

# Design & Experimental Investigation of Flue Gas and Combustion Control system for Single Pass Evaporator for Generating Steam from Multiple Solid Fuels

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**ABSTRACT** - Create protected areas of village settlements and zones, explain biological classification in detail, create buildings, preserve decorative objects, etc. Bien deces is a refined version of the biological preparation, serving Chinese and candied rustic flavored dishes. On the whole, migration from village to village and to the zone is difficult and can not make transmission and distribution difficult.

The use of Petit increases biodiesel production and promotes soap bubble production. Make the most of the traditional relationship between chandelier tubes and wind instruments. Because we use solid chips like coal chips, coal etc. Waste from biowaste / bio-coal mixture can produce electricity at low cost. Combustion occurs when fuels such as natural gas, oil, and coal react with oxygen in the air to generate heat. The time to determine the success rate of the combustion process. In this study, a gas control and combustion system for a single pass evaporator is designed and manufactured. Test the production model and evaluate its performance

## 1. INTRODUCTION

There is almost no need for migration from the village, migration to the area, movement of land, delivery. Overview of Turbine Manufacturing Methods and Uses of Turbines to Utilize Carbohydrate Production Technology.

Combustion is associated with some emissions to the atmosphere. The increase in CO<sub>2</sub> emissions is limited only by energy savings. Combustion can reduce CO and NO<sub>x</sub> emissions. SO<sub>2</sub> emissions can be reduced by desulfurization of the fuel prior to combustion or flue gas after combustion. Our goal is to increase the efficiency of the combustion process, limit fuel consumption and reduce harmful emissions through advanced combustion methods.

In villages and forest areas, large amounts of bio-waste such as dried trees, leaves, animal waste etc. are generated. If used, it can be used in various industries, such as processing of agricultural products such as electricity, rice, sugar etc. Bio-waste / coal-blended bio-waste It is used to produce cheap electricity. It uses a small amount of bio waste such as wood chips, leaves, branches, coal etc.

Combustion is a chemical process in which substances burn rapidly with oxygen and release thermal energy. The burning substance is called a fuel and the source of oxygen, an oxidant. The fuel may be solid, liquid or gaseous, the driving force of the fuel being generally liquid.

The heat generated from combustion fossils, such as natural gas, petroleum, natural fuels such as coal or gasoline, burns in the presence of oxygen to generate heat. Push the piston. Boilers, furnaces and engines are important applications of fossil fuels. Thus, three combustions, turbulence, temperature, and time are determined to be part of the process. As is generally accepted, the temperature is maintained at a constant value. Sufficient time is required to achieve complete combustion from the first ignition. Sufficient air supply is required for better combustion. Fire Triangle requires fuel, oxygen, and an ignition source to achieve a successful combustion. Our focus is on furnace gas including natural drafts.

## 2. METHODOLOGY

We want to get together in preparation for our project

- ❖ Flu exhaust gas channel chamber
- ❖ First pass exit channel / second pass entry channel
- ❖ Combustion chamber,
- ❖ Second Pass Outlet Channel
- ❖ Air inlet nozzle (natural ventilation),<sup>⊗</sup>
- ❖ Firewood chimney.

Two types of gas path chambers Design and manufacture of two types of gas path chambers

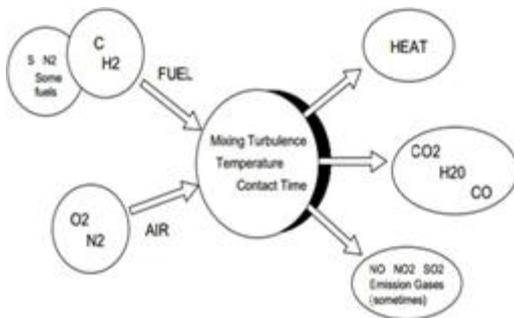
1. Cylindrical chamber
2. Rectangular chamber

Mild steel is used to burn all parts except the cylindrical exhaust gas path chamber, which is made of SA 110. GI sheets are used in making chimneys.

