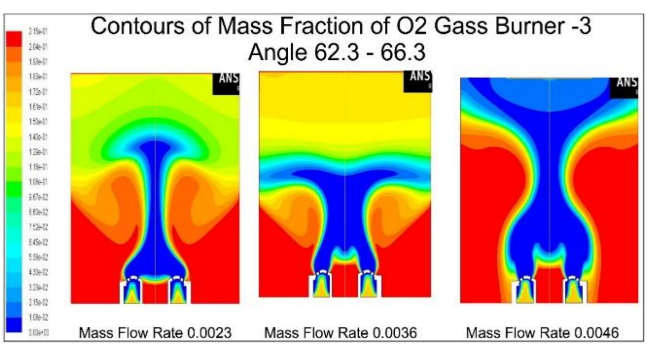
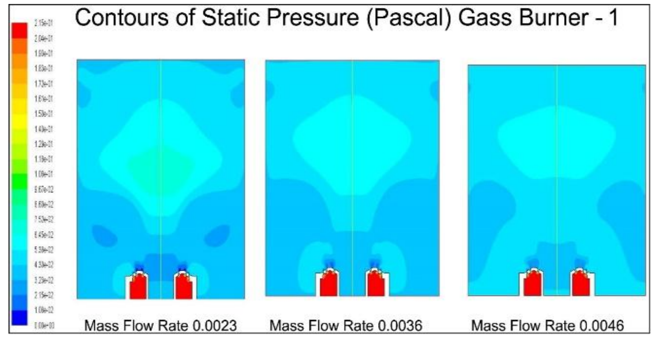


Figure 10

Study – 4 Static Pressure (Pascal)



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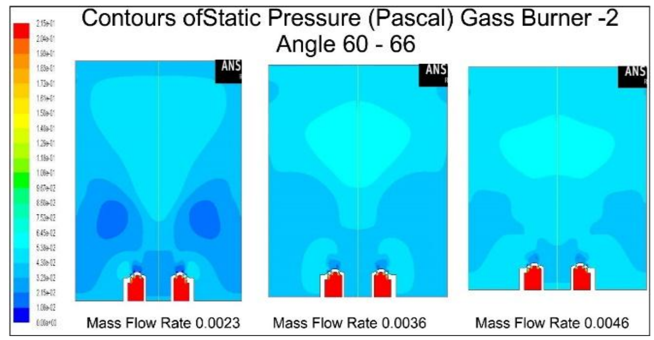

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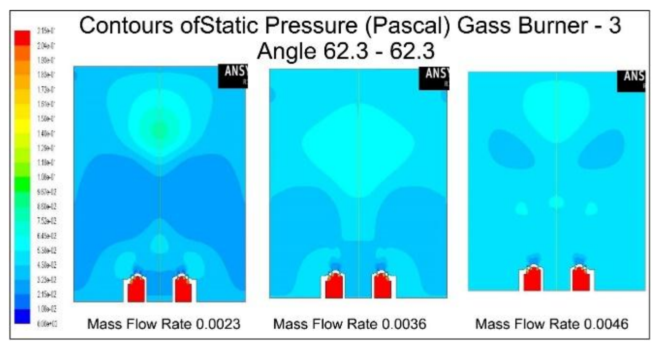
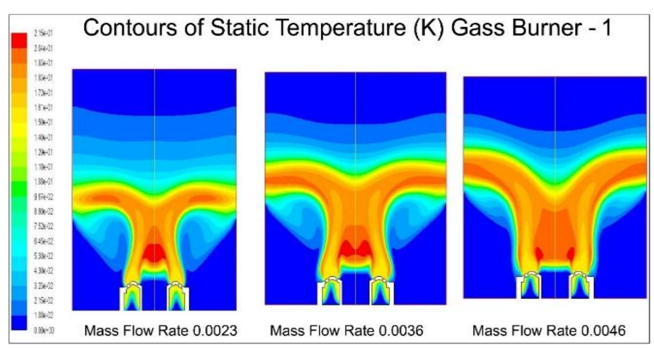


Figure 13

Study – 5 Static Temperature (K)



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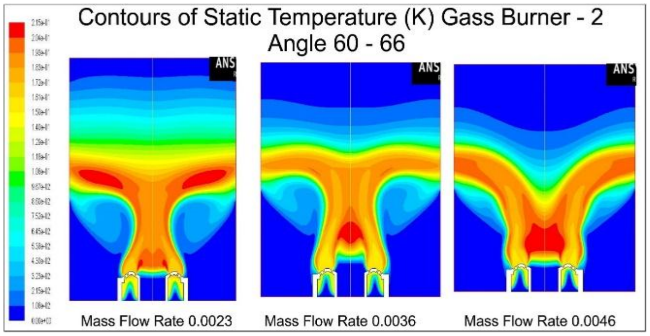

