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Effects of Magnetic Field on Fuel Consumption and Exhaust Emissions in Two-Stroke Engine

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Abstract

The energy of permanent magnets was used in this research for the treatment of vehicle fuel (Iraqi gasoline), to reducing consumption, as well as reducing the emission of certain pollutants rates. The experiments in current research comprise the using of permanent magnets with different intensity (2000, 4000, 6000, 9000) Gauss, which installed on the fuel line of the two-stroke engine, and study its impact on gasoline consumption, as well as exhaust gases. For the purpose of comparing the results necessitated the search for experiments without the use of magnets.

The overall performance and exhaust emission tests showed a good result, where the rate of reduction in gasoline consumption ranges between (9-14) %, and the higher the value of a reduction in the rate of 14% was obtained using field intensity 6000 Gauss as well as the intensity 9000 Gauss. It was found that the percentages of exhaust gas components (CO, HC) were decreased by 30%, 40% respectively, but CO_2 percentage increased up to 10%.

Absorption Spectrum of infrared and ultraviolet radiation showed a change in physical and chemical properties in the structure of gasoline molecules under the influence of the magnetic field. Surface tension of gasoline exposed to different intensities of magnetic field was measured and compared with these without magnetization.

Keywords: magnetic treatment, fuel consumption, exhausts emission, IR and UV spectra, surface tension.

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1. Introduction

Today's hydrocarbon fuels leave a natural deposit of carbon residue that clogs carburetor, fuel injector, leading to reduced efficiency and wasted fuel. Pinging, stalling, loss of horsepower and greatly decreased mileage on cars are very noticeable. Most fuels for internal combustion engine are liquid, fuels do not combust until they are vaporized and mixed with air. Most emission motor vehicle consists of unburned hydrocarbons, carbon monoxide and oxides of nitrogen. Unburned hydrocarbon and oxides of nitrogen react in the atmosphere and create smog. Generally a fuel for internal combustion engine is compound of molecules. Each molecule consists of a number of atoms made up of number of nucleus and electrons, which orbit their nucleus. Magnetic movements already exist in their molecules and they therefore already have positive and negative electrical charges. However these molecules have not been realigned, the fuel is not actively interlocked with oxygen during combustion, the fuel molecule or hydrocarbon chains must be ionized and realigned. The ionization and realignment is achieved through the application of magnetic field [1, 2].

Many of experimental studies which present evidences of the benefits of magnetic treatment were occurred. For motor vehicles and industrial boilers, much fuel economy and noticeable soot suppressions could be approached when the magnetic treatment was introduced [3]. For pollution due to automobile emissions, it is of great concern more, particularly in metropolitan cities. It creates a potential threat to the existence of healthy life [4-5], the enhancement of oil recovery and prevention of wax deposition [6]. In petroleum production, transportation and refining; the improvement of fluidity of crude oils [7].

Magnetic fuel treatment works on the principle of magnetic field interaction with hydrocarbon molecules of fuel and oxygen molecules. Liquid fuel is a mixture of organic chemical compounds consisted predominantly of carbon and hydrogen atoms - hydrocarbons. Due to various physical attraction forces, they form densely packed structures called pseudo compounds which can further organize into clusters or associations [8]. These structures are relatively stable and during air/fuel mixing process, oxygen atoms cannot penetrate into their interior. The access of appropriate quantities of oxygen to the interior of these molecular groups (associations) is thus hindered. This result in the incomplete combustion of fuel in the interior of such associations and causes the formation of carbon particles and carbon monoxide as well as increased quantities of hydrocarbons emitted into the environment [9].

It is now well accepted that a hydrocarbon fuel can be polarized by exposure to external force such as magnetism. The effect of such magnetism is the production of a moment created by the movement of the outer electrons of a hydrocarbon chain moving the electrons into states of higher principal quantum number. This state effectively breaks down the fixed valance electrons that partake in the bonding process of the fuel compounds. These states create the condition for freer association of fuel particulars. In so doing, the hydrocarbon fuel becomes directionalized or aligned which does not necessarily create new hydrocarbon chains but more explainable aligns the conduced magnetic moment into a dipole relationship within itself. This magnetic alignment then permits rapid bonding with the respective oxidizing media. The result of which is, of course, more complete and rapid burning of the hydrocarbon fuel [10, 11].

