HIGH PERFORMANCE AND LOW POLLUTANT EMISSIONS FROM A TREATED DIESEL FUEL USING A MAGNETIC FIELD

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Abstract

In the combustion of hydrocarbon fuel there was needing to lower the volume of unburned gases and pollutant emissions and increase combustion efficiency. The first to be oxidized are the hydrogen atoms when hydrocarbon fuel is combusted and in normal conditions some of the carbon will be only partially oxidized; this is responsible for the incomplete combustion. A magnetic field unit was manufactured for altering H atom in the hydrocarbon fuel from the stable state (parahydrogen) to the more reactive unstable state (orthohydrogen) so that transform the hydrocarbon molecule from its para state to the higher energized ortho state. In this research the pollutant emissions and combustion efficiency was studied for diesel fuel in an electrical generator (100KVA) for four weeks period with and without magnetic field unit.A Flue gas analyzer unit (IMR 1400) was used for testing and analyze the exhaust of the electrical generator.The output data for magnetized diesel fuel was compared with the output data of normal diesel fuel and showed significant decreasing in pollutant emissions and increasing of combustion efficiency using the magnetic field Unit.

Key words: **magnetized fuel, diesel, orthohydrogen, pollutant, emissions, combustion efficiency.**

رفع مستوى الأداء وتقليل الانبعاثات الملوثة من احتراق وقود الديزل المعالج باستخدام المجال المغناطيسي

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الخلاصة

عند احتراق الوقود الهيدروكاربوني يجب تخفيض حجم الغازات غير المحترقة وانبعاث الملوثات وزيادة كفاءة الاحتراق.إن أول جزء يتأكسد عند احتراق الوقود هو ذرات الهيدروجين وفي الضر وف الاعتيادية يتأكسد جزء من الكار بون جزئيا مما يسبب احتراق غير تام للوقود. تم تصنيع وحدة مغنطة لتحويل جزيئات الهيدروجين في الوقود الهيدروكاربوني من الحالة المستقرة(بارا هيدروجين) إلى حالة اكثر فعالية غير مستقرة(أورثوهيدروجين) ولهذا تتحول جزيئات الوقود من حالة بارا إلى حالة اورثو ذات طاقة أعلى.تم في هذا البحث دراسة انبعاث الملوثات وكفاءة الاحتراق لوقود الديزل في مولد كهربائي (100KVA) لمدة أربعة أسابيع مرة باستخدام وحدة المجال المغناطيسي ومرة أخرى بدونها.استخدم جهاز تحليل

الغازات(IMR1400) لفحص وتحليل النواتج الغازية من المولد الكهربائي. النتائج لوقود الديزل الممغنط عند مقارنتها مـع نتـائج وقود الديزل الاعتيادي بينت انخفاض واضح في انبعاث الملوثات وزيادة في كفاءة الاحتراق عند استخدام وحدة المغنطة.

Nomenclature:

ETA: burning efficiency.
O_2 : volume content of oxygen in dry flue gas in %.
q_A : flue gas losses.
t_A : flue gas temperature.
t_L : combustion air temperature in degree Celsius.

Introduction

The simplest of hydrocarbons, methane, (CH_4) is the major (90%) constituent of natural gas (fuel) and an important source of hydrogen. Its molecule is composed of one carbon atom and four hydrogen atoms, and is electrically neutral.
From the energy point of view, the greatest amount of releasable energy lies in the hydrogen atom because in octane (C_8H_{18}) the carbon content of the molecule is (84.2%). The carbon portion of the molecule when combusted, will generate (12,244 BTU per pound of carbon). On the other hand, the hydrogen, which comprises only 15.8% of the molecular weight, will generate an amazing(9,801 BTU of heat per pound of hydrogen)(Goodger, 1985).

