
UNIVERSITI PUTRA MALAYSIA

# INFLUENCE OF A COMMERCIAL FUEL ADDITIVE ON COMBUSTION CHARACTERISTICS

MD ISA BIN ALI

# INFLUENCE OF A COMMERCIAL FUEL ADDITIVE ON COMBUSTION CHARACTERISTICS

By

MD ISA BIN ALI

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*To my wife and children, for*
*their patience and support during*
*the long preparation of this thesis.*

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**Chairman:** **Associate Professor Md. Abul Hossain Mollah, Ph.D.**

**Faculty:** **Engineering**

The worse quality fuels in over 30 years have contributed to exessive emissions, poor performance and many others. Today, there exists a variety of fuel additives to perform under severe conditions to improve the fuel's combustion characteristics. However, the effectiveness and mode of operation of such additives are not completely understood.

This study discussed the experimental findings using a Combustion Laboratory Unit. Experiments were performed to determine the effects of a particular fuel additive on combustion characteristics which includes emissions, efficiency, heat release and the fuel consumption rate. Fuels (gasoline) with and without the additive were fired succesively in the unit. MARVEL, a commercial fuel additive was used for the analysis. The concentration of the additive in the basic fuel were within 0.2% to 1.6% by volume.

It was found that, with the presence of the fuel additive, it decreased the carbon dioxide emission by 2%, maintained the carbon monoxide level less than 4% and the heat release increased by 5%. The additive was also found to increase the combustion efficiency by 8%, and decreased the fuel consumption rate by 5%.

From the above findings, the use of the additive to modify certain combustion characteristics of fuel can improve the basic fuel quality and performance. As this additive has been developed primarily for gasoline fuels, many such additives can also be employed in other type of fuel.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENGARUH SEJENIS BAHAN TAMBAH KOMERSIAL BAHANAPI KE ATAS CIRI-CIRI PEMBAKARAN**

**Oleh**

**MD ISA BIN ALI**

**Julai 2001**

**Pengerusi:** **Profesor Madya Md. Abul Hossain Mollah, Ph.D.**

**Fakulti:** **Kejuruteraan**

Kualiti bahanapi yang kurang memuaskan disepanjang 30 tahun yang lampau, telah mengakibatkan beberapa masalah seperti pencemaran, prestasi yang kurang baik serta pelbagai lagi. Pada hari ini, telah wujud pelbagai jenis bahan tambah bahanapi dengan sifat-sifat yang tertentu untuk memperbaiki ciri-ciri pembakaran bahanapi tersebut. Walaubagaimanapun, keberkesanan dan kaedah operasi bahan tambah-bahan tambah itu masih belum diketahui sepenuhnya.

Kajian ilmiah ini membincangkan hasil ujikaji dengan menggunakan sebuah Radas Analisa Pembakaran.. Ujikaji-ujikaji telah dijalankan untuk mengkaji pengaruh bahan tambah ke atas ciri-ciri pembakaran termasuk komposisi gas ekzos, haba terhasil, kecekapan pembakaran keseluruhan dan akhir sekali kadar penggunaan bahanapi. Bahanapi (gasoline) berserta bahan tambah dan bahanapi tanpa bahan tambah telah dibakar di dalam radas tersebut. Sejenis bahan tambah komersial, MARVEL, telah digunakan dalam kajian ini. Peratusan bahan tambah yang

dicampurkan ke dalam bahanapi adalah diantara 0.2% hingga 1.6% pada nisbah isipadu.

Adalah didapati bahawa, dengan kehadiran bahan tambah tersebut, pengeluaran karbon dioksida berkurang sebanyak 2%, mengekalkan paras karbon monoksida di bawah 4% dan kadar haba dihasilkan meningkat sebanyak 5%. Bahan tambah ini juga didapati dapat meningkatkan kecekapan pembakaran sebanyak 8% serta mengurangkan kadar penggunaan bahanapi sehingga 5%.