Hydrocarbon molecules treated with a high magnetic field tend to de-cluster forming smaller associates with higher specific surface for the reaction with oxygen leading to improved combustion. In accordance with van der waals discovery of a weak clustering force, there is a strong binding of hydrocarbons with oxygen in such magnetized fuel, which ensures optimal burning of the mixture in the engine chamber. The consequence of treating fuel with a high magnetic field is improved combustion of fuel and consequently increased engine power as well as reduced fuel consumption. An additional consequence of improved fuel combustion is reduced emissions of carbon particles, carbon monoxide and hydrocarbons [8, 12]. In our study, focus has been laid on the understanding of magnetic action modes which have led to the fuel economy and reducing exhaust emissions in engine applications.

De-cluster of fuel

Hydrocarbons have basically a "cage like" structure. That is why during the combustion process oxidizing of their inner carbon atoms is hindered. Furthermore they bind into larger groups of pseudo-compounds. Such groups form clusters (associations). The access of oxygen in the right quantity to the interior of the groups of molecules is hindered and it is this shortage of oxygen to the cluster that hinders the full combustion [13]. The exhaust should theoretically contain carbon dioxide, water vapour and nitrogen from air, which does not participate in the combustion. Practically the exhaust gases contain CO, H_2, HC, NOx and O_2. In reality, complete combustion of fuel is never achieved and the incompletely oxidized carbon is evident in the form of HC, CO or is deposited on the internal combustion chamber walls as black carbon residue. Hydrocarbon fuel molecules treated with the magnetic energy tend to de-cluster, creating smaller particles more readily penetrated by oxygen, thus leading to better combustion [14]. They become normalized & independent, distanced from each other, having bigger surface available for binding (attraction) with more oxygen (better oxidation). In accordance with van der Waals' discovery of a weak-clustering force, there is a very strong binding of hydrocarbons with oxygen in such magnetized fuel, which ensures optimal burning of the mixture in the engine chamber [2].

In our study, focus has been laid on the understanding of magnetic action modes which have led to the fuel economy and exhaust emission reduction in engine application (10 pt) Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

2. Methodology

The effect of the magnetic field on fuel (gasoline Iraqi) used in the engines and its impact on the amount of consumption, as well as emission of exhaust gases, the appropriate method was examined. We include below the description of the materials and equipment used.

2.1. Magnetic devices

Four magnetic devices used in this research were manufactured in the laboratories of the Water Research Centre / Ministry of Science and Technology. Each device contains the number of permanent magnets arranged alternately in multiple stages. The magnetic intensities of those magnets are (2000, 4000.6000, 9000) Gauss. Figure (1) represents one of them.

Fig. (1). a photograph of one of the magnetic devices

2.2. Engine

Two-Stroke Engine with spark ignition, Chinese origin TWP20C with a capacity of up to 5.5 hp was selected, for being used in most Iraqi homes for the implementation of the experiments. An external tank includes a volumetric scale and valve was connected instead of the main reservoir of the engine so as to measure the amount of fuel consumed during operation and for each experiment.

2.3. Fuel

The fuel which provides by gasoline filling stations to the cars and small generators was used in our current research.

2.3. Procedure

Figure (2) represents a photograph of the fuel magnetization unit used in the implementation of the experiments.

- Periodic inspection of the engine parts for each experiment.
- Three accelerated rotation of the engine (3500, 4500, 5000) r.p.m, was taken, which representing an initial speed and low, medium and higher than the other so as to know the amount of fuel consumption in each of these speed at all magnetic intensities.
- Start up the engine after putting a certain amount of fuel in the external tank, and set the selected speed for the experiment. Process will continue operating for two hours and for each test, during which the exhaust gas was measured at several times for accuracy. After that, calculate the amount of consumed fuel in the end of the experiment through the rankings is installed on the external tank of the engine.
- Repeat this process for the second speed to know the amount of consumed fuel and the amount of exhaust gases.
- Repeat the process in paragraph (3) after install the magnetic device with intensity 2000 Gauss on the fuel line, as well as re-install the same speed because it will increase after install the magnetic device. The exhaust gases during operation were measured, as well as the amount of consumed fuel after the end of the operation. The amount of consumed fuel after the installation of the magnetic device was deducted from the quantity before the installation of the magnet to know the quantity saved, and the same principle applies to the exhaust gases.
- Repeat the process in paragraph (5) for each magnetic intensity and also for the three above speed.