Hydrogen, the lightest and most basic element known to man, is the major constituent of hydrocarbon fuels (besides carbon and smaller amount of sulphur and inert gases). It is the first element of the chemical periodic chart, has the atomic number 1 and atomic weight (1.0079). Since it possesses only one electron, it has the valence of positive 1. It has one positive charge (proton) and one negative charge (electron), i.e. it possesses a *dipole moment*. It can be either diamagnetic or paramagnetic (weaker or stronger response to the magnetic flux) depending on the relative orientation of its nucleus spins. Even though it is the simplest of all elements, it occurs in two distinct isomeric varieties (forms) - *para* and *ortho*.It is characterized by the different opposite nucleus spins. In the para H_2 molecule, which occupies the even rotation levels (quantum number), the spin state of one atom relative to another is in the opposite direction ("counterclockwise", "antiparallel", "one up & one down"), rendering it diamagnetic; whereas in the ortho molecule, which occupies the odd rotational levels, the spins are parallel ("clockwise", "coincident", "both up"), with the same orientation for the two atoms; therefore, is paramagnetic and a catalyst for many reactions. Thus, the spin orientation has a pronounced effect on physical properties (specific heat, vapor pressure) as well as behavior of the gas molecule. The coincident spins render orthohydrogen exceedingly unstable. In fact, *orthohydrogen* is more reactive than its *parahydrogen* counterpart. The liquid hydrogen fuel that is used to power the space shuttle or rockets is stored, for safety reasons, in the less energetic, less volatile, less reactive parahydrogen form. During the start of the shuttle, the orthohydrogen form is beneficial since it allows to intensify the combustion processes. To secure conversion of para to ortho state, it is necessary to change the energy of interaction between the spin state of the H_2 molecule. At $20^{\circ}C$ (room temperature), 75% of hydrogen is in the para (i.e. stable) form.It is only when the liquid hydrogen temperature is dropped to $-235^{\circ}C$ that 99% of the hydrogen is in the ortho, more volatile, and unstable (i.e. more combustibly reactive) state. Obviously, keeping hydrogen fuel at this low temperature to attain the added combustion efficiency is not practical(Mike R. ,1998).

American rocket scientist, Simon Ruskin, realized that parahydrogen could be converted to higher energized orthohydrogen through magnetic stimulation, i.e. the application of the proper magnetic field to change the spin state of the hydrogen molecule. This greatly enhances the energy of the atom and the general fuel reactivity, i.e. the combustion efficiency (S. Ruskin ,1958).

Hydrocarbons have basically a "cage-like" structure. That is why oxidizing of their inner carbon atoms during the combustion process 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. (It has nothing to do with incoming air from the manifold in the fuel mixture when even though there may be excess of it, this will not provide the required hydrocarbon-oxygen binding.) and stemming from this shortage of oxygen to the cluster that hinders the full combustion. In order to combust fuel, proper quantity of oxygen from air is necessary for it to oxidize the combustible agents. For example, in order to totally and completely burn 1 kg of gasoline, one needs about 15 kgs of air. In the exhaust there should be then: carbon dioxide, water vapor, and nitrogen from air which does not participate in the combustion. Practically, the exhaust gases contain: CO, H_2, HC, NO_x and O_2(Goodger ,1985).

For many years, designers of the internal combustion engines have had one goal: to oppose the effect of molecular association of the hydrocarbon fuel and to optimize the combustion process. The peculiar problem in designing engines for air pollution is that in order to fully burn all the hydrocarbons in the combustion chamber, operating temperatures of the cylinders have had to be increased. While older engines may have produced relatively large quantities of unburned hydrocarbons and carbon monoxide, they produced low quantities of oxides of nitrogen. Also, with the renewed interest in performance engines, compression ratios are creeping upward again, and once again the mechanism for producing higher levels of nitrogen toxins is increased. Similarly, turbo charging effectively alters the compression ratio of a vehicle, further adding to the nitrogen problem.The feed and exhaust systems have been perfected, the ignition controlling electronics has been perfected, the fuel/air mix metering devices have been brought to perfection, and finally the catalytic converters have been found indispensable. But even then, fumes that leave the "afterburners" are not ideally clean - engine still burns only part of the fuel (or precisely the incompletely oxidized carbon atoms in the form of CO). The rest is discharged as polluting emissions (HC, CO, NO_x) or is deposited on the internal engine walls as black carbon residue. All this has been caused by the incomplete combustion process. The reasons for it being that(Magnetizer & Live Streams International Mfg. Co.,2002):

1. Hydrocarbons form the so-called associations, close molecular groups, interior of which is deprived of access of the suitable amount of air; the lack of oxygen impedes the full combustion. The tendency of HC molecules to cluster causes local macro-groupings (condensing) of molecules to clog the pipes and fuel nozzles. The excess of air in the fuel mixture will not provide for the complete combustion. Hence, the exhaust fumes contain considerable amounts of unburned CO, HC, and soots.

2. Oxygen with negative 2 valences is negative, and hydrocarbon has neutral molecular structures which by passing through steel fuel lines gets negatively (micro) charged. Therefore, when these two

atoms come together with the same potential in a combustion chamber, they repel, which result in incomplete combustion. Therefore, all serious research has been aimed at bringing about fuel reactivity with oxygen (oxygenated fuels); since increased oxidation means increased combustion.