### 3. COMBUSTION

The original substance is called fuel, and the source of oxygen is called oxidant. The fuel may be solid, liquid or gas, for the cause of combustion, ie a chemical process where the substance burns rapidly with oxygen to release heat. The driving force of an airplane is that fuel is usually liquid. Heat from the combustion of fossil fuels is used to expand gas in industrial processes, environmental heating, or combustion processes when fossil fuels such as natural gas, petroleum, coal, gasoline, etc. react with oxygen to form a piston be done.

When fossil fuels are burned, carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O) are the main chemical products formed from reactant O<sub>2</sub> in air. Therefore, the state of three of the combustion T, temperature, time, and determination, success or failure, safety elements that must be fixed with oxygen to react and maintain the fuel element at the appropriate temperature. Because the combustion procedure is maintained at an appropriate value. The combustion process is performed at the oxygen concentration, the reactance element is continued, and the reactivity is required. It is therefore required from the first ignition in order to influence the complete combustion.



Combustion Diagram

### PRINCIPLES OF CLASSIFICATION OF FUELS

Fuels can be broadly classified in two ways.

- a) according to the physical state they exist in nature-solids, liquids and gases
- b) according to its procurement form-its nature and manufacture.

However, all of these classes have the qualitative or intensive value of fuels, ie their power to develop thermal strength or temperature under normal use conditions, iecombustion in fuels containing mixtures No. Intelligence Tables A brief description of natural and manufactured fuels is in the table.

Natural Fuels	Manufactured Fuels
<b>Solid Fuels</b>	
Wood Coal Oil shale	Tanbark, Bagasse, Straw Charcoal Coke Briquettes
<b>Liquid Fuels</b>	
Petroleum	Oils from distillation of petroleum Coal tar Shale-oil Alcohols, etc.
<b>Gaseous Fuels</b>	
Natural gas	Coal gas Producer gas Water gas Hydrogen Acetylene Blast furnace gas Oil gas

### 4. MODELLING

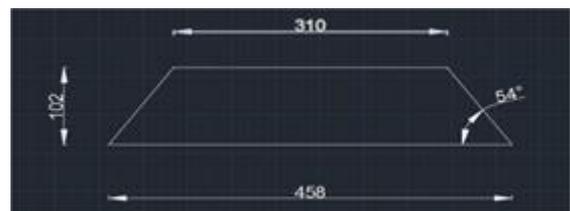
Two types of exhaust gas passage chambers are designed in the production of exhaust gas passage chambers. They are:

1. Cylindrical chamber
2. Rectangular chamber

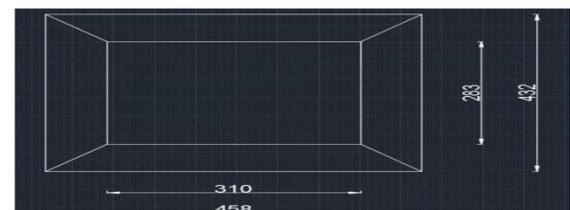
All the designs are drawn by using AUTO CAD Software



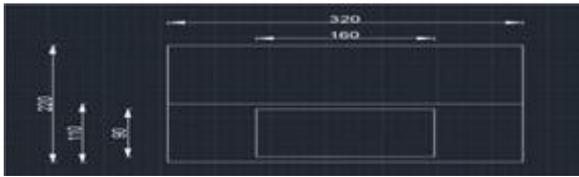
Front view of Rectangular chamber



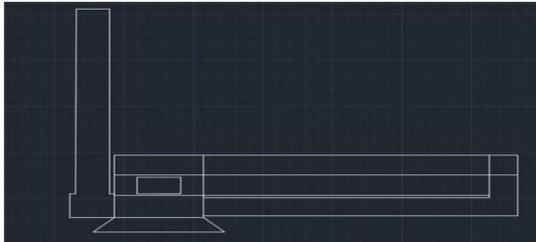
Side view of air inlet nozzle



Top view of air inlet nozzle



Front view of combustion chamber



Assembly Drawing



Next to it the cylindrical tube is made into two equal parts for accommodating evaporator and also for if there are any pressure differences inside the evaporator should be rectified immediately with the help of hand wheel cutter. After placing the evaporator in the cylindrical chamber rejoin two half portions of cylindrical chamber without any leakages. So, to rejoin these two portions flat strips are used with the thickness of 3mm and width of 25.4mm (1 inch). These flat strips are available in any hardware shops. Also cutting four flat strips to the length of 1038mm with the help of hand wheel cutter and 3mm holes are drilled on the flat strips with the distance of 100mm for all flat strips. These flat strips are placed one over the other and are connected with the help of nut and bolts of 3mm diameter.

