Notre contribution à planète

airlov

COMMENT ÇA MARCHE ?

ANNEXES

Annexe 9 : Etudes publiées

INP
L'Institut de Physique du CNRS

Actualités scientifiques

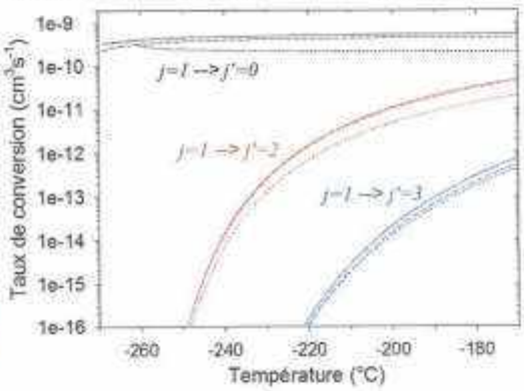
Une détermination quantique du taux de conversion entre les formes *ortho* et *para* de la molécule d'hydrogène

Août 2011

Des physiciens viennent de calculer avec précision le taux de conversion entre les deux états *ortho* et *para* de la molécule d'hydrogène H_2. Cette conversion joue un rôle central dans de nombreux phénomènes astrophysiques : refroidissement des petits objets proto-galactiques, formation des étoiles, chimie du deutérium, …

En collaboration avec des collègues espagnols de l'Instituto de Fisica Fundamental, des physiciens et astrophysiciens du Laboratoire Interdisciplinaire Carnot de Bourgogne (CNRS / Univ. de Bourgogne), du Laboratoire d'Ondes et Milieux Complexes (CNRS / Univ. du Havre), de l'Institut de Planétologie et d'Astrophysique de Grenoble (CNRS / Univ. Joseph Fourier) et de l'Observatoire de Paris viennent d'ouvrir une nouvelle piste vers la compréhension quantitative des processus de transformation de l'*ortho*-H_2 en *para*-H_2 dans l'Univers. Ils ont réalisé des calculs exacts de ce processus qui met en jeu la réaction $H^+ + H_2$ en faisant appel à une méthode de dynamique purement quantique combinée avec un potentiel d'interaction très précis du système H_3^+. Ces résultats vont servir à améliorer notre compréhension du rôle joué par le rapport *ortho/para* de H_2 dans l'Univers et son évolution.

La molécule d'hydrogène, H_2, est la molécule la plus abondante dans l'Univers. Elle est au cœur de l'ensemble de la physico-chimie du milieu interstellaire. Cette molécule existe sous deux formes appelées *ortho*-H_2 et *para*-H_2 ; dans l'*ortho*-H_2 les spins des deux protons ont la même orientation, tandis que dans le *para*-H_2, ils sont orientés tête-bêche. Les physiciens ont analysé avec une approche quantique la réaction entre H_2 et l'ion H^+ (autrement dit un proton seul) qui est le principal mécanisme pour convertir l'*ortho*-H_2 en *para*-H_2 dans la plupart des environnements astrophysiques. Ces calculs quantiques fournissent pour la première fois un taux de conversion rigoureux pour la transition *ortho-para* qui joue un rôle clé en astrophysique dans le refroidissement des objets où règnent de très basses températures comme les nuages denses et froids (environ -260 °C). Ce résultat a aussi une grande importance dans la chimie du deutérium qui dépend de manière importante de l'abondance en *ortho*-H_2. Il s'agit là notamment d'améliorer notre connaissance sur la formation du système solaire en expliquant pourquoi le contenu en eau deutérée (HDO) des océans terrestres est différent de celui mesuré dans les planètes géantes ou dans les comètes.



Taux de conversion *ortho-para* ($j=1 \rightarrow j'=0$ et $j=1 \rightarrow j'=2$) et ortho-ortho $j=1 \rightarrow j'=3$ pour la réaction $H^+ + H_2(v=0, j) \rightarrow H_2(v=0, j') + H^+$.