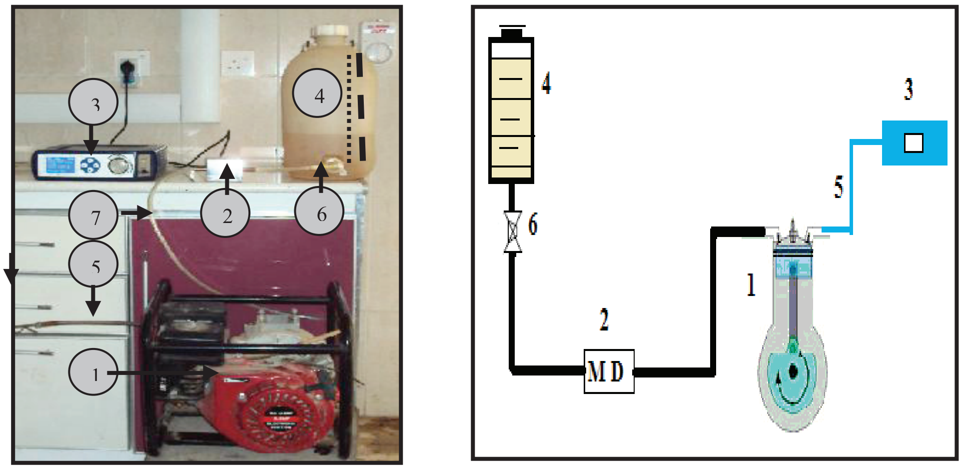

Fig.2. a photograph of the fuel magnetization unit (1. Engine, 2. Magnetic device 3. Measuring device for exhaust gases, 4. Fuel tank, 5. Gas sensor, 6. Valve, 7. Flexible tube for fuel)

2.4. Test and measurement equipment

Samples up to 100 ml of fuel before and after the process of magnetization were taken for each magnetic intensity and to measure the absorption spectrum of the infrared device using the IR prestige-21-SHIMADZU range (400-4000) 1/ cm.

As well as, similar samples to measure the spectrum of UV absorption, using a device UV-1650PC/UV-VIS spectrophotometer from SHIMADZU.

Surface tension of the fuel before and after the magnetization was measured for all intensities, where the sample size of 50 ml was taken and examined by a device KSV Instruments LTD-series SIGMA 70, using (Wilhelmy plate). The gases CO, CH and CO2 were measured by analytical gases device type AVL, made in AUSTRALIA.

3. Results and discussion

3.1. Effect of magnetic field on fuel consumption and exhaust gases

Figure 3 represents the amount of fuel consumed with the intensity of the magnetic field for three different engine speeds. The amount of untreated fuel consumed in the engine for the three speeds were (1350, 1560, 1775) ml, respectively. While these values decreased with the use of a magnetic field, where the amount of consumed fuel treated by using high magnetic field intensity less than that treated by using low intensity.

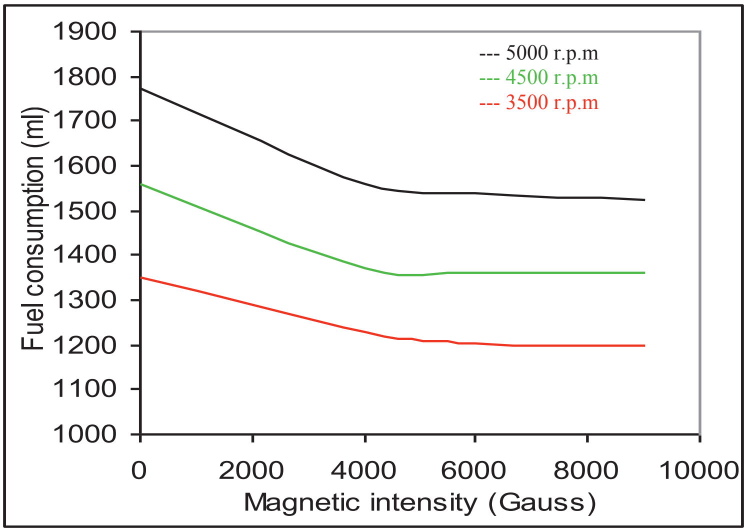

Fig. 3. Reducing the amount of consumed fuel with increasing magnetic field intensity

