STUDY ON POOL COMBUSTION OF TIRE WASTED FUEL, PLASTIC FUEL AND DIESEL FUEL

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ABSTRACT

This thesis is study about the characteristic of flame for plastic and tire fuel compare with diesel fuel. Three kind of fuel were experimented by using combustion chamber. The measurement of fuel considers particulate matter measurement and exhaust flame temperature. The parameter measurements in this experiment are temperature, height, color of the flame and particulate matter. This result shows that plastic fuel has the higher height and temperature of flame compare with tire and diesel fuel. However, plastic fuel shows lower in particulate matter and dry soot compare with tire and diesel. It can conclude that plastic fuels high possibility applied as a one of alternative fuel for internal combustion engine.

ABSTRAK

Tesis ini merupakan kajian mengenai ciri-ciri api untuk plastik dan bahan api tayar berbanding dengan minyak diesel. Tiga jenis bahan api telah dieksperimen dengan menggunakan kebuk pembakaran. Pengukuran bahan api menganggap pengukuran *Particulate Matter(PM)* dan suhu nyalaan ekzos. Pengukuran parameter dalam eksperimen ini adalah suhu, ketinggian, warna nyala dan *Particulate Matter(PM)*. Keputusan ini menunjukkan bahawa bahan api plastik mempunyai ketinggian yang lebih tinggi dan suhu nyalaan berbanding dengan tayar dan diesel. Walau bagaimanapun, bahan api plastik menunjukkan jelaga dalam *Particulate Matter(PM)* yang lebih rendah dan kering berbanding dengan tayar dan diesel. Ia boleh membuat kesimpulan bahawa kemungkinan bahan api plastik digunakan sebagai salah satu bahan bakar alternatif untuk enjin pembakaran dalaman.

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LIST OF SYMBOL

^{o}C	Degree Celsius
^{o}F	Fahrenheit
%	Percentage

LIST OF ABBREVIATION

SYMBOL	SPECIFICATION
PM	Particular Matter
DPM	Diesel Particular Matter
CO_2	Carbon Dioxide
CO	Carbon Monoxide
H2	Hydrogen
H2O	Water
O2	Oxygen
CH	Hydrocarbon
OH	Hydroxide
CH4	Methane
CP	Constant Pressure
EC	Elemental Carbon
SO2	Sulphur Dioxide
NOX	Nitrogen Oxide
cm	Centimetre
m	Meter

g	Gram
l	Litre

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Nowadays, the global warming is a reality that faces us today and will affect people even more in the future. One of the factors of global warming is combustion. The combustion process is extremely dependent on time, temperature and turbulence. Time is important to combustion because if a fuel is not given a sufficient amount of time to burn, a significant amount of energy will be left in the fuel. Too much time to burn on the other hand will produce very long flames, which can be a function of bad mixing. The correct balance of time and mixing will achieve complete combustion, minimize flame impingement and improve combustion safety. In addition, a properly controlled combustion process strives to provide the highest combustion efficiency while maintaining low emissions of harmful gases. (Michael Biarnes, 2006)

As we know in our country public transportation is important. Many people use public transportation such as bus, taxi, train and others to go their office or other place. By using transportation our city is not crowded with many car and its can avoid from the many accident happen. By the way, since the price of diesel fuel increased people need to buy expensive ticket. This is the major problem for the people that have lower salary and live at the develop city to survive their life. In this project, two difference kinds of alternative fuels are used which are tire fuel and plastic fuel. Tire fuel is used because it has a high heating value. This fuel extracted from waste tire through pyrolysis process. For the plastic fuel, it actually extracted from waste plastic such as bottle and all things that from plastic that have characteristics of low sulphur content, low reaction temperature and better combustibility than petrol and diesel. To recycle this waste plastic it have four step which is primary recycling, secondary recycling, tertiary recycling and quaternary recycling. All four step is important to producing the fuel. Diesel fuel in general is any liquid fuel used in diesel engines. Diesel fuel comes in several different grades, depending upon its intended use. Like gasoline, diesel fuel is not a single substance, but a mixture of various petroleum-derived components, including paraffins, isoparaffins, napthenes, olefins and aromatic hydrocarbons, each with their own physical and chemical properties.(Robert E. Reynolds, 2007)

1.2 PROBLEM STATEMENT

Nowadays many people in our country use public transportation to go their office such as car, bus, and others. In these cases all the transportation needs a diesel fuel to move. Since the price of diesel fuel is increase every year, many people ate frustrating. To overcome this problem, there is an idea to find an alternative fuel for diesel engine such as tire fuel and plastic fuel. The problem is, only a few data of flame characteristic and exhaust emission investigated using tire and plastic fuel.