Comparaison entre les nouveaux résultats, quantiques exacts (trait plein) et statistiques (trait tireté), et les résultats anciens (trait pointillé).

En savoir plus

Ortho-para H_2 conversion by proton exchange at low temperature : an accurate quantum mechanical study, P. Honvault[1], M. Jorfi[2], T. González-Lezana[3], A. Faure[4], L. Pagani[5], *Phys. Rev. Lett.* 107, 023201 (2011).

Contact chercheur

Pascal Honvault, enseignant - chercheur
Mohamed Jorfi, chercheur
Alexandre Faure, chercheur
Laurent Pagani, chercheur

Informations complémentaires

- [1]**Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB)**, UMR 5209 CNRS - Univ. de Bourgogne
- [2]**Laboratoire d'Ondes et Milieux Complexes (LOMC)**, FRE 3102 CNRS - Univ. du Havre
- [3]**Instituto de Fisica Fundamental, (CSIC)**, Madrid, Spain
- [4]**Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)**, UMR 5274 CNRS - Univ. Grenoble 1
- [5]**Laboratoire d'Etudes du Rayonnement et de la Matière en Astrophysique** (LERMA), UMR 8112 CNRS - Obs. de Paris - UPMC - **Univ. de Cergy Pontoise - ENS**

Contacts INP

Jean-Michel Courty,
Catherine Dematteis,
Karine Penalba,
inp-communication@cnrs-dir.fr

Experimental Study the Effect of Electromagnetic Field on Performance & Emission of IC Engine

[1]Nitin Karande, [2]Sachin kumar Kore, [3]Akram Momin, [4]Ranjit Akkiwate, [5]Sharada P.K, [6]Sandip K. Kumbhar

[1,2,3,4,5] UG Student, Dept. Of mechanical engg. Shivaji University Kolhapur, INDIA.
[5]M.Tech Scholar, Dept. of Mechanical Engg. VTU Belgum, Karanataka, India,
[6]Asst. Professor, Department of Mechanical Engg. AITRC Vita, Shivaji University Kolhapur, India.

Abstract: **The present work deals with fuel ionization by using magnetic field which will ensure complete combustion of air-fuel mixture. Incomplete combustion in engine is due to improper mixing of hydrocarbon and oxygen molecule. In I.C. engine incomplete combustion produced large amount of emission gasses like CO, HC & NO_X etc. & incomplete combustion fuel gives lower efficiency. These attempt is made in this work to improve the combustion efficiency of internal combustion engines by adopting a magnetic fuel ionization method in which the fuel is ionized due to the magnetic field. To overcome these issues electromagnets are developed called as electro-magnetic fuel conditioner. This help to aligns & orientation of hydrocarbon molecules, better atomization of fuel. Use of such electromagnet mounted in path of fuel lines improves mileage & reduces emission of vehicle. These experiments are conducted at different engine loading conditions. The work in particular is very significant on account of its impact on the global automobile market.**

Keywords: **aligns& orientation, efficiency, electromagnetic fuel conditioner, HC**

I. INTRODUCTION

Over the last decade there so many efforts towards the improving power output and emission of internal combustion engines per fuel, but success up to 31%. It is very difficult to improve the more than that efficiency but magnetic fuel conditioner help to improve 3-4% in present value. We have, combustion of fossil fuel has release of pollutants such as CO, HC and NO_X like many component in environment. When these pollutants are in place, an atmospheric phenomenon called smog is created by the action of sunlight on hydrocarbon (HC) in the atmosphere, and the main source of HC is the exhaust gases of vehicles, the rapid increase in traffic causes the increase in the percentage of smog.

That effect the deterioration of air & harmful for health is irritate the eyes & throats, noxious smell, decrease visibility. Wide range of pollutants are believed to penetrate deeply into human lungs including aerosols of many small particles. Due to the reduction the emission from mobile sources increase the demand. Hydrocarbon leaves the natural deformation of carbon clog stalling, loss of horsepower & reducing mileage. There are many method MPFI, EGR, PCV, CATALYTIC use to complete combustion as well as minimize the emission. This is new technology working the similar to other technology but in better way. Electro-Magnetic field that ionized the fuel on the principle of magnetic field mutual action with hydrocarbon molecules of fuel and oxygen molecules. There are various physical attraction forces between hydrocarbons and they form densely packed structures is called pseudo compounds which can later organize into clusters.