To illustrate the percentages of fuel saving with the magnetic intensity for the mentioned three speeds above clearly, these percentages were calculated by deducting the amount of fuel consumed after treatment from the amount before treatment and converted to a percentage scale, as illustrated in the Figure 4

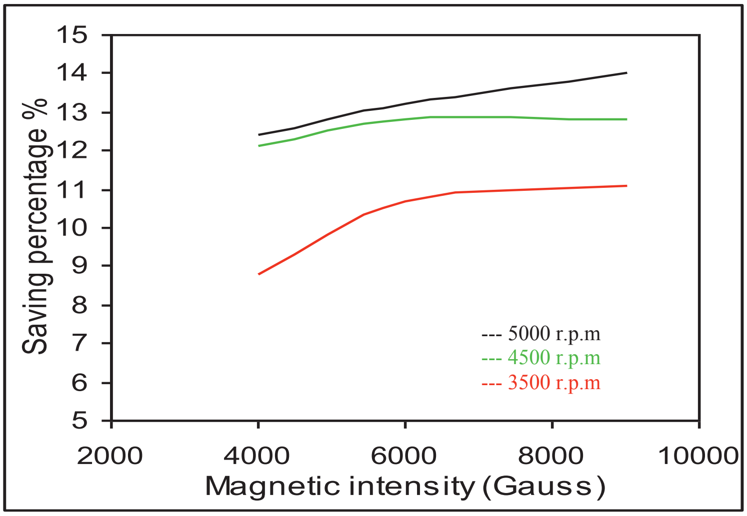

Fig. 4. Increased rate of fuel saving with increasing magnetic field intensity

The fuel saving percentage was ranged between (9-14) % depending on the magnetic field intensity, as well as the engine speed. In the same context, the percentages of fuel saving but with increasing engine speed for three magnetic intensities, are described in Figure 5. The percentage was greatest in the high speed and high intensity.

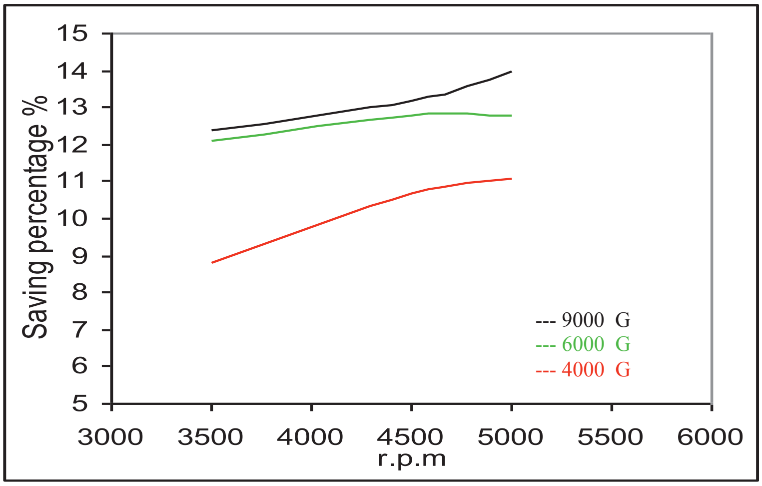

Fig. 5. Increased rate of fuel saving with increasing engine speed

The percentage of the exhaust gases which measured during the operation of the engine, for three speeds, before and after magnetic treatment was shown in Figure 6 and Figure 7. It was found that the reducing percentage of the gases (HC, CO) up to (30, 40) % respectively, but the percentage of CO_2 increased about 10%, as shown in the Figure 8.

