Conceptual Analysis of Combustion to Prove Heat Not Converted but Generated during Combustion of Fuels

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Abstract: ***Combustion is the oldest technology known to mankind, it has been used for more than one million years. At present a major portion of our worldwide energy support (e.g. lighting, electrical power generation, heating) is provided by combustion. Combustion became a peculiar topic for research at the later half of the 20th century, when people became more aware about harmful effects of burning of fossil fuels on the environment. The basic combustion process includes the fuel, oxidiser and heat. The proportions of fuel and oxidiser are balanced out on the left and right side of the combustion chemical reaction. The point remains of interest is the heat, not the one required to start the combustion but the one released during combustion. In this paper an attempt is being made to analyse combustion of different types of fuels to conclude heat produced during combustion is not a conversion of mass but is generated ingenuously.***

1. Introduction

Combustion is a type of chemical process in which a substance reacts rapidly with oxygen and usually accompanied by the generation of heat and light in the form of flame [1]. The substance to be combusted is called the fuel, and the source of oxygen is called the oxidizer.

During combustion, new chemical substances are created from the fuel and the oxidizer. These substances are called exhaust. Most of the exhaust comes from chemical combinations of the fuel and oxygen. When a hydrogen-carbon-based fuel (like gasoline) burns, the composition after combustion includes water (hydrogen + oxygen) and carbon dioxide (carbon
+ oxygen).

If the gasoline is burned in presence of air, and as air contains 21% oxygen and 78% nitrogen, the combustion products can also include nitrous oxides (NOX, nitrogen + oxygen). The temperature of the exhaust is high because of the heat that is transferred to the exhaust during combustion. In the next section we will review combustion reactions of different fuels.

2. Combustion of Different Types of Fuels

a) Combustion of Wood

Wood is formed by the process of photosynthesis. Photosyn- thesis is the process by which plants use sunlight to produce glucose from carbon dioxide and water. Photosynthesis may be summarised by the following figure:

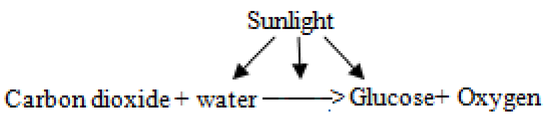

Figure 1: Photosynthesis Equation

In chemical terms, photosynthesis is a light-energized oxida- tion–reduction process [2]. In plant photosynthesis, the energy of light is used to drive the oxidation of water (H_2O), producing oxygen gas (O_2), hydrogen ions (H^+), and electrons. Most of the displaced electrons and hydrogen ions are transferred to carbon dioxide (CO_2), which is deduced to organic products. In most green cells, carbohydrates—especially starch and the sugar sucrose are organic products of photosynthesis.

Photosynthesis reaction involves two reactants, carbon dioxide and water. These two reactants yield two products, namely, oxygen and glucose. Photosynthesis reaction is as follows:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

where, $C_6H_{12}O_6$ is the chemical formula of several simple sugars, the three most notable of which are glucose, fructose and galactose.

Wood being a result of photosynthesis mainly consists of cellulose ($C_6H_{10}O_5$), which are nothing but interlinked glucose, which is a sugar [3]. As the chemical nature of wood is closely related to sugars. To make things simpler, let's consider wood to be composed just of sugar, whose formula is $C_6H_{12}O_6$

The combustion of wood occurs in two stages:

"Primary Combustion" is the burning of solid material directly. In this the solid is converted to flammable gas.

"Secondary Combustion" is the burning of gas fuels which produces the flames of fire.

The two reaction products are Carbon dioxide CO_2 and Water H_2O. Both are released as gases in air [4]. Carbon dioxide is a normal component of air; water is generally known as a liquid, but it is a gas at the high temperature of flame. Indeed, gaseous water is a normal component of air (atmospheric humidity). So in wood combustion we observe solid wood disappear and be converted to gas products, leaving only some ashes. These are formed by minor components of wood that cannot burn and remain solid.