Using the magnetic field

- Rule 1 :

When hydrocarbon fuel (methane molecule) is combusted, the first to be oxidized are the hydrogen atoms (or precisely electrons on their outer shells). Only then, are the carbon atoms subsequently burned ($CH_4 + 2O_2 = CO_2 + 2H_2O$). Since it takes less time to oxidize hydrogen atoms in a high-speed internal combustion process, in normal conditions some of the carbon will be only partially oxidized; this is responsible for the incomplete combustion.Oxygen combines with hydrogen readily; however, the carbon-oxygen reaction is far less energetic. Oxygen always has a valence of minus two. The valence of carbon, on the other hand, can be plus or minus due to the configuration of its four electrons in the outer shell, which requires a total of eight electrons for completion. The optimum combustion efficiency (performance) obtained from the magnetic field application on fuel is first indicated by the amount of increase in carbon dioxide (CO_2) produced, which has been validated by state emissions control devices. Furthermore, as the pollutants decrease, the combustion efficiency increases. The drop of HC & CO emissions is easily proven by comparative gas flue analysis & opacimeter emissions tests.

- Rule 2 :

The application of the intense & focused magnetic field converts fuel molecules to a positive charge.

- Rule 3:

Altering the spin properties of the outer shell ("valence") electron enhances the reactivity of the fuel (and related combustion process). The higher energized spin state of hydrogen molecule clearly shows a high electrical potential (reactivity) which attracts additional oxygen. Combustion engineering teaches that additional oxygenation increases combustion efficiency; therefore, by altering the spin properties of the H_2 molecule, we can give rise to its magnetic moment and enhance the reactivity of the hydrocarbon fuel and ameliorate the related combustion process. The strong magnetic field, with sufficient flux density to have the required affect on fluid passing through it, substantially changes the isomeric form of the hydrocarbon atom from its para-hydrogen state to the higher energized, more volatile, ortho state, thus attracting additional oxygen. Fuel structure and properties, such as e.g. electrical conductivity, density, viscosity, or light extinction are changed; its macrostructure beneficially homogenized.

- Rule 4:

Hydrocarbon molecules form clusters called "associations." It has been technically possible to enhance van der Waals' discovery due to the application of the high power, permanent magnetic device, strong enough to break down, i.e. de-cluster these HC associations. They become normalized & independent, distanced from each other, having bigger surface available for binding (attraction) with more oxygen (better oxidation). A simple analogy is of burning coal dust and a coal bricket. There, where one aims at higher efficiency, during the combustion process, one has to give a molecule the greater access to oxygen. In case of burning of powdered coal dust, adding of oxygen may even cause explosions. Thus, with our fuel energizer, the oxygenation and the combustion efficiency increases. Fuel is more active and dynamic, and the combustion process faster and more complete. These "new" hydrocarbon molecules have one more important characteristic: they not only dissolve and eliminate carbon varnish in the combustion chambers, on the surface of jet nozzles, spark plugs and exhaust pipe, but do not allow new and harmful deposits to reform. Furthermore, the energizer's work ensures better performance of carburetor or fuel injectors, makes start ups easier, considerably increases driving dynamics, etc. The power and torque in the whole range of rotational velocity of crank-shaft also go up. Thanks to de-clustering of hydrogen molecules, in the combustion chamber, increased saturation & reactivity of the fuel mixture with oxygen is achieved, resulting in a more complete oxidation of the primary hydrogen element and further oxidation of carbon (C), the secondary fuel element, since, 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. The positively charged fuel, so to speak, swells, thickens, and needs larger quantity of air, which is easily remedied by adjusting the change in air/fuel ratio in carbureted cars (Magnetizer & Live Streams International Mfg. Co., 2002).

Carbon dioxide is a direct by-product of the incineration of harmful carbon monoxide gas and nitrous oxide emissions from motor vehicles are caused primarily by the conversion of oxides of nitrogen (NO_2) into nitrous oxide (N_2O) by vehicle catalytic converters. Catalytic converters were never intended to be a long term solution to the problem of air pollution caused by internal combustion engines, but rather they were adopted as a short term option, until advances in technology could offer a more effective solution. Unfortunately, thirty years has passed and the automobile industry is still relying on this temporary solution (U.S. Department of Energy , 1997).

Finally there is an innovative discovery emerging from the laboratory that makes it feasible to augment the effectiveness of the catalytic converter with a new process to lessen green house gas emissions. Developed by a company called Save the World Air Inc., and marketed under the brand name EcoChargR, this revolutionary new technology has been proven effective at reducing the amount of unburned gases being expelled from internal combustion engines, resulting in a substantially lower amount of engine waste requiring incineration by catalytic converters. The processes underlying this new discovery have been validated by findings of a multi-year study sponsored by the Rand Corporation and conducted at Temple University (R. Tao, 2005).

