UPGRADING PETROLEUM PRODUCTS THROUGH USING NOVEL ADDITIVES TECHNOLOGY

By

Manal Mohamed Metwally

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY
in

CHEMICAL ENGINEERING

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Dedicated to

My mother,

My husband,

And

My children

وَمَا أُوتِيتُمْ مِنْ الْعِلْمِ إِلاَّ قَلِيلاً)

صدق الله العظيم

(الإسراء : 85)

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ABSTRACT

Egypt faces nowadays severe economic crisis, and due to it the Egyptian government took many decisions to overcome it , such as cutting fuel subsidies , floating dollar and controlling imports.

So this scientific study aims to upgrade the gasoline efficiency either from naphtha or gasoline 80 and to improve its environmental qualifications to match with European standards.

By doing this Egypt saves its hard currency, reduce the imports of gasoline 95 and protecting the environment to be more healthy.

The new technique in this study depends on adding Methanol on gasoline and test it via two blends in different climatic conditions .In addition to that the technique used low cost products to make the feasibility a positive one .

In the laboratory studies many blends have been made by using different materials and additives to reach the optimum chemical qualifications.

Toxic lead additives to gasoline are no longer used in many countries worldwide. The principle objectives of the present work are to upgrade the quality of some petroleum products through various operations. Preparation of low cost premium gasoline, upgrading Gas Oil's physical properties as well as the conversion of the vacuum residue into clean coal are among the prime objectives. Also, another objective is to study the effect of the RVS technology on internal combustion engines.

This study investigated the effect of alternative additives such as Methanol, MTBE on the 80 RON gasoline, light and heavy Naphtha via different blends of variable percentages. The CFR engine was employed to measure the Octane number of the produced blends while mixtures of other alternative additives were prepared and added to the previously mentioned blends. The obtained results showed that the additives have led to a significant improvement of the measured octane number of gasoline. Nevertheless, it was noted that decreasing the Methanol percentage had a negative effect on the environment. As illustrated by the results, it is noted that the gain in the research octane number in the methanol blended samples is higher than base gasoline. Also, the gaseous emissions produced on combustion such as carbon monoxide, nitric oxides and unburnt hydrocarbons have shown a noticeable decrease of 26% for unburnt, 16% for CO and 14.5 % for NOx. Nevertheless, Carbon dioxide emissions have increased by 5.6 % which may be attributed to the complete combustion of the fuel on the expense of Carbon monoxide emissions. Moreover, the effect of

oxygenate addition on the volume of air required to be detected in the decrease in the NO_x emissions.

The conducted study, using this booster will directly decrease air pollution. Increasing the percentage of oxygenate in the blend will reduce the carbon dioxide emissions and consequently will save carbon credit expenditures. The oxygenate additives are economic and environmental and they can save money by increasing octane number and decreasing CO_2 emissions (CO_2 credit). And Methanol may be a little better but MTBE and Ethanol are also giving good numbers.

The present work showed that the use of additives had a good impact on the environment by the reduction of CO, CO_2 and NOx produced emissions as a measure after the various treatment methods. The conducted study indicated that the use of Alternative additives decrease the cost of fuel and has a significant impact on the economy. However the results revealed that, improvement characters of Solar by decrease sulfur through using high technique, the additive on solar decrease sulfur by about 50% and high technique decreased the percentage of sulfur by about 15%.

The application of the RVS technology improves the engines performance by: Reducing the fuel or energy consumption, decreasing repair and service costs and increase the engines life time.

CHAPTER 1 Introduction

1.1Background

For the past years Egypt has been trying to boost its gasoline fuel production. Despite having significant fuel reserves and promising new discoveries Egypt has not been fast or efficient enough to face the growing domestic demand. Egyptian fuel subsidies was reduced during the fiscal year 2015/2016 by 28.7% compared to the previous the year 2014/2015, as the country aims to reduce costly energy assistance that consume a large portion of the state budget. Additionally, Egypt allocated 35.04BillionEGP in the budget EGP formed energy aid during the current fiscal year 2016/2017, as the government is expected to implement further cuts to subsidy expenditures. Egypt raised gasoline prices up to 78% in 2014, however prices of oil more than halved between mid-2014 and early 2016, Egypt's subsidy bill fell pointedly, although the resuscitation in prices is avoirdupois on public coffers once again. Egypt now outlay $795 million per month and imports 5 million tons of gasoline 95 yearly to meet its energy needs, according to the petroleum ministry. Target of Egypt is ameliorating air feature by increasing the number of natural gas vehicles, and gradually decrease used of leaded gasoline.

Gasoline is one of the most required products of the petroleum industry. It is produced in the refinery and used as a fuel for transportation. In the refinery, about 70% of the crude oil converted into gasoline [1].