1.3 OBJECTIVE

The objective of this project is:

i. To analyze of flame characteristic using tire fuel, plastic fuel and diesel fuel (color and temperature).
ii. To analyze the measurement of Particulate Matter.

1.4 PROJECT SCOPE

The scopes of this project are:

i. Experimental of flame characteristic by pool combustion
ii. Take the data of Particulate Matter gas at flame chamber.

1.5 PROCESS FLOW CHART

Figure 1.1 shows the process flow of how this project done. This makes useful tools how processes work done throughout the project.

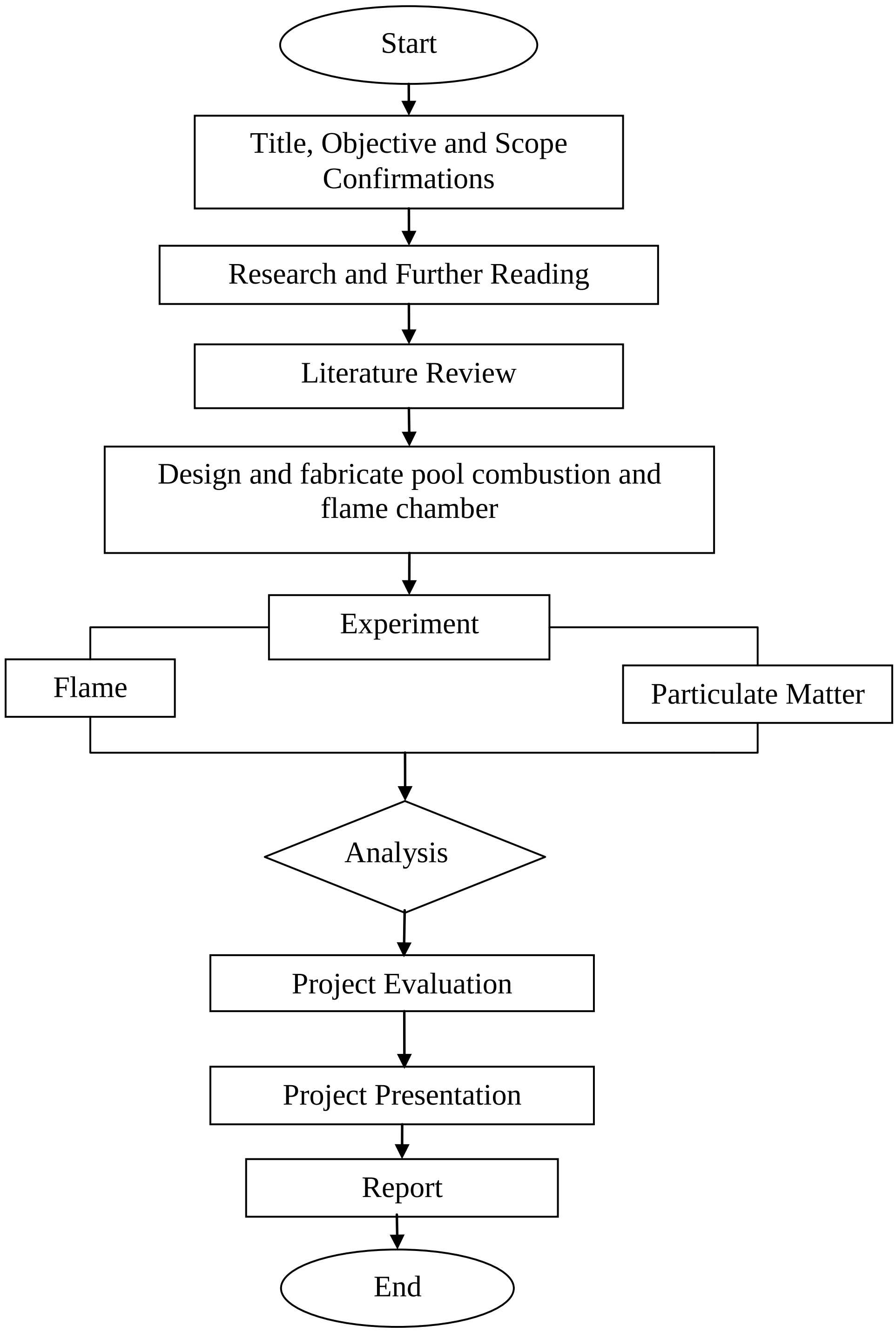

Figure 1.1: Process flow chart

CHAPTER 2

LITERATURE REVIEW

2.1 FLAME

2.1.1 Definition of Flame

Flame is a self sustaining propagation of localized combustion zone at subsonic velocity. Other than that, flame occupies only a small portion of the combustible mixture at any one time. Combustion waves that travel subsonically relative to the speed sound in the unburned combustible mixture (Jose M. C. Mendes-Lopes, 2003).

2.1.2 Basic Requirement for Combustion

Rapid oxidation of a fuel accompanied by the release of heat and light together with the formation of combustion products. This is the definition of combustion as quoted from Webster's dictionary.

Fuel + oxidant $\longrightarrow$ heat/light + combustion products

There is three type of requirement for combustion. They are fuel, oxygen and ignition (energy). Figure 2.1 show the combustion triangle.