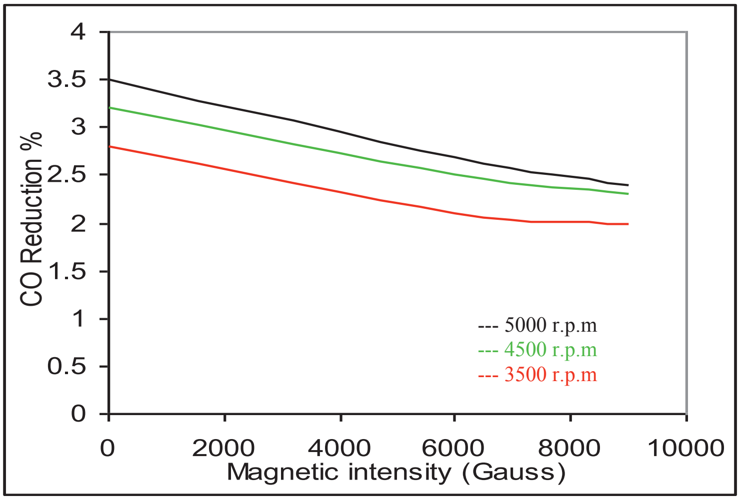

Fig. 6. Decrease rate of CO gas with magnetic intensity

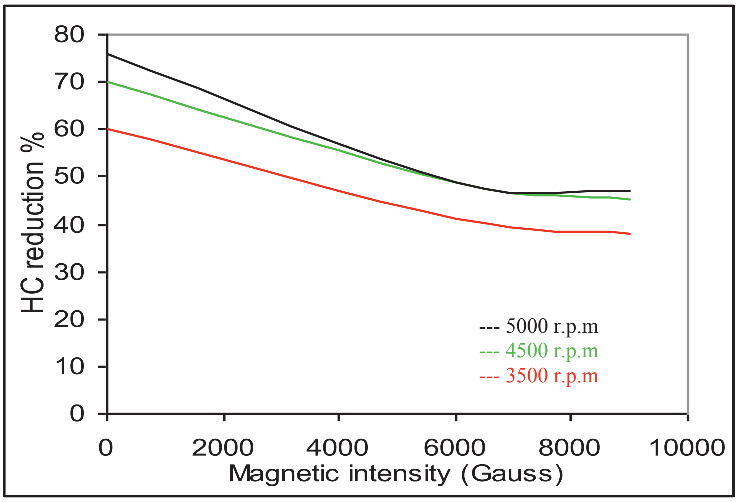

Fig. 7. Decrease rate of unburned hydrocarbons HC with magnetic intensity

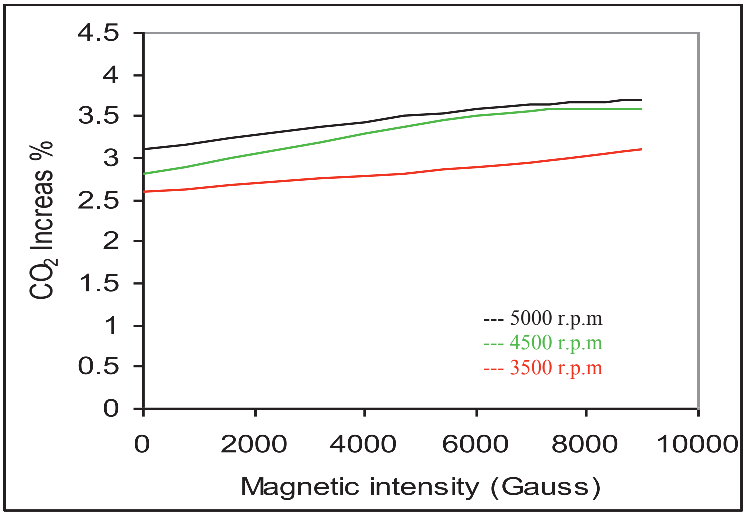

Fig. 8. Increase rate of CO_2 gas with magnetic intensity

Magnetization of fuel, breaks down the bonds between hydrocarbon chains which results in decreased density, surface tension and, hence smaller particulars and droplets during atomization or injection within an internal combustion engine. Smaller particles and droplets Causes increased evaporation rates, improved mixing of fuel and oxidizer, and improved promotion of oxidation. The net effect is an increase in the rate of combustion, an increase in power, and reduced pollutants.

Increased oxidation of the hydrocarbon fuel causes several effects. Faster and more complete oxidation results in more rapid and more complete combustion of the fuel. Faster and more efficient combustion creates a more concentrated and more forceful driving force on the pistons of an internal combustion engine, albeit for a shorter duration of time. Typically, this result in the desirable effect of increasing the engine's revolutions per minute (rpm) for the same amount of fuel burned. The net effect is increased power and/or a corresponding decrease in fuel consumption for a given power output

3.2. Effect of magnetic field on microstructure of fuel

As are known, the infrared spectrum of absorption of fuel provides an insight into its molecular structure, because the wavelengths of the movement and vibration of these molecules are within the ranges of wavelengths of this ray. To see the effect of magnetic field on these molecules a sample size of 500 ml of fuel have been taken and exposed to a magnetic field with different intensities (2000, 4000.6000, 9000) Gauss without retention time within the system of magnetization. About 100 ml of the above sample were taken, as well as those, but without magnetization to be examined by infrared spectrometer (FTIR). Figure 9 shows the infrared absorption spectra of treated and untreated fuel.

