Itroduction

The nature of combustion

What the combustion or burning?

The sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species.

The release of heat can produce light in the form of:

1. Glowing
2. Flame

Fuels of interest often include organic compounds (especially hydrocarbons) in the gas, liquid or solid phase.

When the combustion is occurs?

In a complete combustion reaction, a compound reacts with an oxidizing element, such as oxygen or fluorine, and the products are compounds of each element in the fuel with the oxidizing element. For example:

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

What is the content of air?

As actual combustion reactions come to air, which is 78 percent nitrogen , will also create small amounts of several nitrogen oxides, commonly referred to as NOx increasing.

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What is the method used in engineering practice ? and what is the disadvantage of it ?

Increasing surface area to increase reaction rate . for example liquid spray combustors which are used in burners ,diesel engines increases in surface area can also produce undesirable results such as accidental explosions. Another common method of causing fast reaction is to increase the temperature.

What the reactant burns producing?

The reactant burns in oxygen, producing a limited number of products. When a hydrocarbon burns in oxygen, the reaction will primarily yield carbon dioxide and water.

What is the Complete combustion?

When elements are burned, the products are primarily the most common oxides. Carbon will yield carbon dioxide, sulfur will yield sulfur dioxide.

When the NOx appear ?

NOx species appear in significant amounts above about 2,800 °F (1,540 °C), and more is produced at higher temperatures. The amount of NOx is also a function of oxygen excess. In most industrial applications and in fires, air is the source of oxygen (O2). In air, each mole of oxygen is mixed with approximately 3.76 mol of nitrogen.

Incomplete combustion What the useful of heat sink?

Incomplete combustion will only occur when there is not enough oxygen to allow the fuel to react completely to produce carbon dioxide and water. To reduce the heat flame or quenched the fire by using such as a solid surface or flame trap .

How the pyrolysis in most fuel and in incomplete combustion occurs ?

For most fuels, such as diesel oil, coal or wood, pyrolysis (الانحلال الحراري) occurs before combustion. In incomplete combustion, products of pyrolysis remain un burnt and contaminate the smoke with noxious particulate matter and gases Partially oxidized compounds are also a concern; partial oxidation of ethanol can produce harmful acetaldehyd, and carbon can produce toxice carbon monoxide.

Who we can improved the quality of combustion?

The quality of combustion can be improved by the designs of combustion devices, such as burners and internal combustion engines. Further improvements are achievable by catalytic after-burning devices (such as catalytic converters) or by the simple partial return of the exhaust gases into the combustion process.

Smoldering:

Is the slow, low-temperature, flameless form of combustion, sustained by the heat evolved when oxygen directly attacks the surface of a condensed-phase fuel. It is a typically incomplete combustion reaction.

Smoldering example:

Solid materials that can sustain a smoldering reaction include:

1. Coal
2. Cellulose
3. Wood
4. Cotton
5. Tobacco and dust.

Common examples of smoldering phenomena are the persistent combustion of biomass behind the flaming fronts of wildfires.

Rapid combustion

Bunsen burner:

The Bunsen burner consists of a metal tube on a base with a gas inlet at the lower end of the tube, which may have an adjusting valve; openings in the sides of the tube can be regulated by a admit as much air as desired (See Fig. 1).

Fig. 1: Bunsen burner.

Where we use Bunsen burner?

Used in heating, sterilization, and combustion.

What is the type of gas used in Bunsen burner?

The gas can be natural gas (which is mainly methane) or a liquefied petroleum gas, such as propane, butane, or a mixture of both.

The type of flame in Bunsen burner:

It burns with a pale blue flame, the primary flame, seen as a small inner cone, and a secondary, almost colorless flame, seen as a larger, outer cone, which results when the remaining gas is completely oxidized by the surrounding air.

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Boiler

What is the boiler:

Is a device which burns gas, oil, electricity, or coal in order to provide hot water. A boiler incorporates a firebox or furnace in order to burn the fuel and generate heat (See Fig. 2).

What is the boiler process?

The generated heat is transferred to water to make steam, the process of boiling. This produces saturated steam at a rate which can vary according to the pressure above the boiling water. The saturated steam thus produced can then either be used immediately to produce power via a turbine and alternator, or else may be further superheated to a higher temperature.