The external force of magnetic field helps to polarize the hydrocarbon fuel. Due to that hydrocarbon fuel change their orientation and increase space between hydrogen This hydrogen of fuel interlocks with oxygen and producing a more complete combustion in the combustion chamber. It has been noted that when the fuel passes through a magnetic field, it helps increasing the atomization process by improved air fuel mixing

a. Background Of An Electromagnet

In 1819, Hans Christian Oersted, the Danish physicist and chemist (1777-1851), noticed that a current in a wire caused a compass needle to deflect. He had discovered that moving electric charges create a magnetic field. A dedicated teacher, he made this discovery while teaching his students at the University of Copenhagen. He Suspected there might be an effect and did the experiment for the very first time in front of his class. With his discovery, Oersted was the first to identify the principle of an electromagnet.

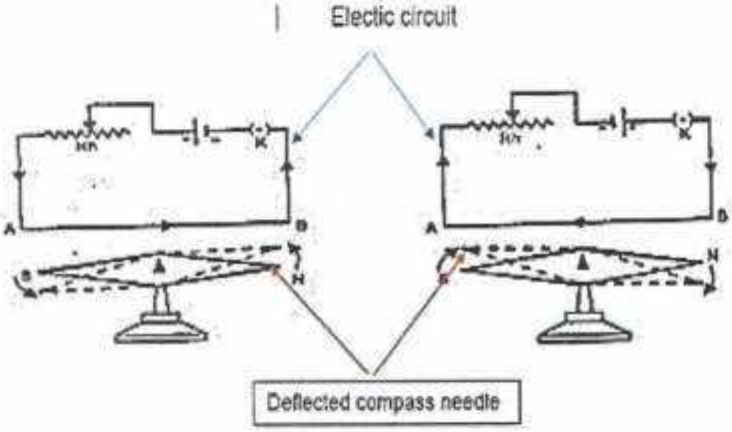


Fig.1.1.1 Oersted law

II. MAGNETIC FUEL CONDITIONER

An electromagnetic fuel conditioner is device which arrange the fuel molecules & alter the atomic structure so that proper combustion take place in engine. Magnetic field applied at fuel line atomize the fuel & which get adhere to oxygen enhance fuel air mixing ratio. Basic concept of magnetize fluid is that: In 1989, Hans Dehmelt of university of Washington awarded Noble prize in physics for his great contribution in fundamental property of electron [1]. According that electron have ability to store the energy within itself called spine. When provide small of magnetic field, it absorb the energy and changing property. Particle made up of number of atom which have same number proto & neutron charge, if greater number of electron then '– ve' charge obtain & vice versa.