The use of catalytic converters in passenger cars, light trucks, and heavy duty trucks since 1973 to present times has seen a complete reversal, from practically no such devices being used in 1973 to nearly all vehicles manufactured being equipped with these devices today. Clearly the explanation for the global increase in GHG emissions is multivariate in nature and due (partly) to the aggregate effect of a variety of variables that include (a) an increase in vehicle miles driven annually, (b) an increase in the number of vehicles produced annually, but also and perhaps most significantly to (c) the percentage of vehicles now in use equipped with catalytic converters (United States Environmental Protection Agency, 2001).

To help mitigate the effect of global warming caused by the use of catalytic converters, it has been discovered that treatment of fuels by short pulse magnetic field, prior to combustion, has been proven to affect changes in the molecular structure of crude oil and derivative fuels, thereby resulting in a decrease in surface tension and favorable alteration in viscosity levels. The process of exposing fuel to electric or magnetic fields subsequent to carburetion or fuel injection and just prior to combustion, has been verified to enhance the combustion process thereby increasing the exposure of fuel molecules (that are normally contained within the inner regions of fuel clusters) so that oxygen molecules can bond with more individual fuel molecules. This enhanced level of combustion, results in more fuel molecules, per cluster, being ignited and subsequently lessening the amount of unburned fuel being exhausted from the engine. This enhanced combustion process also decreases the amount of unburned fuel waste requiring incineration by the catalytic converter. Such an increase in engine effectiveness also results in improved gas mileage, because more particles of fuel (per cluster) are being combusted, thereby requiring fewer clusters of fuel being needed by the engine, per mile of travel. Since CO_2 is a natural by-product of the incineration of CO, the only effective way to reduce the production of this GHG is to incinerate less CO. Additionally, since N_2O is a natural by-product of incineration of NO_X, the only way to effectively reduce the production of this GHG is also to incinerate less NO_X (R. Tao , 2006).

In April of 2006, STWA reported that the EcoChargR had successfully passed EURO3 emission standards, besting their previous performance, during tests conducted at the National Motorcycle Quality Inspection & Certification Center in Shanghai, China. (Save the World Air Inc., 2006).

The catastrophic effect caused by global warming is expected to dwarf this number and change our environment in such a way as humankind has never before experienced. Global warming is expected to manifest it's destruction in rising sea levels that displace large numbers of people throughout the world, combined with changes in average annual temperatures that result in disruptions to food supplies and increases in disease. Adoption of this new magnetic treatment of fuel to lessen GHG emissions might well be the viable option if we are to avoid the catastrophic consequences that await our planet, if we fail to adopt a viable solution to global warming (World Health Organization, Climate Change Report, 2001).

Because of the importance of Magnetic devices in the energy savings there was a limitation in finding data about these devices and this research will be provide data about these devices for the first time in Iraq.

Experimental Work

- **The diesel generator used in the experimental work**:
  Perkins 1006 TAG2 generator was used for testing. The generating set model –PL150 generates 150 KVA as a prime power and 16.5 KVA as standby power manufactured by FG Wilson (Engineering) Ltd. The number of cylinders in the engine was 6-Vertical in Line cylinders. The combustion system was direct injection and of 4 Stroke cycle. The location of the generator in the college of engineering/ AlQadissyia University.
- **The fuel used in the experimental work**:

Consider a diesel fuel with an extraordinarily large number of large molecules, which are associated as incipient solids in the liquid mixture. Consider such a liquid-incipient solid mixture being placed into a strong magnetic field. The energy of the magnetic field will cause some, maybe just a few of the paired, opposite spinning electrons to have parallel spins. The molecules with the parallel spin components will seem strange to the molecules next to them and they will not as easily "nestle" next each other. The Iraqi diesel fuel was used in the testing. The chemical analysis of the crude oil was showed in the Table (2).

- **The Flue gas analyzer unit(IMR1400):**

The IMR1400 unit is a state of the art combustion analyzer .the unit measures gas temperature, ambient or room temperature, O2, CO, draft pressure and smoke spot. All further values, as CO_2, Coair free, excess air, efficiency and losses are calculated.