The combustion reaction of wood is as follows: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

C=6 C=6
H=12 H=12
O=18 O=18

Mass is balanced on left hand side and right hand side. Therefore, we can say that the heat and light energy obtained during combustion of wood is generated, due to the acceleration of charged particles which happened during the recombination of atoms.

One another myth that is present regarding photosynthesis is that the photons required for the process are completely absorbed by the electrons and the same number of photons are released when the plant is used for combustion. But, according to Einstein's Theory of Stimulated emission when photons are incident on electrons, the electrons in the lower energy level jump to higher energy level, stay there and again come back to the lower energy level emitting a photon of same energy [5]. The electrons in higher energy level emit a photon immediately and go to the lower energy level when photons are incident on them.

b) Combustion of Candles

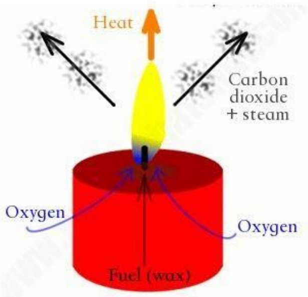

Figure 2: Combustion of Candle

All waxes are essentially hydrocarbons, which means they are largely composed of hydrogen (H) and carbon (C) atoms. When you light a candle, the heat of the flame melts the wax near the wick. This liquid wax is then drawn up the wick by capillary action [6]. As wax is consumed, capillary action draws more liquid wax along the wick. As long as the wax doesn't melt away from the flame, the flame will consume it completely and leave no ash or wax residue. The heat of the flame vaporizes the liquid wax turns it into a hot gas, and starts to break down the hydrocarbons into molecules of hydrogen and carbon.

These vaporized molecules are drawn up into the flame, where they react with oxygen from the air to create heat, light, water vapor (H_2O) and carbon dioxide (CO_2). Enough heat is created to radiate back and melt more wax to keep the combustion process going until the fuel is used up or the heat is eliminated. A quietly burning candle flame is a very efficient combustion machine. But if the flame gets too little or too much air or fuel, it can flicker or flare and unburned carbon particles (soot) will escape from the flame before they can fully combust. The wisp of smoke you sometimes see when a candle flickers is actually caused by unburned soot particles that have escaped from the flame due to incomplete combustion.

For a paraffin candle, the balanced chemical equation is [7]: $C_{25}H_{52} + 38O_2 \rightarrow 25CO_2 + 26H_2O$

C=25 C=25
H=52 H=52
O=76 O=76

Mass on both sides of the equation is same. Therefore, visible light and heat obtained from the combustion of candle, which is nothing but electromagnetic radiation produced from acceleration of charged particles present in the atom, is generated rather than being a conversion of any type of energy.

c) Combustion of Coal

Coal is a fossil fuel, formed largely by the partial decomposition and 'coalification' of ancient plants under high pressure of overburden at elevated temperature during the course of hundreds of millions of years. Coal is not a homogeneous chemical compound, but instead is a mixture of a wide variety of hydrocarbon compounds whose structure remains largely unknown. In addition to volatile and nonvolatile combustible compounds, coal contains compounds which do not burn, and survive combustion in a solid form called ash [1]. Three different processes which interact are distinguished in coal combustion: pyrolysis of the coal (which generates volatile compounds and a carbon rich solid called char), burning of the volatile compounds, and burning of the char.

- Pyrolysis of Coal: The pyrolysis (thermal decomposition and degasification) of the coal occurs at temperatures higher than 600 degree K. A separation into char and volatile compounds is observed.
- Burning of Volatile Compounds: The volatile compounds, which are formed during pyrol- ysis, are burnt in the gas phase. The governing processes are evaporation, diffusion into the gas phase, and then combustion.
- Burning of the Char The residual char particles, enriched in carbon, containing most of the mineral matter of the original coal are often spherical. The residual char particle can be burned out under an oxidizing condition at sufficiently high temperature. The reaction between the char and oxygen is a gas-solid heterogeneous reaction. The gaseous oxygen diffuses to, and into, the char particle, being absorbed, and reacting on the pore surface of the particle. The primary reactions of char combustion is as follows: $C + O_2 = CO_2$