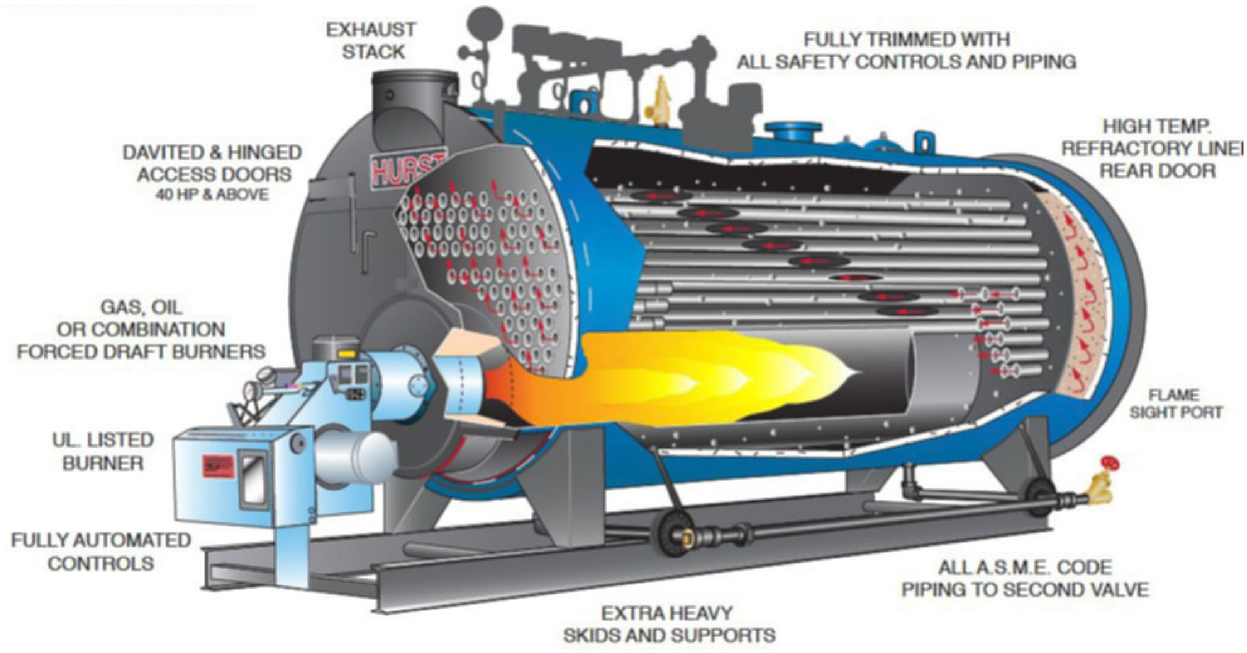

Fig. 2: Steam Boiler.

Internal combustion engine

The internal combustion engine:

Is an engine in which the combustion of a fuel (normally a fossil) occurs with an oxidizer (usually air) See Fig. 3.

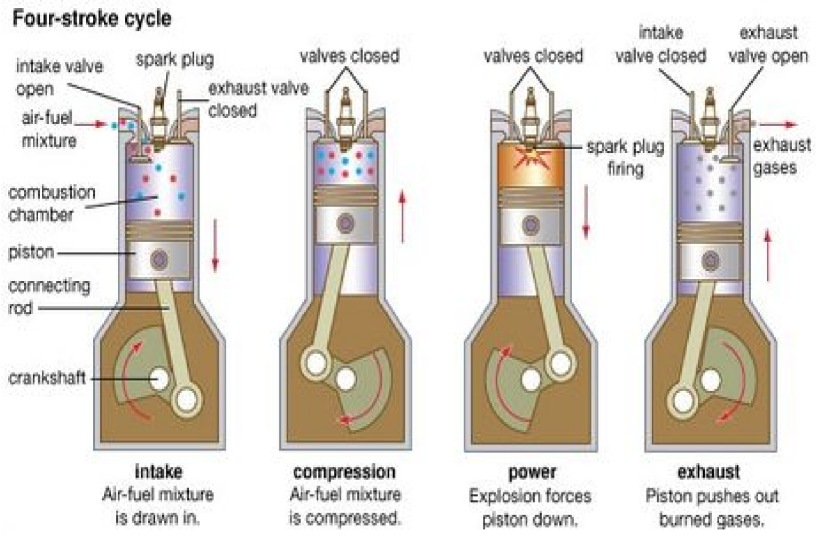

Fig. 3: Internal combustion engine.

What happens After the reaction is initiated by a spark?

After the reaction is initiated by a spark ,a flame should spread rapidly and smoothly through the gas mixture and the expanding gas drives the piston down the cylinder.

What happens when the gas expands in (ICE)?

In an internal combustion engine (ICE) the expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons, turbine blades, or nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.