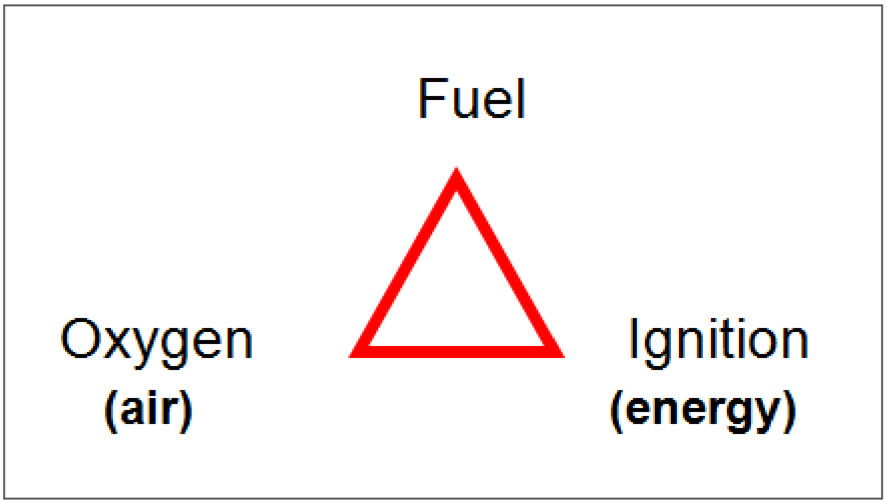

Figure 2.1: Triangle of Combustion

Source: www.fkm.utm.my/~mazlan/

2.2 FLAME HEIGHT

Flame is a body or stream of gaseous material involved in the combustion process, which emits radiant energy at specific wavelength bands depending on the combustion chemistry of the fuel involved (Massachusetts, 2002). In most cases, some portion of the emitted radiant energy is visible to the human eye as the glowing, gaseous portion of a fire, which is typically referred to as its flame. The flame generally consists of a mixture of and another gas, typically a combustible substance such as hydrogen, carbon monoxide, or a hydrocarbon. The brightest flames are not always the hottest. For example, hydrogen exhibits a high flame temperature. However, it combines with oxygen when burning to form water, hydrogen has an almost invisible flame under ordinary circumstances. When hydrogen is absolutely pure and the air around it is completely free of dust, the hydrogen flame cannot be seen, even in a dark room. In order to gain a better understanding of flames, a burning candle can be used as an example. When the candle is lit, the heat of the match melts the wax, which is carried up the wick and vaporized by the heat. As it is broken down by the heat, the vaporized wax combines with the oxygen of the surrounding air and produces heat and light in the form of a flame.