Two distinct type hydrogen

(a)Para-Hydrogen **(b) Ortho-Hydrogen**

Fig.2.1 Rotational view of para & ortho hydrogen

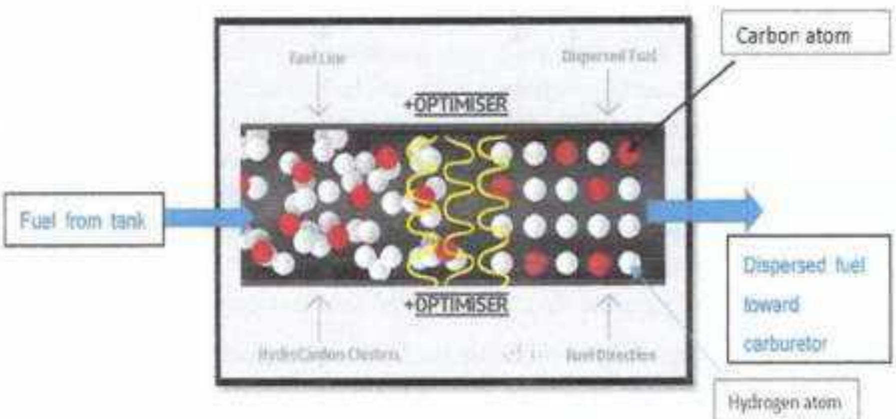
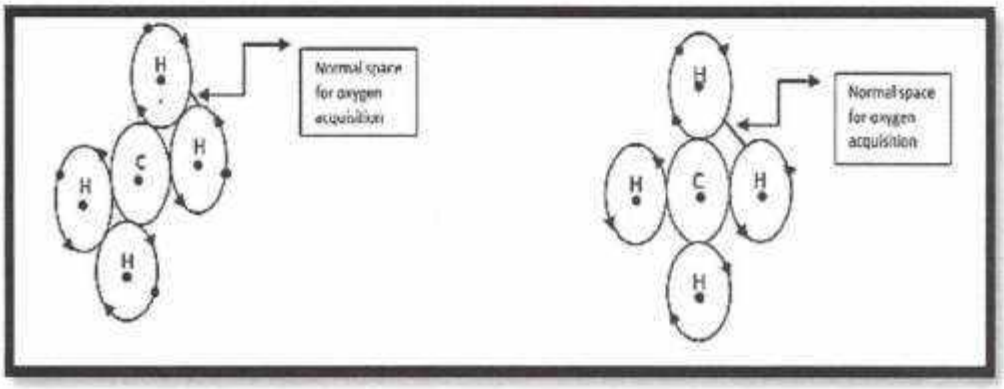


Fig.2.2 process of the fuel ionization

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, as said by Paul (1993), Park K et al (1997). Hydrogen occurs in two different part isomeric forms one is Para which is normally occurs in fuels, second is ortho which is achieved by applying magnetic field. These two forms are the different opposite nucleus spins. The ortho state can be achieved by applying strong magnetic field along the fuel line. In the para Hydrogen molecule, which occupies the anti-parallel rotation, the spin state of one atom relative to another is in the opposite direction, therefore it is diamagnetic. In the ortho molecule, which occupies the parallel rotational levels, the spin state of one atom relative to another is in the same direction. When the fuel passes through a magnetic field, created by the strong electro-magnets, due to that magnetic field hydrocarbon change their orientation and convert from para state to ortho state.

In ortho state inter molecular force is considerably reduced and increase space between hydrogen. This hydrogen of fuel actively interlocks with oxygen and producing a more complete burn in the combustion chamber. The result is better fuel economy and reduction in hydrocarbons, carbon monoxide and oxides of nitrogen that are emitted though exhaust. The ionization fuel also helps to dissolve the carbon build-up in carburetor, jets, fuel injector and combustion chamber, thereby keeping the engines clear condition. Electro-Magnetic kit is installed on cars, trucks, auto rickshaw, and heavy trucks immediately before carburetor or injector on fuel line.



(a)Para state **(b) ortho state**

Fig.2.3. Conversion of para to ortho state

III. OBJECTIVES

By this technique of electromagnetic field used to reduce exhaust emission following objectives are obtained:

1. To study electromagnetic field used to decrease intermolecular force of attraction of hydrocarbon atoms.
2. To study reduction in exhaust emission.
3. To prepare Electromagnetic kit or model.
4. To test fuel emission on various engines.
5. To improve in engine performance.
6. To study increase in mileage of vehicle.
7. To study increase in engine life

IV. CONSTRUCTION OF ELECTROMAGNETIC FIELD

Electromagnets are magnets that are created when there is electric current flowing in a wire. The simplest electromagnet uses a coil of wire, often wrapped around some iron. Because iron is magnetic, it concentrates the magnetic field created by the current in the coil.

