

# General Introduction of Combustion

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**Abstract** - General phenomena of combustion is understood by experiment of candle. Performing candle practical conclude the phase change and entropy effect of different fuel. Also observe change in calorific value of different fuel according to change in phase.

**Key Words:** Phase change in combustion, general phenomena, example of combustion

## 1. INTRODUCTION

Combustion is an abnormal phenomenon whose quantity is converted into energy and some byproducts through chemical reaction. Combustion is the study of chemicals where reactions flows take place at rapid and highly exothermic reaction. It is interdisciplinary in nature. It is briefly understood by below parts. [1] Comprising thermodynamics: In this part we understand reactant is converted into product and release heat, also we calculate how much chemical energy is converted into heat energy. [2] Chemical kinematics: In thermodynamics we ignore the time, but actually time is very important and it is considered in chemical kinetics, chemical kinetics show that how much time will be require to complete the process [3] Oxidation mechanism of Fluid Or fluid mechanics: Chemical reaction is occurring in a flowing medium. So, it follows the theory of fluid mechanics. This part is provided to understand the oxidation of fuel. [4] Transport phenomena: It is clear from the idea of combustion flow field, generally, combustion will occur in front portion only, this can be understood by given figure.

### 1.1 Phase change in combustion

Any matter will ignite at a high state of entropy. Phase of any matter is depending upon entropy of matter also. So, change in entropy will give the change in phase. Every matter is present at certain phase at room temperature.

It is available in three phases mainly Solid, Liquid and Gas.

Maximum entropy at a constant pressure is always present in gaseous form. During the combustion prosses in any phase of matter, it requires gaseous form Solid phase is transfer in liquid and liquid phase is transfer into gaseous form by absorbing some latent heat energy.

## 2. GENRAL PHENOMENA

When we start the combustion of any solid phase fuel, first it requires some heat quantity to achieve high entropy level at

front layer. As it absorbs the heat of combustion; it gets converted into liquid phase and further into gaseous phase. Entropy of gas is increased more and it achieves a stage where entropy gets very high. So, space between two molecules increases so cohesive force gets reduced and is oxidized. At this stage endothermic oxidation reaction occurs and releases heat. Same process is done in liquid phase fuel. But in this process changing from solid to liquid phase latent heat is not required. So, less heat is absorbed compared to solid phase fuel. Same in gaseous fuel, in this only one sensible and latent heat is required to give high energy compared to solid and liquid phase fuel. Solid-sensible-latent-liquid Liquid-sensible -latent-gas Gas-sensible-latent-combustion product. All this heat changing requirement is fulfilled by absorbing the combustion heat. So, it is clear that, always combustion efficiency is not achieved by 100%.  $\eta < 100\%$

And the combustion efficiency of solid, liquid and gas are denoted like this  $\eta_{\text{solid}} < \eta_{\text{liquid}} < \eta_{\text{gas}}$

This efficiency is measure at constant pressure of a fuel at different state at same mass. Calorific value is also defined as "the energy produced after burning unit kg or unit m<sup>3</sup> of fuel." According to above theory; gaseous fuel has much calorific value compared to liquid and solid. Solid have very low calorific value compared to liquid and gas. So,  $Cv(\text{solid}) < Cv(\text{liquid}) < Cv(\text{gas})$

This difference cannot be reduced.