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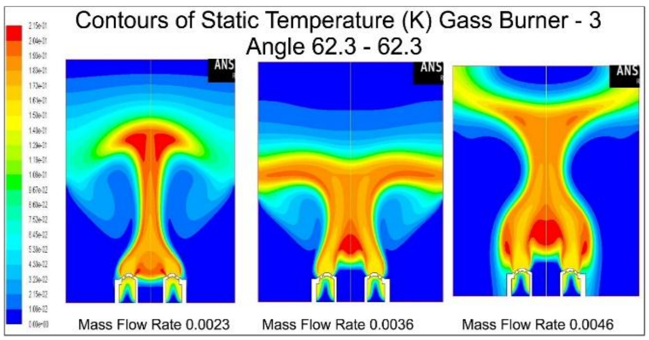
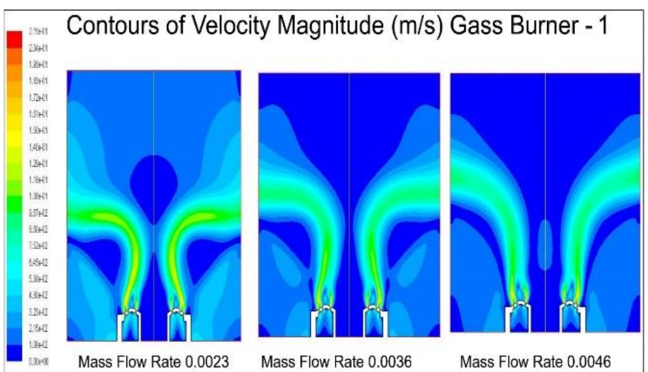


Figure 16

Study – 6 Velocity Magnitude (m/s)



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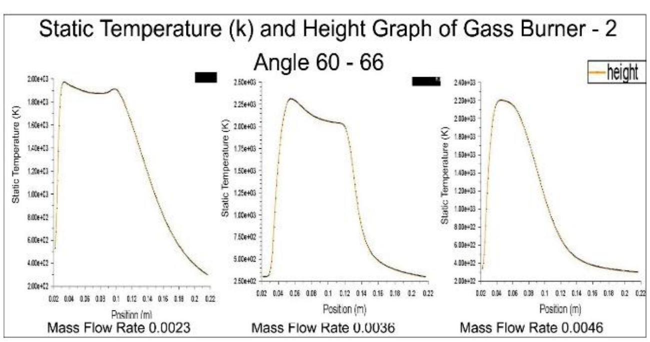

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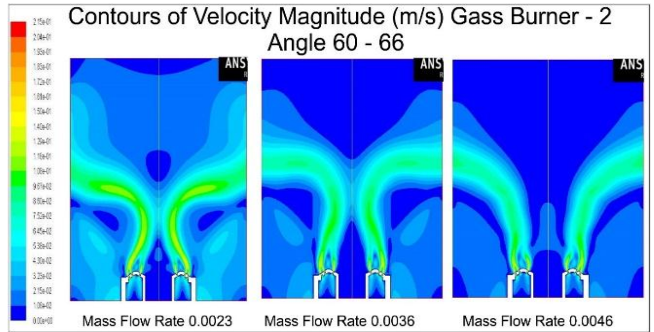

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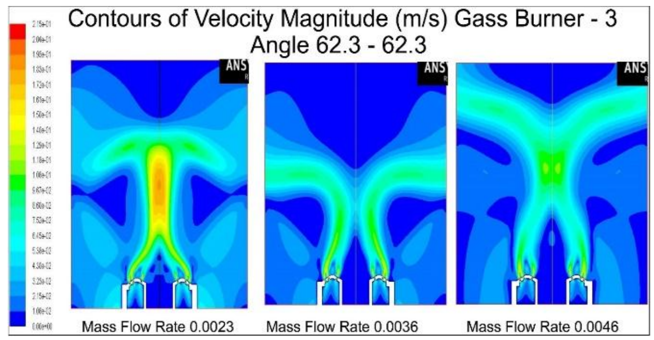
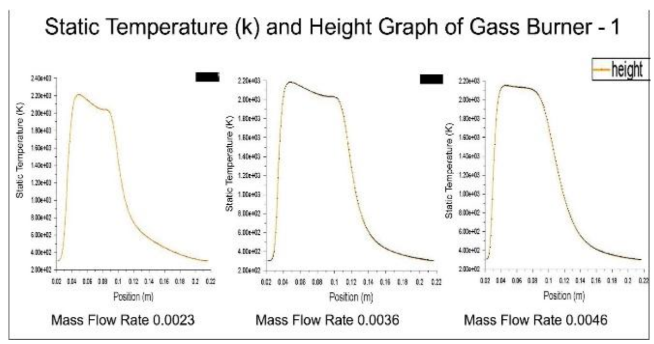