(a) (b) (c)

Fig.5 Structure of electromagnetic circuit

An electric current flowing in a wire creates a magnetic field around the wire, due to Ampere's law. To concentrate the magnetic field, in an electromagnet the wire is wound into a coil with many turns of wire lying side by side. The magnetic field of all the turns of wire passes through the center of the coil, creating a strong magnetic field there. A coil forming the shape of a straight tube (a helix) is called a solenoid. Much stronger magnetic fields can be produced if a "core" of ferromagnetic material, such as soft iron, is placed inside the coil. The ferromagnetic core increases the magnetic field to thousands of times the strength of the field of the coil alone, due to the high magnetic permeability μ of the ferromagnetic material. This is called ferromagnetic-core or iron-core electromagnet.

The direction of the magnetic field through a coil of wire can be found from a form of the right-hand rule. If the fingers of the right hand are curled around the coil in the direction of current flow (conventional current, flow of positive charge) through the windings, the thumb points in the direction of the field inside the coil. The side of the magnet that the field lines e merge from is defined to be the North Pole.

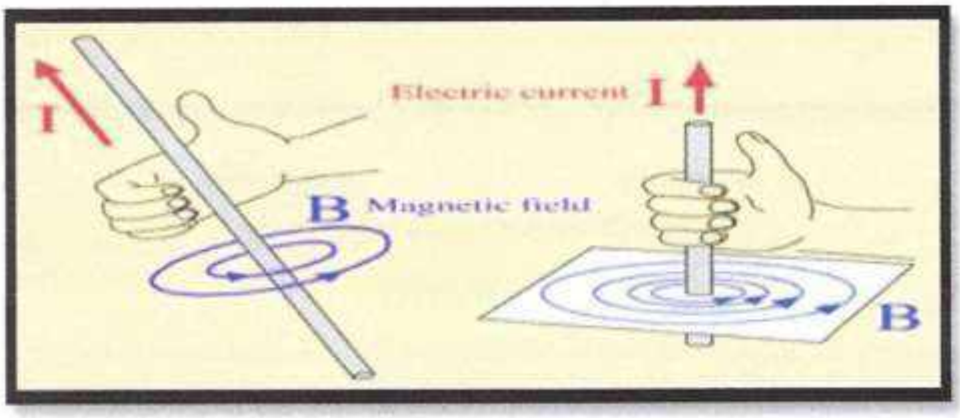


Fig.6 The right hand rule

When your fingers curl in the direction of current, your thumb points toward the magnet's North Pole.For generating electromagnetic field source of energy of electric energy is used as the automobile battery. The microprocessor chip is used to vary the frequency of the electromagnetic field. The range of frequency is set from 1.5 kHz to 38 kHz. This frequency is set so that to break the bonding of hydro-carbon molecules bonds. This frequency matches with respective hydro-carbon molecules natural frequency and resonance is created and strong bonding is broken. This frequency varies from highest limit to lowest limit in micro seconds.

The electrical supply from the battery is given to the input of the circuit. Where frequency is varied in micro-seconds. There are two output connections. The simply wire is wound around the fuel line to generate electromagnetic field. At the center of wire resistor is used as consumer. In same way other set of wire is used to generate the electromagnetic field

a. SPECIFICATION OF ELECTROMAGNETIC CIRCUIT

- Frequency band : 1kHz to 38kHz
- Per coil voltage : 12 V
- Per coil current : 350mA
- Per coil power : 4.2 watt.
- Resister : 47 Ω

V. DETAILS OF ENGINE SETUP

The setup consists of three cylinder, four stroke, and petrol (MPFI) engine connected to hydraulic dynamometer for engine loading. The setup has stand-alone type independent panel box consisting of air box, fuel tank, and manometer, fuel measuring unit, digital speed indicator and digital temperature indicator. Engine jacket cooling water inlet, outlet and calorimeter temperature is displayed on temperature indicator. Rotameter are provided for cooling water and calorimeter flow measurement. The setup enables study of engine for brake power, BMEP, brake thermal efficiency, volumetric efficiency, specific fuel consumption, and air fuel ratio and heat balance. Provision is also made for conducting Morse test.