It is clear from the above equation that mass on both sides is equal and still tremendous amount of heat is produced. This heat is produced due to acceleration of charged particles, and is not a conversion of mass or any other type of energy.

d) Combustion of Petrol and Diesel

During combustion of liquid fuel, heat transfer to fuel increases the vapor pressure and thus the fuel evaporates into gas phase, until subsequent gas phase ignition commences. A non-premixed flame surrounds the fuel. It is important to note that it is the vapor and not the liquid itself is what ultimately burns. Every liquid fuel has three phases of combustion [1], determined by different physical phenomena:

- Heating Phase: External heat given to the fuel heats up the surface of the fuel. Much of the heat is converted into the fuel until the fuel is approaching a boiling temperature.
- Fuel Evaporation Phase: Fuel evaporates into gas and a combustible mixture is formed.
- Combustion Phase: The mixture ignites and burns as a laminar non-premixed flame, whose area decreases in time again repeating the same three stages.

The two most used liquid fuel are Gasoline and Petrol, their equations are as follows: Gasoline or Petrol

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

C=16	C=16
H=36	H=36
O=50	O=50

Diesel

$4C_{12}H_{23} + 71O_2 \rightarrow 48CO_2 + 46H_2O$

C=48	C=48
H=92	H=92
O=142	O=142

From the above two equations it is clear that mass before combustion and after combustion is same. Therefore, the heat obtained from combustion of these fuels is not a conversion of any type of energy but is being generated due to acceleration of charged particles present in the atom.

e) Combustion of Methane

The combustion of methane means that it is possible to burn it. Chemically, the combustion process involves a reaction between methane and oxygen in the air [8]. During combustion of methane with oxygen, the reaction products is carbon dioxide (CO_2) and water (H_2O).

Natural gas is the cleanest burning fossil fuel. Coal and oil, the other fossil fuels, are more chemically complicated than natural gas, and when combusted, release a variety of potentially harmful air pollutants. Burning methane releases only carbon dioxide and water. Since natural gas is mostly methane, the combustion of natural gas releases fewer byproducts than other fossil fuels [9].

The following reaction represents the combustion of methane:

$CH_4[g] + 2O_2[g] \rightarrow CO_2[g] + 2H_2O[g]$ C=1 C=1

H=4	H=4
O=4	O=4

One molecule of methane, (the [g] referred to above means it is gaseous form), combined with two oxygen molecules, react to form a carbon dioxide molecule, and two water molecules usually given off as steam or water vapor during the reaction and energy.

As we can observe from the above equation that the mass on the left hand side of the equation and right hand side of the equation is same. Thus, we can conclude that the heat obtained during combustion is due to acceleration of charged particles in the atoms, is generated instead of being a conversion of any type of energy.

3. Heat

Heat is nothing but concentrated emission of electromagnetic radiation, mainly consisting of infrared radiation and is measure in degree Celsius [10]. Electromagnetic radiation and thus infrared radiation are produced only when there is an acceleration of charged particle.

All bodies, whether they feel hot or cold, emit infrared radiation. Hot and cold are relative terms [11]. A so-called hot body radiates radiations faster than the human body, while a cold body radiates radiations at a slower rate than human bodies do. This means that the cold and the hot body emits radiation in all direction, due to the nature of electromagnetic radiation. Therefore, it can be said that the heat released during combustion is on because of the acceleration of charged particles in the atoms and molecules, of the fuels and the oxidizers, and thus it is not a conversion of any type of energy but created indigenously.

4. Conclusion

From the analysis of combustion reactions, we have understood that the mass is conserved on both sides of the combustion reactions and thus the heat energy obtained during combustion is not a conversion of mass. On the other hand, we have also inferred that heat is nothing but electromagnetic radiations which can only be produced when there is an acceleration of charged particle.

Therefore, we conclude that heat is generated during combustion of fuels in presence of oxidizer and is neither the conversion of mass nor the conversion of any other type of energy.

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