The candle flame consists of three zones, which are easily distinguished. The innermost, nonluminous zone is composed of a gas/air mixture at a comparatively low temperature. In the second luminous zone, hydrogen (H_2) and carbon monoxide (CO) (two of many products from the decomposition of the wax) react with oxygen to form combustion products, which include water (H_2O) and carbon dioxide (CO_2). In this zone, the temperature of the flame is 590–680 °C (1,094–1,256 °F), which is sufficiently intense to dissociate the gases in the flame and produce free carbon particles. (Massachusetts, 2002) These particles are heated to incandescence and then consumed. Outside the luminous zone is a third, invisible zone in which the remaining CO and H_2 are finally consumed. This zone is not visible to the human eye. (Massachusetts, 2002) Figure 2.2 shows the temperature distribution through the flame of a burning candle.

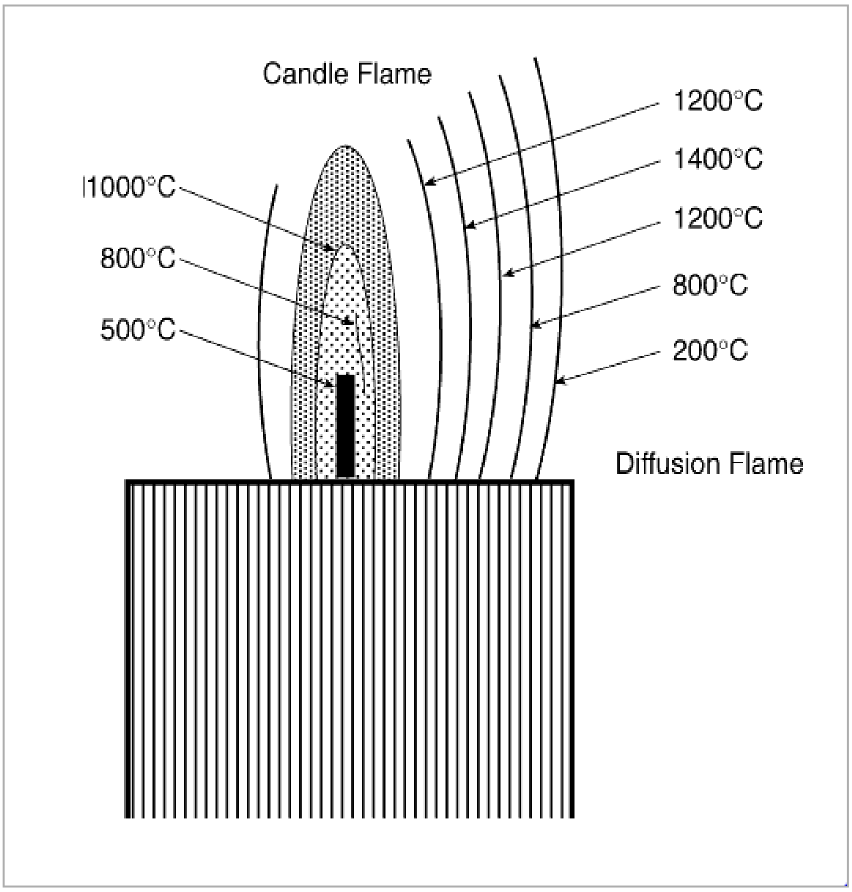

Figure 2.2: Temperature distribution through the flame of a burning candle

Sources: http://www.nrc.gov/

2.3 LAMINA AND TURBULENT FLAME

In combustion we can see the flame weather it have turbulent flame or lamina flame figure 2.3 show that when the velocity of nozzle increase the flame become a turbulent flame.