Fig.5.1 Experimental setup of electromagnetic kit

a. ENGINE SPECIFICATIONS

Product : Engine test setup 3 cylinder, 4 strokes, Petrol

Engine :Make Maruti, Model Maruti 800, Type 3 Cylinder, 4 Stroke, Petrol (MPFI), water cooled, Power 27.6Kw at 5000 rpm, Torque 59 NM at 2500rpm,stroke 72 mm, bore 66.5mm, 796 cc, CR 9.2

Dynamometer	: Type Hydraulic
Propeller shaft	: With universal joints
Air box	: M S fabricated with orifice meter and manometer
Fuel tank	: Capacity 15 lit with glass fuel metering column
Calorimeter	: Type Pipe in pipe
Temperature sensor	: Thermocouple, Type K
Temperature indicator	: Digital, multi channel with selector switch
Speed indicator	: Digital with non contact type speed sensor
Load sensor	: Load cell, type strain gauge, range 0-50 Kg
Load indicator	: Digital, Range 0-50 Kg, and Supply 230VAC
Rotameter	: Engine cooling100-1000 LPH; Calorimeter 25-250 LPH
Pump	: Type Monoblock
Overall dimensions	: W 2000 x D 2750 x H 1750 mm

VI. RESULT AND DISCUSSION

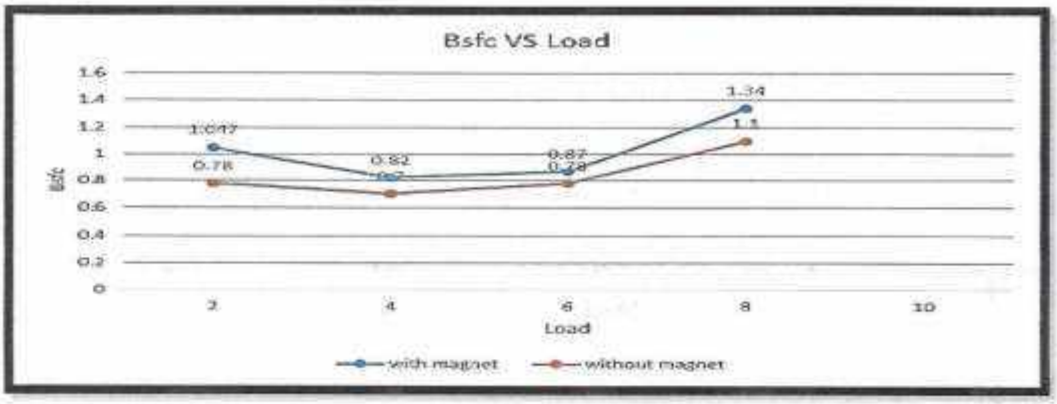
From below experimental result table it is conclude that the efficiencies of engine increases by adding the magnetic field in the path of fuel line. This experimental test have been carried out fixed load condition. Above value of thermal efficiency & volumetric efficiency increasing that is indicate that the maximum air-fuel bonding achieved by magnet. So that the better burning is carried out & obviously emission levels will less from the engine

Table no.1

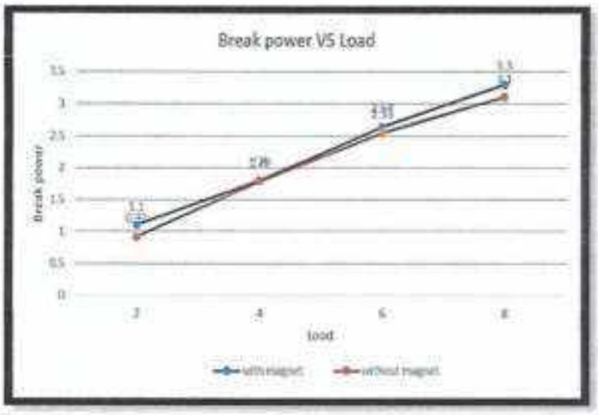
	2kg		4kg		6kg		8kg	
Parameters	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
BP (kW)	0.92	1.1	1.79	1.8	2.55	2.64	3.1	3.3
Mass of fuel(kg/s)	2.6e-4	2.38e-4	4.1e-4	3.7e-4	5.79e-4	5.78e-4	1.1e-3	1.02e-3
Bsfc (kg/kWhr.)	1.047	0.78	0.82	0.70	0.87	0.78	1.34	1.1
Heat I/p (kW)	11.83	0.78	18.21	16.28	27.13	25.48	52.09	45015
Thermal eff.	7.81	10.47	9.86	11.6	9.39	10.38	6.1	7.33
Volumetric eff.	40.38	67.38	42.07	79.08	44.47	84.65	47.57	90.27