The IMR1400 unit is a comfortable, easy to use flue gas analyzer in robust aluminium case. All accessories needed for measuring are situated inside the case, so that an immediately readiness is guarantied. The communication with the analyzer takes place with a clear designed keyboard and a four line alphanumeric LCD with switchable backlight, so that also in dimly lit situations all values are viewable. The operation is designed as menue technic, so that it is very easy , to handle the analyzer in a short time. The IMR1400 unit is equipped with a buffered memory, so that all adjustments and stored measures are also available when the instrument is switched off. The integrated printer allows to protocol directly at the measuring place. The RS232-interface allows a downloading to an PC or printer. The IMR1400 unit is equipped with an automatic CO-flush(option). If too high CO-concentrations appears, which could destroy the sensor, the flue gas in the CO-box is mixed by air with an additional pump, until the values are within the allowed range again. During this time the CO value is disabled at the screen the gas flow through the IMR1400 unit was shown in figure(1). To reach the highest accuracy , the analyzer should have an ambient temperature between 10 and 40 ºC. If the analyzer was at minus temperature for a longer time, switch on and let run for warm up about some minutes before measuring. Proof the condensate trap.

- **The magnetic field unit:**

The magnetic field unit was manufactured locally and it’s a simple unit consist of a body from copper alloy ,inner of the body contains four magnets provides magnetic flux of (1500 gauss).the fuel flow inside the magnet pipe and the magnetic field lines cuts the fuel flow so that the fuel is magnetized.

The experimental work was done on an elecrical generator of (150 KVA) with diesel fuel for four weeks period. The electrical generator was a diesel generator . The emissions, gas temperature and ambient or room temperature for the combustion of diesel fuel was obtained using a **Flue gas analyzer unit (IMR 1400).** The flue gas analyzer unit was shown in figure (2). The diesel fuel was treated with magnetic field using a novel manufacured unit was suggested espicially for treating the diesel fuel using the magnetic field. The **Magnetic field unit** was shown in figure (3) and it is place of installation on the fuel line before the fuel filter.

Steps of the testing

1. The electrical generator was operated for four weeks period but not continuously using diesel fuel.
2. The flue gas analyzer must be operate for (60 seconds) for calibration .

3. the set of readings was taken daily for four weeks period using the flue gas analyzer unit firstly for diesel fuel and secondly for treated diesel fuel using the magnetic field unit with the following note:
    - the magnetic field unit was installed properly on the fuel line before the fuel filter and leted run approximately (30 minits)before taking the set of readings.
    - Make sure that the magnetic field unit is not in contact with the engine's metal parts.
4. The readings was recorded using the flue gas analyzer unit for many gas temperatures and loadings.
5. the readings was printed directly using the printer of the flue gas analyzer unit with date and time of the test and using the RS232-interface was downloaded to an personal computer for analysis and graphing.

Results

One of the main components of photochemical smog is oxides of nitrogen; oxygen depending on heat and pressure can form in differing combinations with nitrogen other than the specific nitric oxide formula. Nitric oxide is a colorless gas produced by high temperature combustion; however, when it encounters extra oxygen in the presence of air and sunlight it readily converts to nitrogen dioxide (NO_2). Nitrogen dioxide is the reddish brown haze that we associate with smog. The formula for nitrogen dioxide (NO_2) looks quite similar to the formula for carbon dioxide, but must bear in mind that carbon dioxide cannot support combustion while nitrogen dioxide can. Nitrogen dioxide is very poisonous since the threshold lethal volume (TLV) is 3 ppm, while carbon dioxide still classified as poisonous, as a TLV of 5,000 ppm, while carbon monoxide's TLV is 50 ppm. It is quite shocking to know that nitrogen dioxide is the major component of smog and is approximately 16 times more poisonous than carbon monoxide.

CO:

Figure (4) shows the variation emissions of CO with Gas temperature calculated expermintally from the combustion of Diesel fuel Compared with the emissions of CO from the same Fuel treated with the magnetic field unit.

It was found that for all gas temperature an immediate (approx. after 5 min upon start-up) drop in unburned hydrocarbons and carbon monoxide due to the magnetic conditioning of the fuel which makes it more reactive. As explicitly stated in instructions, upon the **Magnetic field unit** installation in the expermintal work (5-10 minutes thereafter) engine will undergo the so-called "*Stabilization Period*", i.e. the time of the gradual disappearance of prior carbon varnish sediments and the total magnetic saturation of all ferromagnetic metal parts of the feeding system between the installed energizer and the combustion chamber in order to fully activate fuel. The initial saturation lasts about a week .

NO:

Figure (5) shows the variation emissions of NO with Gas temperature from the combustion of Diesel fuel Compared with the emissions of NO from the same Fuel treated with the magnetic field unit. It was found that for all gas temperature the NO concentration lower with magnetized fuel because there is very little oxygen left to produce any additional toxic compounds with nitrogen.

