

# The basic investigation of evaporation rate and burning temperature of various type of liquid fuels droplet

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**Abstract.** The investigation of spray combustion phenomenon in order to improve the combustion efficiency has been conducted through the experimentally or simulation. On the liquid spray combustion phenomenon the size of liquid fuel that was sprayed into the combustion chamber (droplet) is very small, ranging between 1-25  $\mu\text{m}$ . Due to the very small size of liquid droplet, the gravitation effect of liquid droplet was negligible or near the microgravity condition. Therefore, this study was conducted to observe the behaviour of evaporation rate and the burning temperature of various types of liquid fuels droplet. The results of this research can be used as a basis in experiments or modelling of spray combustion. The liquid fuel that was used in this experiment are n-decane, pertamax, pertainite and pertamax turbo. Experiments were performed by injecting liquid fuel into droplets on SiC fiber grids with several variations of droplet size (0.5 mm, 0.75 mm, 1 mm, 1.25 mm and 1.5 mm). The results show that the droplet size of each fuel has a positive correlation to the evaporation rate and also the combustion temperature. This paper will discuss in detail the characteristics of the evaporation rate and the burning temperature of each type of liquid fuels droplet.

## 1. Introduction

Flame-spread among the fuel droplets is an important point in order to produce stable spray combustion. Flame-spread in liquid fuel spray combustion occurs after ignition in diesel engine and in the combustion chamber of the gas turbine engines. The investigation of flame-spread phenomenon have been performed in a simplified system of fuel droplet such as single-droplet combustion [1-3], multiple-droplet combustion [4-8], and droplet array combustion [9-12]. From that excellent study, the phenomenon of flame-spread began clearly to be understood, especially from less volatile fuel of droplet array experiment.

The need of fossil fuels is increasing as the world economy grows. Now, there are concerns about fuel limitations and emissions restrictions in a few countries. This has led to numerous studies to improve methods of fuel-saving and low-pollution. Spray combustion is one form of research to improve combustion efficiency by atomizing fuel into smaller sizes. These sizes generally range from 1-25  $\mu\text{m}$ . To make atomization fuel using microgravity combustion research, where the fuel (droplet) dripped in sic fiber and then dropped free from the 6 meters tower drop.



Microgravitation is a state where the gravity force is low and provides ideal conditions for some experimental configurations that fluid mechanics problems probably can be solved. The effects of gravity can be ignored if the fluid approaches an incompressible state or if the forced convection is greater than natural convection.

Evaporation rates and ignition delays for liquid droplets generally increased and decreased respectively as heated surface temperatures were increased. As a result, evaporation lifetime and ignition delay correlations to surface temperature are not identical. Stated differently, an increase in heated surface temperature may or may not increase overall evaporation rates, and ignition delays may or may not decrease regardless of the increase or decrease in evaporation rate, depending upon the given surface temperature, fluid properties and other factors [13]

Liquid fuels are fuels whose structures are not tight, when compared to solid fuels molecules can move freely. Gasoline / gasoline / premium, diesel oil, kerosene are examples of liquid fuels. Liquid fuels commonly used in industry, transportation and households are the fraction of petroleum. Liquid fuels generally come from petroleum. Petroleum is a natural mixture of liquid hydrocarbons with little sulfur, nitrogen, oxygen, little metal, and minerals [14]

Characteristics of liquid fuels to be used on certain uses for machinery or other equipment need to be known in advance, with the intention that the combustion results can be achieved optimally.

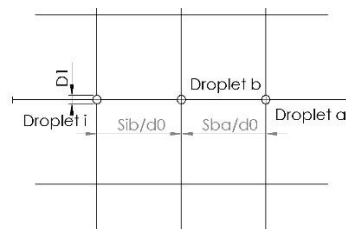
## 2. Materials and method

### 2.1. Materials

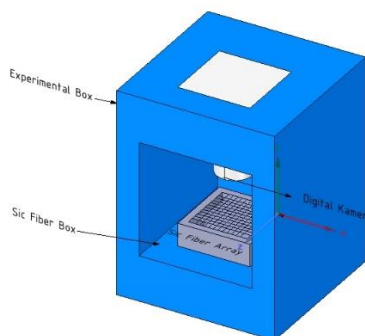
The material used in this experiment is a droplet generator, a fuel consisting of n-decane, pertamax, pertalite and pertamax turbo.

### 2.2. Method

The experiment was carried out by injecting the fuel into a SiC fiber arrangement with a distance of  $S_b/d_0$  (Figure 1). The glass needle containing the fuel is driven by a mechanism that causes droplets to form on the SiC fiber. After the drop arrangement has been completed, the Pentax Q7 digital video camera is placed at the top of the droplet array to record the burning process (Figure 2). Droplet ignition is turned on by using a hot wire made of Fe-Cr.