Table-1: Calorific Value

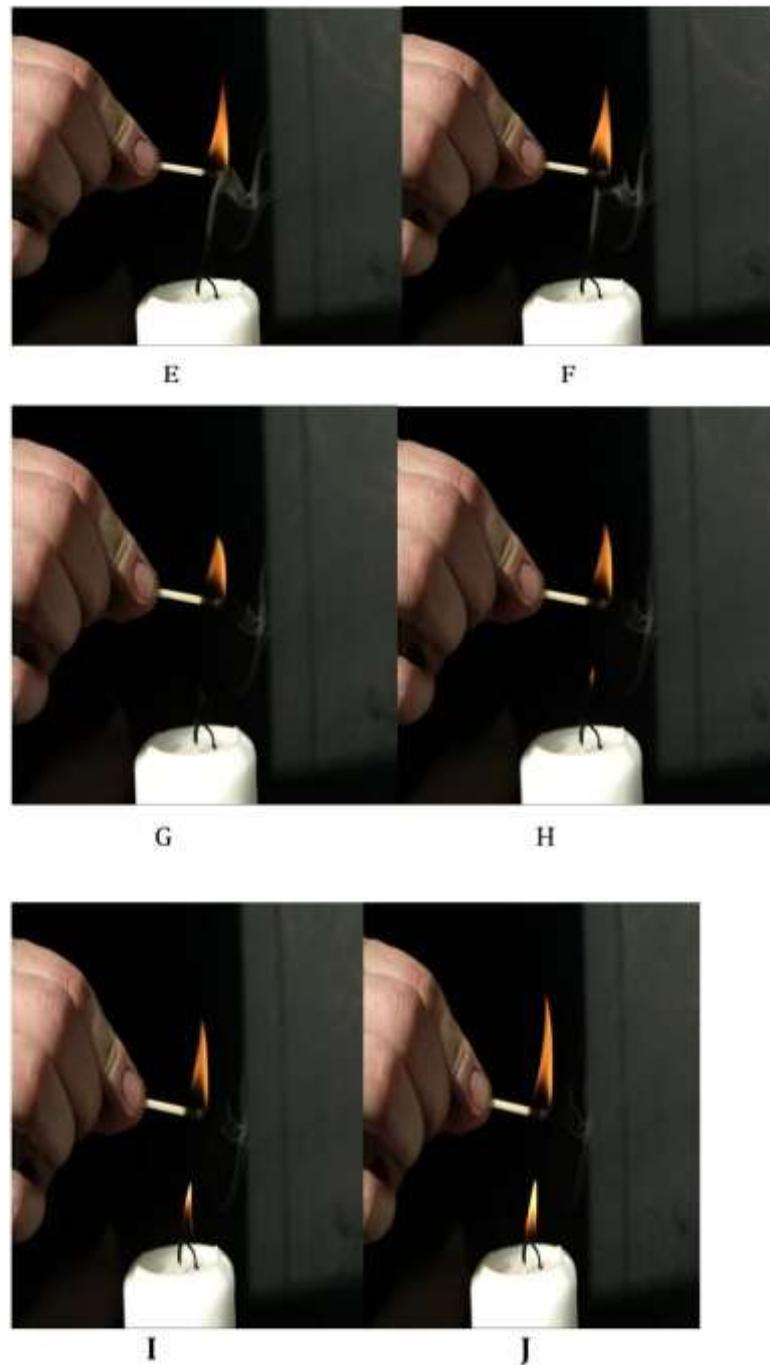
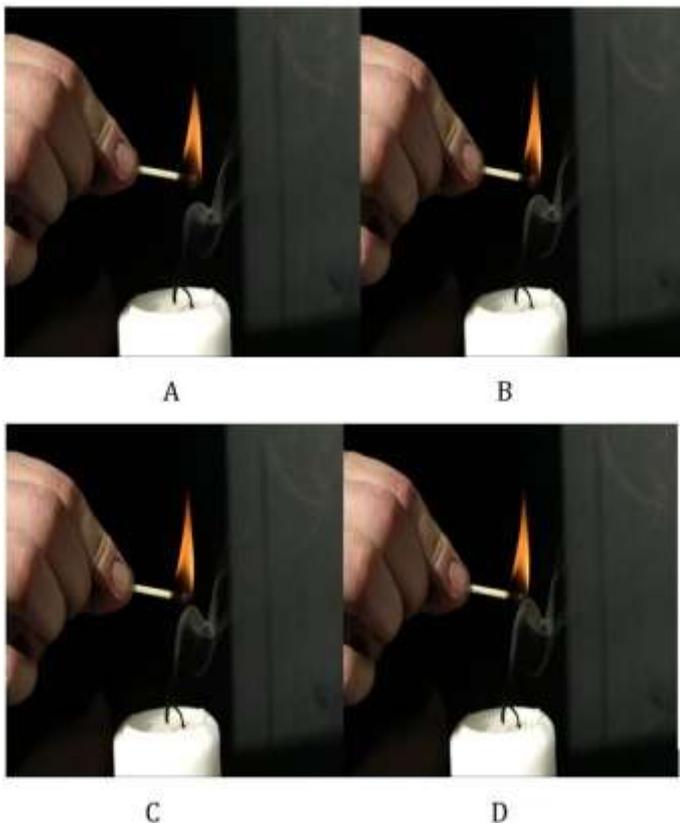
Fuel	Calorific Value
Natural Gas	12,500 Kcal/Kg
Propane-butane	11,950 Kcal/Kg
Diesel	10,000 Kcal/Kg
Fuel oil	9520 kcal/Kg
Brown coal	3500 Kcal/Kg
Wood	2500 Kcal/kg



**Fig 1:** general combustion

A chemical process in which a substance reacts with the oxygen of air to give heat and light is called combustion

**2.1- Understanding combustion by candle example**



Candle combustion is shown in above figure. Candle is mad up of wax and thread

Let's, understand combustion process in candle. A little flame is provided to thread and it is transferred from wax by conduction. Wax is in solid form at room temperature, but due to conduction by thread it is converted into liquid and then into gaseous form. It is continuously converted by absorbing heat. Gaseous form of wax means vaporized wax; absorbs some heat and gets oxidized. Candle gets maximum heat by convection and radiation, but maximum heat loss occurs by conduction. Combustion occurs layer by layer in candle.

### 3. CONCLUSIONS

1. Combustion is always done into gaseous form.
2. In any condition combustion don't give 100% efficiency.
3. It always gains maximum heat energy in gaseous form compared to liquid and solid form at same mass.
4.  $C_v(\text{solid}) < C_v(\text{liquid}) < C_v(\text{gas})$ .

### REFERENCES

1. Clausius, R. (1850) "uber die bewegende kraft der Wärme". Annalen der Physik und Chemie, 155:3 pp 368-397
2. Clausius R., (1877) Ueber verschieden fuer die Anwendung bequeme Formen der Hauptgleichungen der mechanischen Waermetheorie Annalen der Physik and Chemic 200:3 pp 353-400.
3. Combustion Theory (second edition) by Forman A. Williams
4. Combustion Physics by Chung K. Law