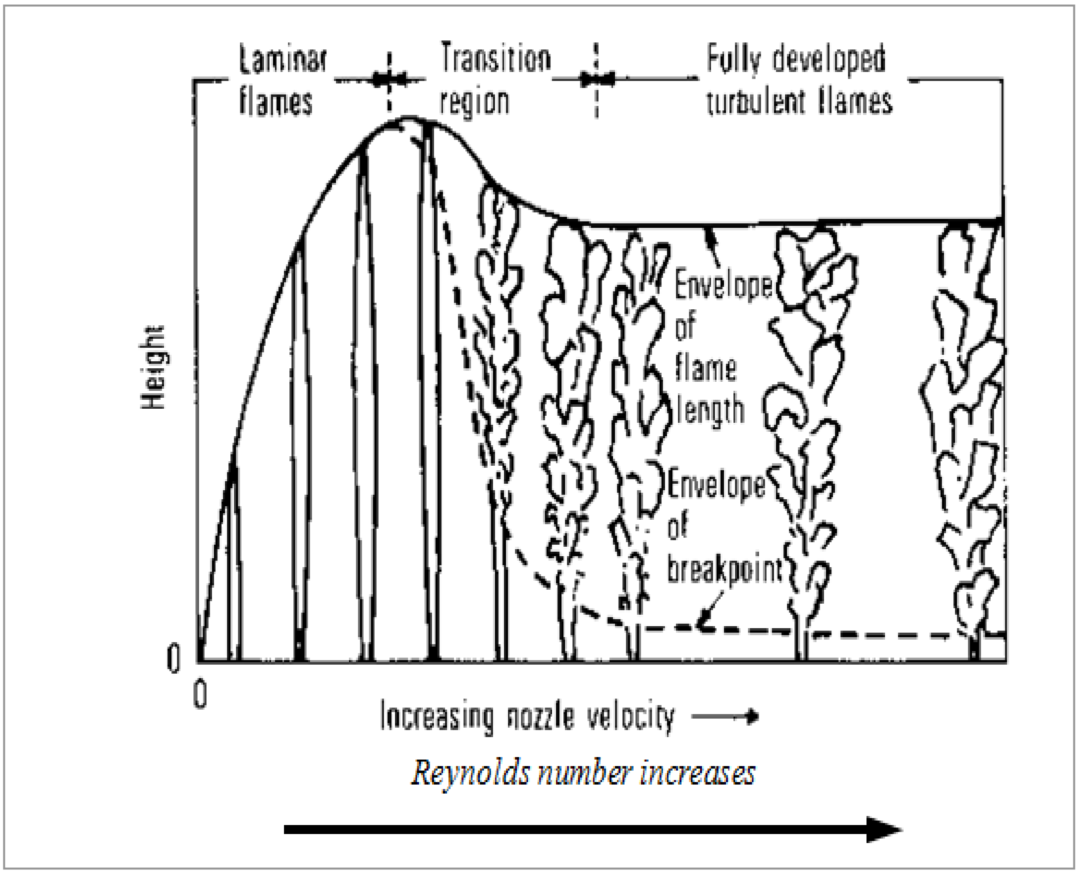

Figure 2.3: Graph for Lamina and Turbulent Flame

Sources: www.fkm.utm.my/~mazlan/

2.3.1 Laminar Premixed Flame

In some instances of premixed turbulent combustion, the flame surface behaves locally like a laminar flame. Studies of laminar flames have a bearing therefore, on the turbulent case, especially those studies concerned with the effects of straining and curvature on the flame. The simplest case is that of a plane laminar flame propagating steadily into quiescent reactants, the propagation speed is the laminar-flame speed, which is uniquely determined by the thermo chemical state of the reactants. Figure 2.4 show that in lamina premixed flame it consist two zone which is preheat zone and reaction zone.