NO_x:

Figure (6) shows the variation emissions of NO_x with Gas temperature from the combustion of Diesel fuel Compared with the emissions of NO_x from the same Fuel treated with the magnetic field unit. It was found that for all gas temperature the NO_x concentration lower with magnetized fuel. One of the chief reasons for the **Magnetic field** to have possibility to lower the NO_x level, as found expermintally is due to the low reactivity of nitrogen gas. If we can bind up all the available oxygen with the hydrocarbon fuel, there simply will be no oxygen left over to form the unwanted nitrogen

Burning Efficiency :

The values of excess air, burning efficiency, and losses are calculated in the memory of IMR1400 unit and not calculated manually.

The calculation of the flue gas losses was based on the Equation (1) and **Table(1)** (Instruction Manual ,HL860 ,Exhaust Analysis Device, 2002):

$$q_A = (t_A - t_L) * (\frac{A_2}{20.9 - O_2} + B) \ (\%) \qquad \ldots Eq.(1)$$

The burning efficiency was calculated using the Equation (2):

$$ETA = 100 - q_A \quad (\%) \qquad \ldots Eq.(2)$$

For the free selectable fuel the calculation of losses was calculated using the Equations(3)and (4) (Instruction Manual ,HL860 ,Exhaust Analysis Device, 2002):

$$q_A = f * \frac{(t_A - t_L)}{CO_2} \quad (\%) \qquad \ldots Eq.(3)$$

$$f = CO_2 * 0.038 \quad (\%) \qquad \ldots Eq.(4)$$

Figure (7) shows the variation of Burning efficiency with Gas temperature from the combustion of Diesel fuel Compared with the Burning efficiency for the same Fuel treated with the magnetic field unit. It was found that for all gas temperature the Burning efficiency higher with the magnetic field unit. The highest burning efficiency was achieved at the highest carbon dioxide level, since carbon dioxide cannot be subsequently oxidized.

The purpose of a catalytic converter is to reduce all carbon monoxide to carbon dioxide. The amazing part is that the Magnetizer reduces emissions on cars with catalytic converters. The increased combustion efficiency was occurred within the engine due to increased fuel reactivity with oxygen (increased oxidation), the main factor responsible for increased combustion efficiency. It was a complete waste to allow an engine to run inefficiently and to burn the excess carbon monoxide in it's catalytic converter, the wasted heat merely "heats-up" the exhaust system, instead of providing useful work within the engine.By establishing proper fuel burning parameters by magnetic means, we can be assured that an internal combustion engine was getting the maximum energy per gallon of fuel. The temperature variation was effected by electrical load variation.

Comparison Between the Results of the Research with the Other Data:

The comparison of the results with the data of (Greg, (2000)) obtained from Detroit diesel 11.1mine engine was showed in the **Table (3)**. The variation of the results resulted from the differences between the two magnetic field units used in the shape of magnates and strength of the magnetic field.

Conclusion

The experimental results showed :

1. Magnets applied to hydrocarbon fuel lines appears to reduce fuel consumption.
2. Magnets applied to hydrocarbon fuel lines appears to improve emission quality due to more complete combustion.
3. Diesel engine operation will improve significantly.
4. The burning efficiency higher with the magnetic field unit
5. Magnets applied to hydrocarbon fuel lines appears to interrupt the solidification process so that there will not be so many “almost-solid” particles in the liquid.
6. As documented by tests, the magnetic treatment of fuel has reduced the production of NO_x by 20% ,NO by 5% and CO increased by 2% .
7. Less refueling time and longer operating times.

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Table (1) : the values of parameters in the equation(1) for a variety of fuels.

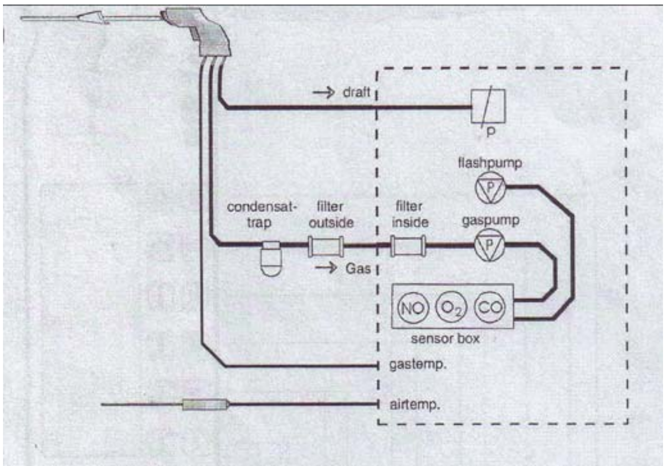
	Oil light	Natural gas	Town gas	Coal gas	Liquid gas	coal	Wood Dry
CO_{2max}	15.5	11.8	11.6	12.5	13.5	20.5	20.5
A_2	0.68	0.66	0.63	0.6	0.63	0.65	0.65
B	0.007	0.009	0.011	0.011	0.008	0.008	0.008
Ref O_2	3%	3%	3%	3%	3%	7%	11%

Table (2): The chemical analysis of the crude oil

element	Wt%
Carbon	85
Hydrogen	14
Sulfur	0.38
Nitrogen	0.1
Oxygen	0.5
metals	0.02

Table (3): the comparison between the experimental results and Greg results.