Gasoline is considered as the main dropper obtained from crude oil in the refinery. complex mixture of light hydrocarbons raining from 5 to 10 carbon atoms and havening boiling range of 40^{o}C to 190^{o}C. A typical gasoline is predominantly a mixture of paraffin's (alkanes, saturated hydrocarbons they are single bonded), naphthenic (cycloalkanes, cyclic saturated hydrocarbons), aromatics and olefins (alkenes, unsaturated hydrocarbons they are double bonded) gasoline at the level consumer called petrol or super, benzoyl, motor spirit or gas.

In the past years, the petrochemical method for the production of fuels was improved to face the high demand by increasing amounts and qualifications. . Different additives were added to provide the required characteristics to decrease the knock in engines gasolines used today. Components were used selective are antiknock factor to improve octane number of unleaded gasoline divided into many groups: metallic, alcohols, aromatics, and others [2].

Petroleum refiners have introduced certain substances to gasoline in order to enhance the performance of their product and/or to comply with product specifications and environmental regulations developed to address pollution caused mainly by motor cars. These substances are known as "additives". Their use generally allows an increase in fuel quality by providing sufficient octane i.e. an increase in antiknock quality to be achieved at less expense than modifying the fuel's hydrocarbon composition by energy and crude oil intensive refinery processing.

Fuel additives are compounds formulated to improve the quality and effect of the fuels that used in motor vehicles. However in some cases, the supplier combine the additive into the gasoline itself; in other times, the fuel additive is purvey as a sever product that consumers may use to improve the personification of engines. Methanol is the simplest alcohol that can be used as a building block to larger chemicals. It is a colorless polar liquid miscible with water at room temperature, highly toxic to humans and flammable nature. Special care must therefore be taken in handling, transportation and storage. Request for cleaner and ersatz energy is increased quickly due to trait in methanol production and increased of methanol consumed is predictable to probable continue until the end of this deed. Methanol is widely used as a candid material for formaldehyde production, MTBE and acetic acid [3].

Oxygenates defined as rich material that should dissolve well in gasoline and make it singe better, to this reasoned reducing carbon monoxide and other emissions. MTBE is fuel oxygenate surpass by oil corporation, because it's cheaper to make from the refinery waste-

streams, has about the same heating value as gasoline, mixes well with gasoline, and does not increase gasoline vapor pressure. MTBE has a horrible taste and odor, and can be easily disrupt water in drinking wells [2]. On the other hand, Alcohols weary a higher octane number than typical gasoline. They are more efficiency in low octane gasoline than in high octane gasoline.

The desecration of Naphtha is a liquid petroleum product. Naphtha defined as fraction of hydrocarbons in petroleum boiling between (30°C) and (200°C). It's consisted of a complex mixture of hydrocarbon molecules generally having between (5 and 12) carbon atoms. It typically constitutes (15–30 %) of crude oil, by weight. Naphtha classified into two types: Light naphtha is the bit boiling between (30°C) and (90°C) and consists of molecules with (5–6) carbon atoms. Heavy naphtha boils between (90°C) and (200°C) and consists of molecules with (6–12) carbons atoms [4].

Octane Number (RON) or the Motor Octane Number (MON) of an unleaded gasoline considers one of the most essential measures of gasoline quality. The research octane number (RON) and the motor octane numbers (MON) of gasoline are measurements of its quality of performance as fuel. An octane number is a number which measures the efficiency of the gasoline to withstand knocking. Knocking occurs when fuel combusts prematurely in an engine, causing advantage horseplay which resembles knocking [5].

The guide indicates the effectiveness feature of gasoline and its octane number. The octane number of a gasoline is an indication on how the gasoline will perform under various engine matters. Two different ranking are included: Research Octane Number and Motor Octane Number. Finished gasoline must meet certain octane number specifications.

Finally, RVS is technology that makes use of a mixture of native metals, additives and catalysts that have been mixed with global lubricants in order to facilitate its use. This involves formation of a ferrosilicate layer as a result of a reaction between the crystals of the surface layer and the mixture. New crystals are formed and grow in size producing larger and heavier crystals. They include themselves onto the pristine surface of contact retarding wear [6].

1.2 Aims of the Study:

1- To produce Gasoline 80, Gasoline 92 and gasoline 95 from light and heavy Naphtha and produce gasoline (102 octane number) from gasoline 80 and jet type; The decrease in the cost of Gasoline 95 is expected to lead to a decrease in the cost of Gasoline 80 and gasoline 92. So, one of the aims would be to decrease the cost of Gasoline.

2- Decrease the sulfur in solar cut by a novel technique since Egyptian solar has a high percentage of sulfur.

3- Throw light on the RVS positive effects on the engines.

4- Proving that the use of additives had a good impact on the environment by the reduction of CO, CO2 and NOX produced.

5- Elaborating a sound statistical model to predict the effect of various additions on the Octane Number of gasoline.