The coloured spectra, red, blue, violet, black and green shown in the Figure 9 indicate to the infrared absorption peaks and its strength and position of the fuel under the influence of above magnetic intensities. From this Figure we see that the strengths of absorption peaks of treated fuel at each magnetic intensity increased in the region of (400-4000) $cm^{-}1$, but their positions or frequencies do not change, when compared with that of untreated fuel. This shows that the polarized feature and transition dipole moments of molecules are enhanced relative to that of untreated fuel due to the displacements of atoms constituting fuel molecules and change in the magnetic moment of molecules interaction under the action of the magnetic field.

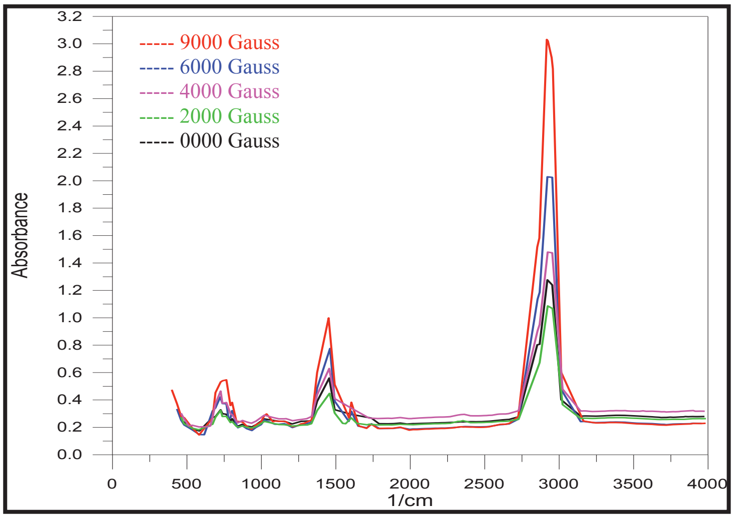

Fig. 9. Variation of strengths of infrared absorption peaks of fuel with magnetic intensity

Because the molecular attraction energy of non polar hydrocarbon is determined by group vibrational frequency, so a conclusion can be easily reached that the higher the frequency the lower the absolute value of molecular attraction energy, or, the lower the group attraction energy. Thus**,** it can be deduced that the molecular attraction force among hydrocarbons decreases after they are magnetized. This is why the property indices of hydrocarbons, such as viscosity and surface tension which are influenced by the molecular attraction force, decline after the hydrocarbons flow through magnetic field.

It is well known that the visible and ultraviolet light radiated by matter is related to the transitions of energy levels and to changes in the state of electrons. Therefore, to study the features of these spectra of visible and ultraviolet light of fuel, it is useful to reveal and exhibit the properties and mechanisms of the influence of magnetic field on electronic motions and atomic structures in the fuel molecules. Thus, here we first measure the spectra of visible and ultraviolet light for a fuel treated with different magnetic intensities and compared with these of untreated fuel as shown in Figure 10.

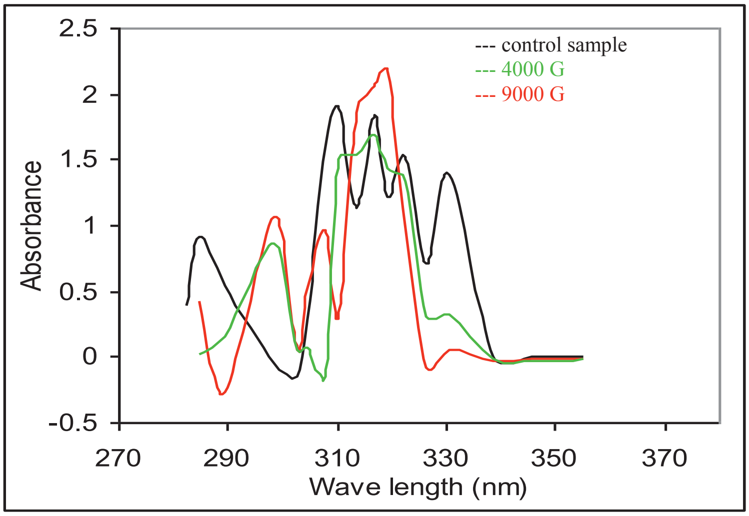

Fig. 10. Absorption spectrum of ultraviolet light for fuel magnetized with different magnetic intensities