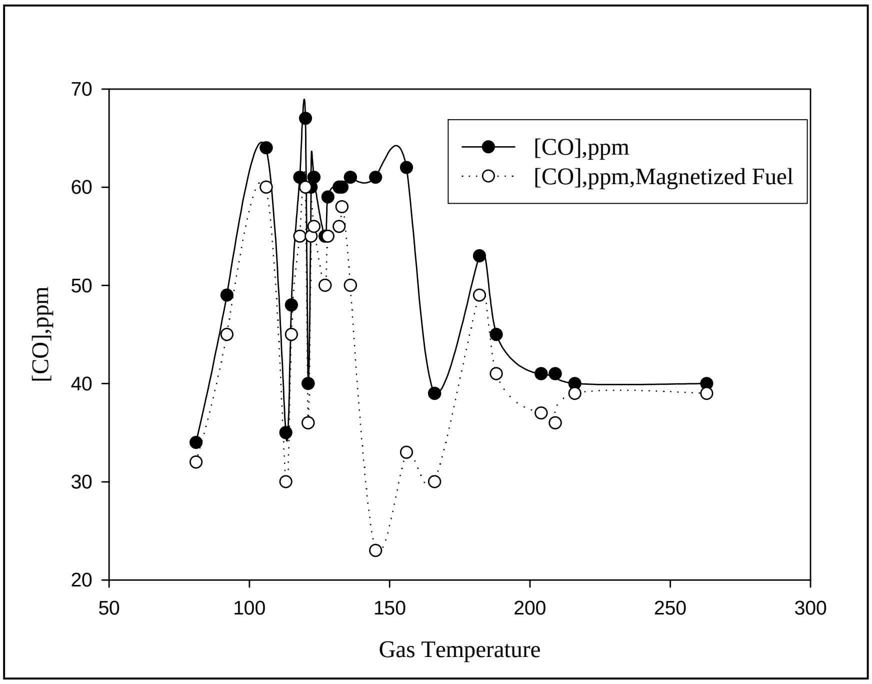
	NO_x%, decreased	NO%, decreased	CO%, decreased
Experimental results	20	5	-2
Greg results	15	3	-4



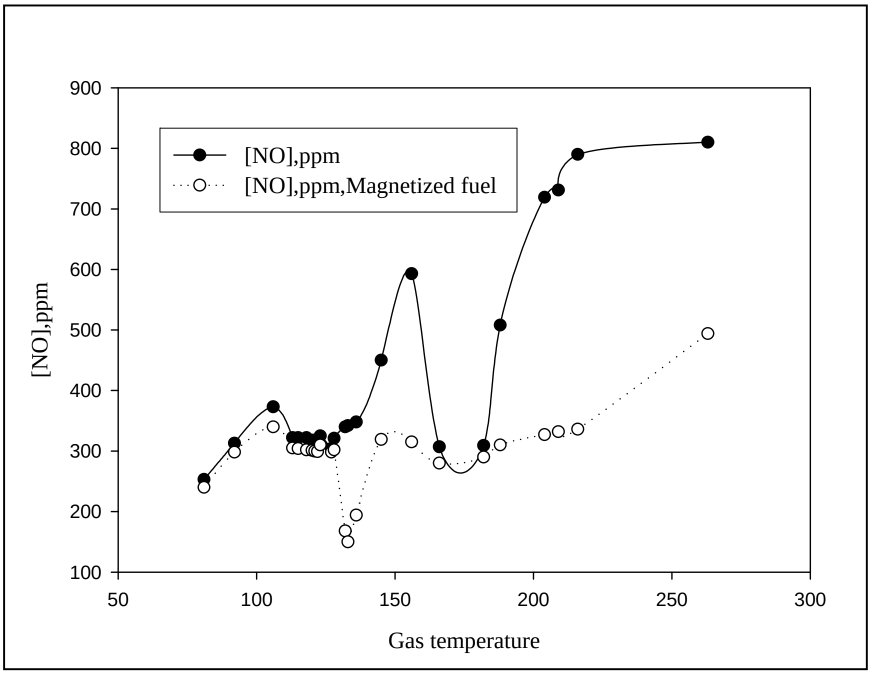
Figure(1): The gas flow through the flue gas analyzer unit (IMR 1400).