Figure 20

Study – 7 Static Temperature and Height Graph



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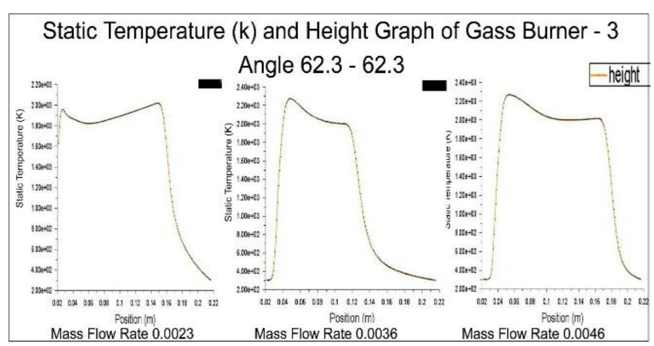

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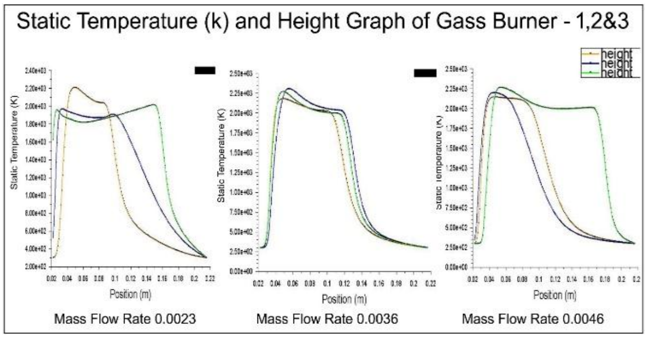
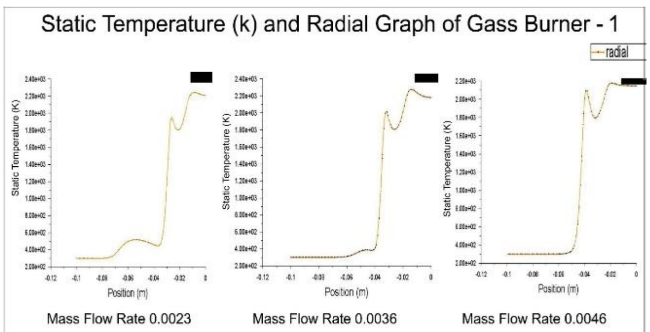


Figure 24

Study – 8 Static Temperature and Radial Graph



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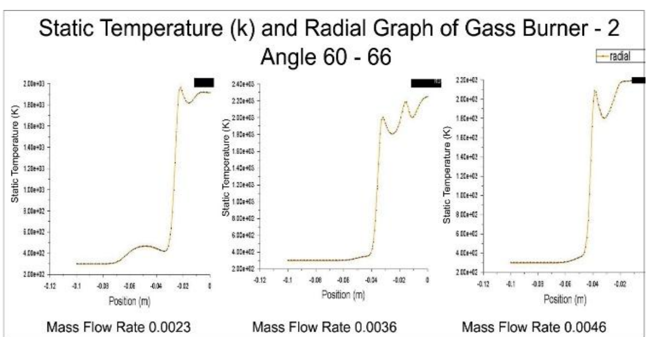

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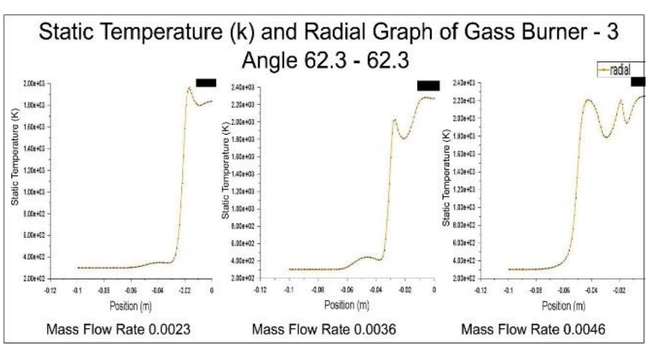