### 5. FABRICATION

In fabrication of flue gases path chamber we would like to design and fabricate two types of flue gases path chambers are made. They are:

1. Cylindrical chamber
2. Rectangular chamber

#### CYLINDRICAL CHAMBER

It is also called as first path of flue gases. We have taken a cylindrical tube for the flow of flue gases coming from the furnace with the length of 1038mm and diameter of 218mm. We marked the cylindrical tube into two equal parts with the help of marker. On the top and bottom of the cylindrical tube the centres are marked on it. On the top of the cylindrical tube various holes are drilled for the outlet of various gauges. At the center of the cylindrical tube we have turbine outlet nozzle is provided with the diameter of 73mm.



Two Mild Steel plates with the dimensions of 230x230 for the exact positioning over the rectangular flue gas chamber and making these mild steel plates into a circle with the diameter of 218mm as this dimension belongs to the outer diameter of the cylindrical tube. The remaining portion is welded over the top of the cylindrical tube as shown in figure below.



#### RECTANGULAR CHAMBER

A mild steel plate is cut in to a dimensions of 1130X230, 1030X230 and two no's of 1030X100 mild steel plates. A rectangle with the dimensions of 1030X230X100 is made with these plates. The rectangular chamber is shown in figure below



### FABRICATION OF COMBUSTION CHAMBER

Combustion chamber is the main part for producing steam because without combustion, water as it absorbs heat from flue gases and supplies the same to the combustion chamber. The combustion chamber is placed above the Air Preheater. A coal feeding window is placed for the feeding of coal and wood to combustion chamber. Air preheater is placed at the left side of the rectangular flue gases path.



### FABRICATION OF AIR INLET NOZZLE

For complete combustion excess air is needed. When there is no sufficient air available for combustion the fuel is left unburned, resulting in inefficiency and undesirable emissions.

Forced draught system is used for the perfect combustion of fuel. For fabrication of air inlet nozzle Mild Steel is used. Mild steel is cut as per the required dimensions and is below the combustion chamber. The dimensions required to fabricate air inlet nozzle is two numbers of 458X310 at a height of 102mm and angle of 54° and also two numbers of 432X283 with the height of 102mm, and an angle of 54°.



### FABRICATION OF COAL FEEDING WINDOW

For feeding the coal a window is placed at the entrance of the combustion chamber. For feeding the fuel rectangular hole of 16X9 mm is drilled at the combustion chamber entrance. Angle plates are placed on upper side and lower sides of feeding window.

### 6. CALCULATIONS

#### FOR 100% COAL

$$\text{Calorific value (CV) of coal} = 2800 \text{ kcal/kg}$$

$$\text{Mass of coal used} = 3 \text{ kg}$$

$$\text{Quantity of steam produced} = 9 \text{ kg}$$

$$\begin{aligned} \text{Steam temperature at evaporator outlet} \\ = 133.6^\circ\text{C} \end{aligned}$$

$$\begin{aligned} \text{Temperature at outlet of the super heater} \\ = 181^\circ\text{C} \end{aligned}$$

$$\text{Pressure (P)} = 2 \text{ bar}$$

$$\begin{aligned} \text{Enthalpy of saturated steam (h)} = \\ 647.3686 \text{ Kcal/Kg} \end{aligned}$$