Figure(2): The flue gas analyzer unit (IMR 1400).

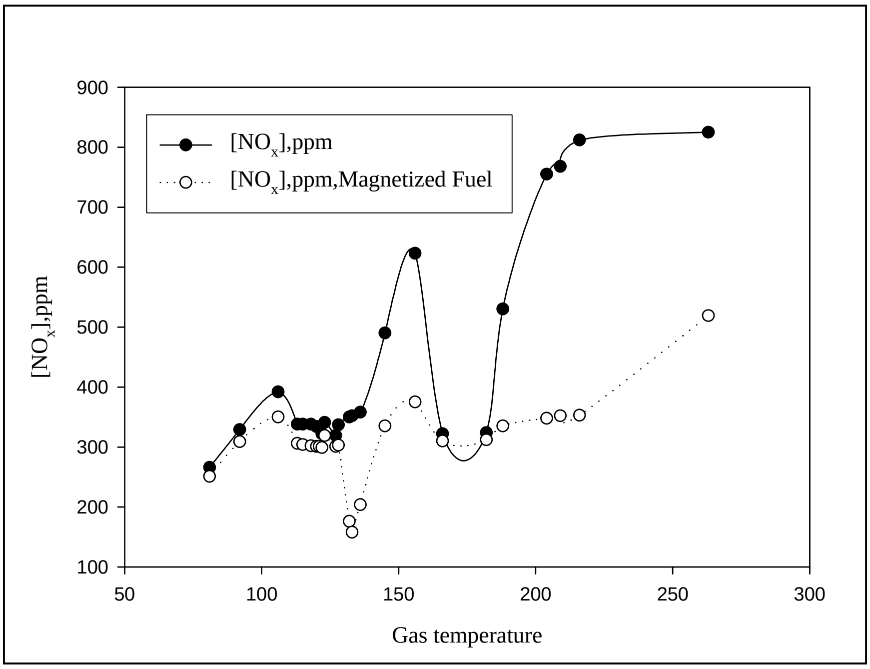
Figure(3): The installed magnetic field unit



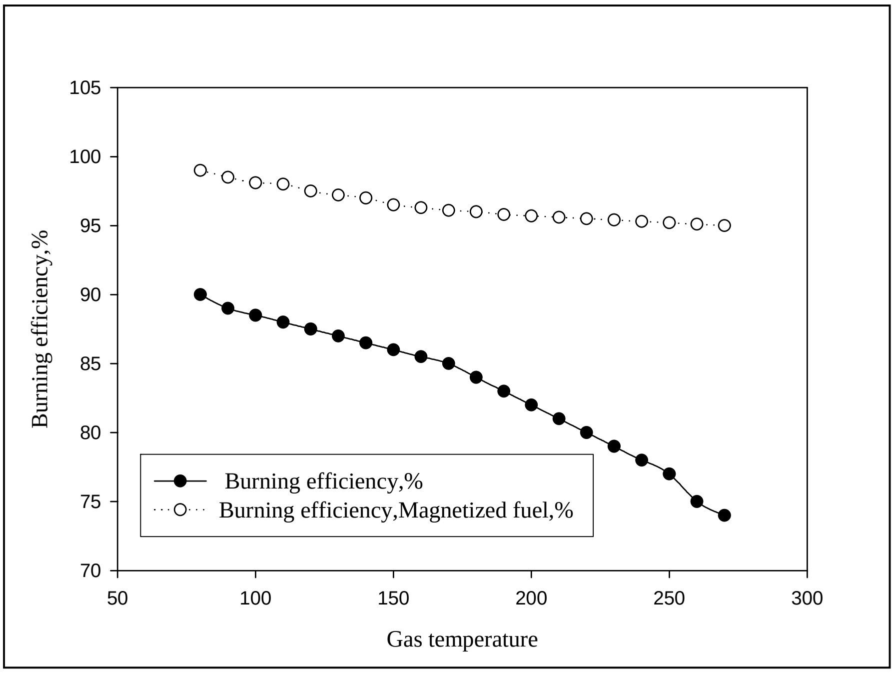
Figure(4): CO emission concentration for diesel fuel and magnetized diesel fuel.



Figure(5): NO emission concentration for diesel fuel and magnetized diesel fuel.



Figure(6): NO_x emission concentration for diesel fuel and magnetized diesel fuel.



Figure(7): Burning efficiency for diesel fuel and magnetized diesel fuel.