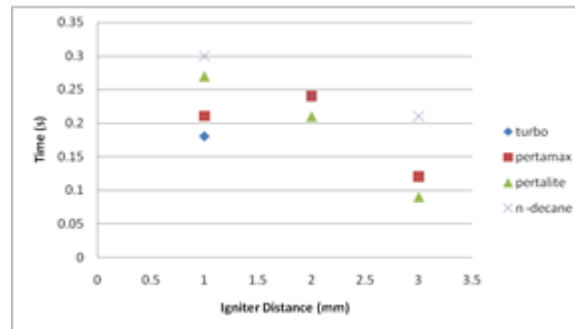
**Figure 1.** Droplet array model.



**Figure 2.** Experiment box.

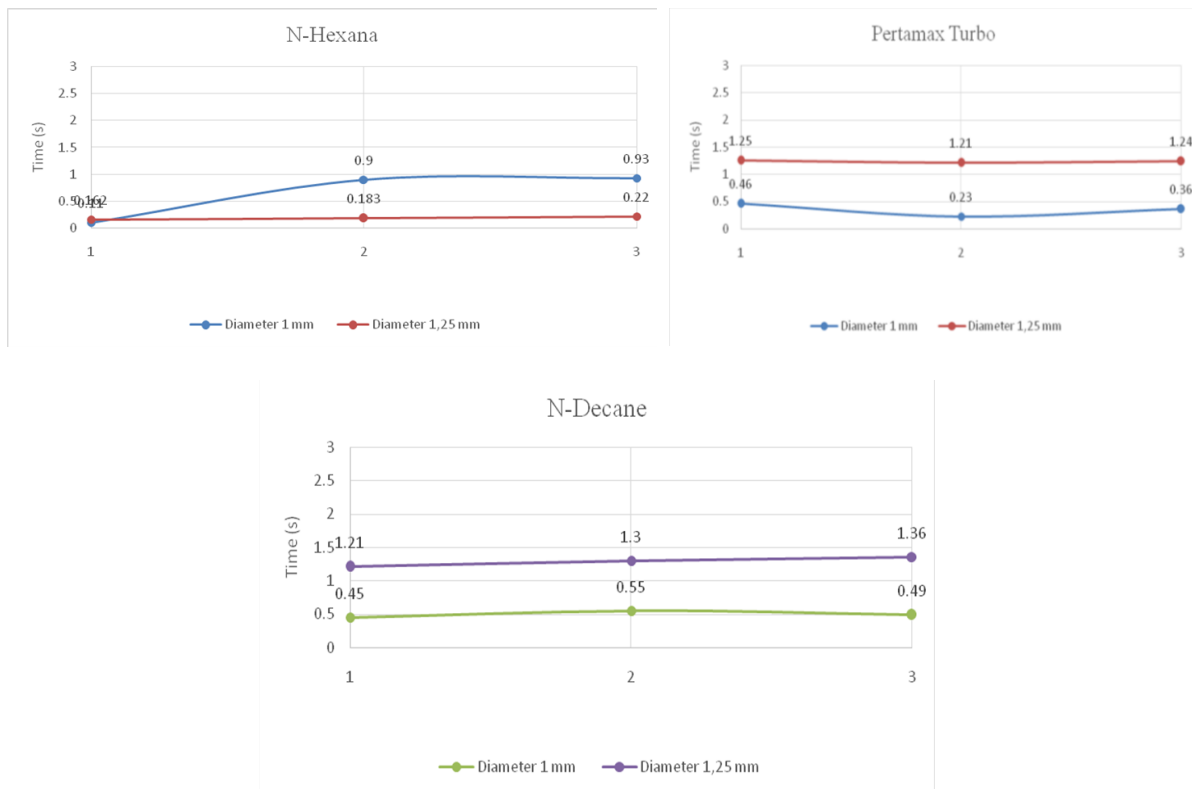
### 3. Result and discussions

The combustion rate of the fuel variations is shown by (Figure 3) where combustible fuel is pertamax with a combustion time of 0.12 s and an igniter distance to a droplet is 3 mm.



**Figure 3.** The effect of igniter distance to burning time.

The rate of evaporation of liquid fuels is shown by (Figure 4). From the graph obtained results n-hexana fuel get evaporated faster than other fuels, so if used for combustion then the fuel burns faster.



**Figure 4.** The rate of evaporation of various fuels.

### 4. Conclusion

From this research we get a conclusion that the fuel pertamax turbo burn faster with a distance of 1mm, 2mm, 3mm igniter so that this fuel will be more effective if used for combustion with the distance. This study also obtained data that n-hexane fuel has a faster rate of evaporation when compared with other fuels, so that this fuel will be more easily burned.

## Acknowledgment

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