(From Steam Tables)

$$\begin{aligned} \text{Degree of superheat} = (\text{Temperature at outlet}) \\ - (\text{Steam temperature at evaporator}) \end{aligned}$$

$$= 181 - 133.6$$

$$= 47.4^\circ\text{C}$$

$$\text{Enthalpy of Super-heated Steam} =$$

$$= (3.75/4.18) * (\text{Degree of Super heat} + \text{Enthalpy of saturated steam})$$

$$= (3.75/4.18) * (47.4 + 647.36)$$

$$= 623.2971 \text{ K}$$

$$\begin{aligned} \text{Efficiency of the boiler} = ((\text{Quantity of Steam Produced}) * (\text{heated steam})) / ((\text{CV of Coal}) * (\text{mass of coal used})) \\ = 0.6678 * 10 \end{aligned}$$

$$= 66.78\%$$

#### FOR 100% DRY COAL

$$\text{Calorific value (CV) of coal} = 2000 \text{ kcal/kg}$$

Mass of coal used = 3 kg

Quantity of steam produced = 9kg

Steam temperature at evaporator outlet  
= 131°C

Temperature at outlet of the super heater  
= 184°C

Pressure(P) = 2 bar

Enthalpy of saturated steam(h)=  
647.3686 Kcal/Kg

(From Steam Tables)

**Degree of superheat** = (Temperature at outlet) - (Steam temperature at evaporator)  
= 184 - 131  
= 53°C

Enthalpy of Super-heated Steam =  
= (3.75/4.18)\*(Degree of Super heat + Enthalpy of saturated steam)  
= (375/4.18) \* (53 + 647.36)  
**= 628.313 Kcal/kg**

Efficiency of the boiler =  
((Quantity of Steam Produced)\*(heated steam))/((CV of Coal)\*(mass of coal used))  
= 0.6283\*100  
**= 62.83%**

**FOR 50% WOOD + 50% COAL**

Calorific value(CV) of coal = 2400kcal/kg

Mass of coal used = 3 kg

Quantity of steam produced = 7.3kg

Steam temperature at evaporator outlet  
= 133.6°C

Temperature at outlet of the super heater  
= 183°C

Pressure(P) = 2 bar

Enthalpy of saturated steam(h)=  
647.3686 Kcal/Kg

(From Steam Tables)

**Degree of superheat** = (Temperature at outlet) - (Steam temperature at evaporator)  
= 183 - 133.6  
= 49.4°C

Enthalpy of Super-heated Steam =  
= (3.75/4.18)\*(Degree of Super heat + Enthalpy of saturated steam)  
= (375/4.18) \* (49.4 + 647.36)  
**= 625.0837 Kcal/kg**

Efficiency of the boiler =  
((Quantity of Steam Produced)\*(heated steam))/((CV of Coal)\*(mass of coal used))  
= 0.6337\*100  
**= 63.37%**

**7. RESULTS**

The experiment carried out by using various fuels and its readings are noted.

Fuel	Efficiency(%)
100% coal	66.78
100% wood	62.83
50% coal + 50% coal	63.37

**8. CONCLUSION**

The experiment is carried out only for as well as for wood and combination of both wood and coal. Therefore efficiency is increases for coal and efficiency is moderate for both and efficiency is decreases for wood. As compared economically the bio fuels are very cheap but the efficiency is somewhat less than other fuels like coal. As fossil fuels are diminishing day to day, it is better to use bio waste as fuel. As it is eco-friendly and emissions are reduced.

Hence solid biofuels are economically preferable.

**REFERENCES**

1. Babcock & Wilcox (1975). Steam/ its generation and use (38 ed.). USA: The Babcock & Wilcox Company. Page No.17
2. Kapitel. Combustion Engineering. Page No. 1 & 2.
3. BIRD. R. B., STEWART, Combustion Fundamentals, Chapter2
4. Types of fuels and their characteristics. Page No.2-10
5. <http://www.electrical4u.com/coal-combustion-theory/>
6. Babcock & Wilcox Co. (2005). Steam: It's Generation and Use (41stedition)
7. <http://www.electrical4u.com/steam-boiler-furnace-grate-firebox-combustion-chamber-of-furnace/>
8. Frederick M. Steingress (2001). *Low Pressure Boilers* (4th ed.). American Technical Publishers
9. Frederick M. Steingress, Harold J. Frost and Darryl R. Walker (2003). *High Pressure Boilers* (3rd ed.). American Technical Publishers
10. Juhasz, Albert J.; Rarick, Richard A.; Rangarajan, Rajmohan. "High Efficiency Nuclear Power Plants Using Liquid Fluoride Thorium Reactor Technology"