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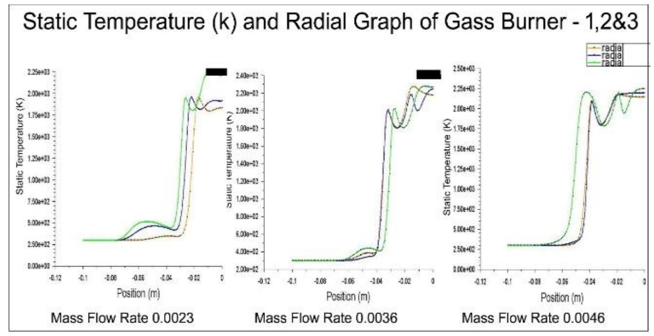

Figure 28

At Constant Pressure Process

$dQ = dU + dW$ ($W = PV$)

$dQ = d(U + PV)$ ($H = U + PV$)

$dQ = dH = mCpdT$

$H = mCpT$ (H= Enthalpy)

Total Enthalpy = (Enthalpy O2 + EnthalpyC3H8) – Enthalpy CO2

Table 1 Bass burner 1

Parameter	**Case 1**	**Case 2**	**Case 3**
Mass flow rate	0.0023 Kg/s	0.0036 Kg/s	0.0049 Kg/s
Max tempture	2210 K	2201 K	2155 K
Cp of CO_2	1.385 KJ/KgK	1.384 KJ/KgK	1.382 KJ/KgK
Cp of O_2	0.918 KJ/KgK	0.918 KJ/KgK	0.918 KJ/KgK
Cp of C_3H_8	1.364 KJ/KgK	1.364 KJ/KgK	1.364 KJ/KgK
H of O_2	4.6662 KW	4.6472 KW	4.5500 KW
H of C_3H_8	8.5394 KW	8.5046 KW	8.3269 KW
H of CO_2	7.0399 KW	7.0062 KW	6.8498 KW
Total H	**6.1656 KW**	**6.1456 KW**	**6.0271 KW**

Table 2: Bass burner 2 Port angle 60-60 degree

Parameter	Case 1	Case 2	Case 3
Mass flow rate	0.0023 Kg/s	0.0036 Kg/s	0.0049 Kg/s
Max tempture	1980 K	2320 K	2234 K
Cp of CO2	1.371 KJ/KgK	1.390 KJ/KgK	1.386 KJ/KgK
Cp of O2	0.918 KJ/KgK	0.918 KJ/KgK	0.918 KJ/KgK
Cp of C3H8	1.364 KJ/KgK	1.364 KJ/KgK	1.364 KJ/KgK
H of O2	4.1805 KW	4.8984 KW	4.7168 KW
H of C3H8	7.6507 KW	8.6944 KW	8.6321 KW
H of CO2	6.2435 KW	7.4170 KW	7.1215 KW
Total H	**5.5877 KW**	**6.4458 KW**	**6.2274 KW**

Table 3: Bass burner 3 Port angle 62.3-62.3 degree

Parameter	Case 1	Case 2	Case 3
Mass flow rate	0.0023 Kg/s	0.0036 Kg/s	0.0049 Kg/s
Max tempture	2000 K	2284 K	1747 K
Cp of CO2	1.373 KJ/KgK	1.388 KJ/KgK	1.386 KJ/KgK
Cp of O2	0.918 KJ/KgK	0.918 KJ/KgK	0.918 KJ/KgK
Cp of C3H8	1.364 KJ/KgK	1.364 KJ/KgK	1.364 KJ/KgK
H of O2	4.2228 KW	4.8224 KW	3.6886 KW
H of C3H8	7.7280 KW	8.8253 KW	6.7504 KW
H of CO2	6.3158 KW	7.2914 KW	5.4324 KW
Total H	**5.6350 KW**	**6.3563 KW**	**5.0065 KW**

CONCLUSION

In current study we analyzed that by change the angle of port of gas burner at different temperature and different mass flow rate the efficiency of burner changes and max heat zone position is also change with in mass flow rate and temperature.

Table 4 : We get max efficiency at following condition

Port Angle	60-66 degree
Mass flow rate	0.0036 Kg/s
Max tempture	2320 K
Cp of O2	0.918 KJ/KgK
Cp of C3H8	1.364 KJ/KgK
Cp of CO2	1.390 KJ/KgK
H of O2	4.8984 KW
H of C3H8	8.6944 KW
H of CO2	7.4170 KW
Total H	**6.4458 KW**

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