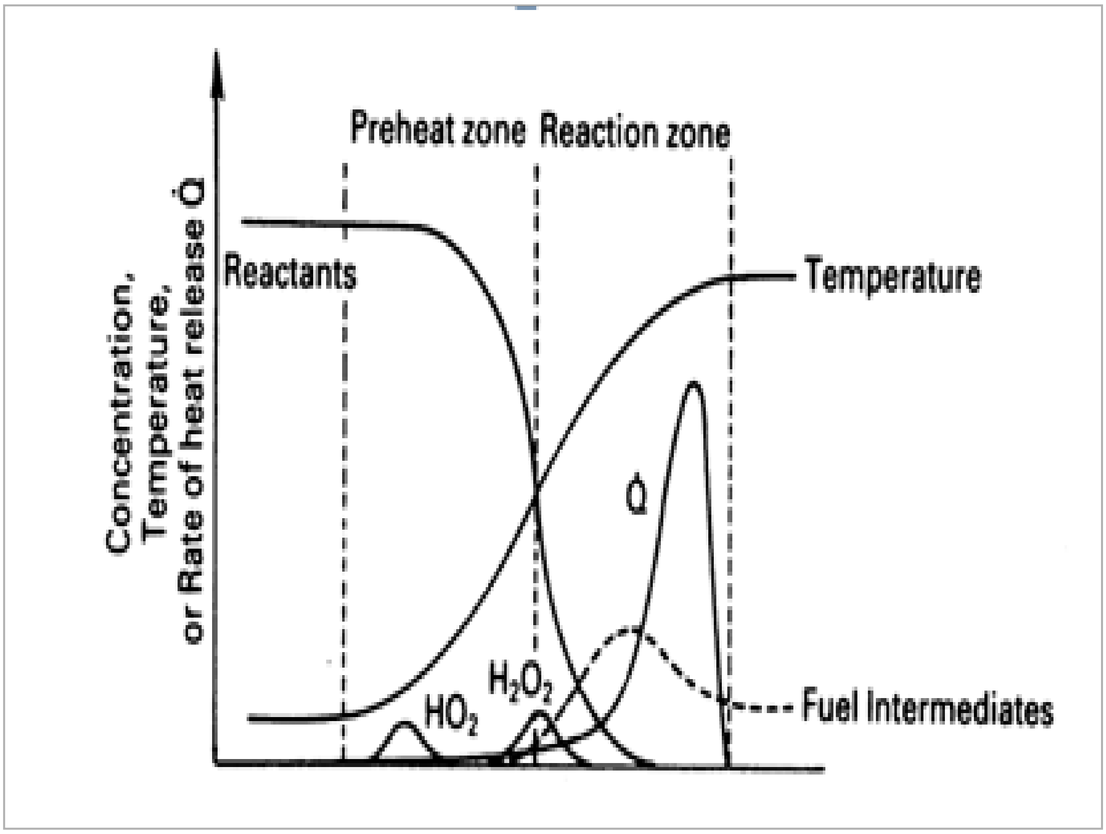

Figure 2.4: Graph for Lamina Premixed Flame

Sources: www.fkm.utm.my/~mazlan/

In the figure 2.4, the preheat zone have only a little heat is released. In the reaction zone, the bulk of the chemical energy is released. While in the atmospheric pressure, the flame thickness is quite thin, hence temperature gradients and species concentration gradients are very large. These gradients provide the driving forces that cause the flame to be self-sustaining the diffusion of heat and radical species from the reaction zone to the preheat zone. Hydrocarbon flames are also characterized by their visible radiation. With an excess of air, the reaction zone appears blue. This blue radiation results from excited CH radicals in the high-temperature zone. When the air is decreased to less than stoichiometric proportions, the flame zone appears blue-green, now as a result of radiation from excited $C_{2.}$ In both flames, OH radicals also contribute to the visible radiation, and to a lesser degree, chemiluminescence from the reaction CO + O —> CO_2 + hu. If the flame is made richer, carbon particles (soot) with its consequent black body continuum radiation, bright yellow to dull orange flame depending on flame temperature.

2.3.2 Turbulent Premixed Flame

As state in a (S. B. Pope, 1987), his study was about turbulent premixed flames that exhibit phenomena not found in other turbulent flows. In some circumstances a thin flame sheet forms a connected but highly wrinkled surface that separates the reactants from the products. This flame surface is converted, bent, and strained by the turbulence and propagates at a speed that can depend on the local conditions. Typically, the specific volume of the products is seven times that of the reactants, the flame surface being a volume source. Because of this volume source there is a pressure field associated with the Flame surface that affects the velocity field and hence indirectly affects the evolution of the surface itself. For the simplest case of a plane laminar flame, this feedback mechanism tends to make the flame unstable.

2.3.3 Flammability Limit

Flammability limit can be defined as a range of fuel and air proportion in which combustion can be self-sustaining is known as flammability limits .A premixed fuel-air mixture will only burn as long as the fuel concentration is between the upper and lower flammability limits, UFL and LFL.

2.3.4 Flame Categories

A flame can be thought of in two distinct categories, including diffusion flame (Figure 2.5) and premixed flame (Figure 2.6). A diffusion flame is one in which the fuel and oxygen are transported from opposite sides of the reaction zone. A premixed flame is one in which the oxygen is mixed with the combustible gas by some mechanical