Daripada keputusan di atas, didapati, dengan penggunaan bahan tambah untuk mengubah ciri-ciri pembakaran bahanapi, ia juga boleh memperbaiki kualiti dan prestasi bahanapi tersebut. Bahan tambah yang dibincangkan ini pada asasnya adalah untuk bahanapi gasoline. Terdapat banyak lagi bahan tambah lain yang juga boleh digunakan untuk jenis-jenis bahanapi lain.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| $Q_f$ | Heat input from fuel |
| $Q_c$ | Heat loss due to cooling water |
| $Q_e$ | Heat loss to exhaust gases |
| $Q_s$ | Heat loss to the unit surfaces |
| $Q_L$ | Unaccounted heat loss |
| $\eta_c$ | Combustion efficiency |
| $m_f$ | Fuel mass flow rate |
| $m_w$ | Water mass flow rate |
| $m_g$ | Mass of dry fuel gas per mass of fuel fired |
| LHV | Fuel lower heating value |
| $c_{pw}$ | Constant pressure specific heat for water |
| $c_{pg}$ | Mean constant pressure specific heat of dry flue gases |
| $T_{w1}$ | Water inlet temperature |
| $T_{w2}$ | Water outlet temperature |
| $T_e$ | Exhaust outlet temperature |
| $T_a$ | Air supply temperature |
| HC | Hydrocarbon |
| ppm | Part per million |
| V | Volume of pipette |
| $\rho_f$ | Density of the fuel |
| t | Time taken to consume the fuel |

# CHAPTER 1

## INTRODUCTION

Combustion is defined as a chemical reaction in which a fuel combines with oxygen liberating large quantities of heat and incidentally light.

The mechanism of combustion, particularly that of complex hydrocarbons, is complicated and is not fully understood. Combustion does not proceed directly from the air-fuel mixture to the final products. Rather, partial oxidation of the fuel occurs at first, and intermediate products are formed. Ultimately, if conditions are right, combustion becomes complete.

Attempts to improve basic petroleum product by non-hydrocarbon additive treatment have existed as long as the petroleum industry itself. Nowadays, certain chemical materials are marketed as additives for some liquid fuels, either to improve their combustion characteristics or to alleviate low temperature corrosion problems due to the fuel's sulphur content. Some common fuel additives are such as oxidation inhibitors, corrosion inhibitors, anti-icing additives, anti-knock compound and dyes.

A host of properties exhibited by fuel (gasolines) results from the use of additives. For example, oxidation inhibitors make gasolines less susceptible to oxidation; this allows the gasoline to be stored for many weeks without excessive gum.

## 1.1 Problem Statement

The use of additives to modify certain physical or chemical characteristics of fuel have been mentioned in most literature. The research activity in most of the literature emphasize the major contribution of a given type of fuel additive to increase the efficiency which centered on the effectiveness of the additive to provide variety of improvements such as knocking, excessive corrosion, and many others. But, how does the additives affects the combustion characteristics such as the combustion efficiency, emissions, and the heat release are not clearly described.

## 1.2 Scope of Study

A study of the effect of the additives is carried out by using a combustion laboratory unit. Fuels with and without additive are fired succesively in the unit and analyses of performance is made.

The majority of the experiments in this study falls into the combustion with the fuel additive and its influence to the combustion characteristics which includes emissions, combustion efficiency and heat release in the unit.

The effect of the additive on the fuel consumption are also included. A single cylinder engine test bed is used for this purpose.

Under the heading of combustion characteristics, other than those dictated above, are included flame speed, reaction rates and flame propagation. However, since the study of the very complicated phases of combustion is beyond the scope of this study, the reader is referred to the references.

## 1.3 Objectives

The objectives of this study is to study the effect of the fuel additive on :-

i. Flue gas composition.

ii. Combustion efficiency.

iii. Heat release (distribution) in the combustion laboratory unit.

iv. Fuel consumption of an engine.

## 1.4 Benefit of Study

i. The findings can be used as a valuable information to the fuel users so that they can plan the used of their fuel safely and economically.

ii. The findings might provide many new business opportunities and a challenge to the additives manufacturers about the need for more effective fuel additive to increase efficiency, while at the same time decreasing the emissions of pollutant.

iii. The findings can be used by any interest organizations especially Department of Environment (DOE), Road and Transport Department (RTD) to plan their environment friendly programmes.

# CHAPTER 2

# LITERATURE REVIEW

Fuels additive are designed to help solve poor quality fuel problems - burned valves, exessive emissions, hesitation, knocking and so on – and vehicle maintainers have caught on their importance.

Today, there exist a variety of combustion or fuel additives to perform under extremely severe conditions. It is found that the additives have been a solution to many problems and substantial reduction in emissions, wear, maintenance and down time.

G.E Gaston (1982) describes a gasoline motor fuel having improved anti-icing, detergency, antirust and ignition control characteristics. It is obtained by incorporating in the fuel a small amount of a combination of a polyoxypropylene monooleaete and N-tallow trimethylenediamine naphthenate.

To illustrate the nature of the improvement obtained, presented in Table 2.1, are the results obtained with engine tests made upon a base gasoline motor fuel (A) and the same base gasoline motor fuel containing an additive (B).