This Figure shows clearly that the intensity in the absorption of ultraviolet light for magnetized fuel increases with increasing wave length of light in the region of 280-360 nm relative to that of untreated fuel. This means that the externally magnetic field greatly changes the feature of ultraviolet absorption of fuel. This means that the externally applied magnetic field greatly changes the feature of ultraviolet absorption of fuel.

It is evident that the ultraviolet absorption strength increases remarkably after the aromatic hydrocarbons have been magnetized. This means that the transition probability of electrons in the π - bond conjugated system among different energy levels has become higher. Since the transition of the bond electrons from the ground level to the excited level is the main process of molecule radicalization. This may enhance the splitting of the C=C bonds in the aromatic rings in the course of combustion under intense actions of light and heat, and therefore the oxidation of the aromatic rings can be accelerated and easily completed thoroughly. As a result, the combustion efficiency of aromatic hydrocarbons would be boosted, which gives rise to the noticeable increase.

3.3. Effect of magnetic field on surface tension of fuel

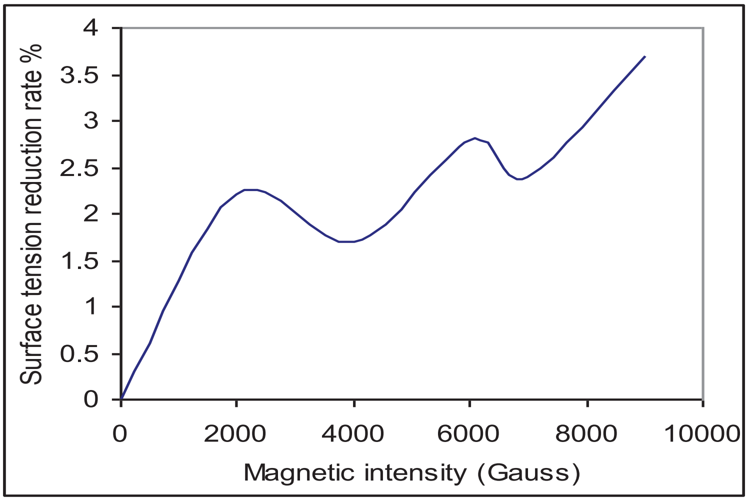

Fig. 11. Change in surface tension of the fuel with the intensity of the magnetic field.

Figure 11 displays the relationship between the decrease rates of the surface tension of magnetized fuel and the applied magnetic intensities. The results show that, after magnetized, the surface tension of the hydrocarbons decreases. However, the decrease rates or the decrease magnitudes do not increase accordingly very well as the strength of the magnetic field increases. At some certain magnetic fields, the surface tension decreases comparatively considerably while at others it decreases comparatively unnoticeably. So, it can be easily concluded that the surface tension of the hydrocarbons decreases fluctuately with the increase of the magnetic field intensity. The value of surface tension is determined not only by molecular attraction force but also by molecular orientation state on the liquid surface. May be the oriented distribution state of hydrocarbon molecules on the liquid surface must have changed after they have been magnetized, and that the oriented distribution state must have changed differently at different magnetic field strength. This can result in high decrease rate, and the fluctuation of the decrease of surface tension.

4. Conclusion

- When fuel is exposed to a magnetic field, we find that its properties are changed.
- Magnetic treatment does not need energy and thus be economically feasible.
- Change some properties of the fuel by the magnetic field, and take advantage of some of the applications that belong to the industry and the environment.
- Increase the efficiency of most equipment and machinery that using hydrocarbon fuel and reduce consumption up to 14%.
- We can understand the mechanism of magnetization of fuel through the impacts of external magnetic field in the microscopic structure, which is the displacement and polarize the fuel molecules.
- Clear changes in the value of surface tension of the fuel, which used in this study and employment of these changes in the applied fields.
- Reduce the amount of environmental pollutants in the exhaust gases up to 40%

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