a. PERFORMANCES GRAPHS:-

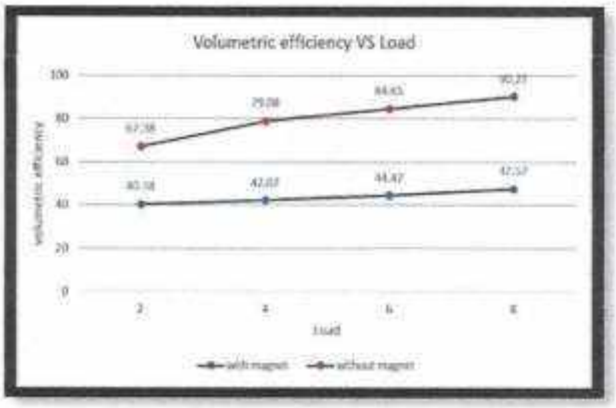
Engine Performances has been analyzed with following graph are plotted between load and other parameter from the experimental result.



Graph.1 Bsfc VS Load



Graph.2 Break power VS load



Graph.3 Volumetric efficiency VS Load

It is observed from the graph 1. That the Bsfc is in magnet case always above the curve that without magnet & the after certain load continuous increase by large difference. Graph 2 is plotted break power VS Load, from the graph with magnet result varies 1 to 2% without magnet. There is large changes in volumetric efficiency 25% or more than that value when adding the electromagnet due to increases by well interlocking of hydrocarbon or oxygen showing in graph 3.

VII. RESULT AND DISCUSSION

Emission testing is done by using the gas analyzer in setup of experiment & direct printed result is obtained Fig. 8. Shows that result of before using magnetic field & Fig.9. After using the magnetic field but this test is conducted the different constant load, below showing printed result is 4kg load applied on the engine.


AIRREX
HG-540
4Gas Emission Analyzer

HC	:	50 ppm
CO	:	0.082 %
CO2	:	13.70 %
O2	:	1.99 %
NOx	:	0 ppm
Lambda	:	1.094
AFR	:	16.08
PEF	:	0.5
Fuel	:	Petrol
H/C	:	1.850
O/C	:	0.000
RPM	:	0 rpm
CENTER ADDRESS	:	

Fig.8 before Using Magnetic Field

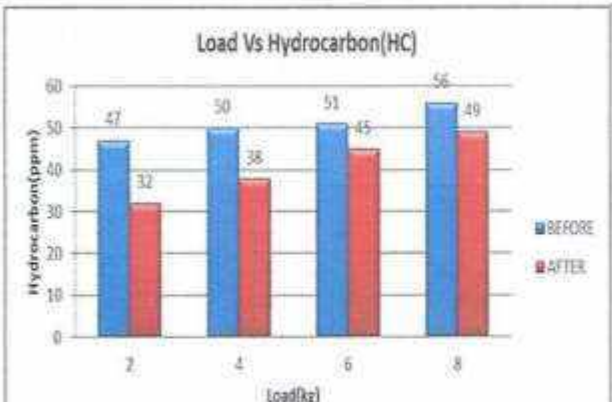

AIRREX
HG-540
4Gas Emission Analyzer

HC	:	38 ppm
CO	:	0.059 %
CO2	:	12.98 %
O2	:	2.73 %
NOx	:	0 ppm
Lambda	:	1.139
AFR	:	16.75
PEF	:	0.5
Fuel	:	Petrol
H/C	:	1.850
O/C	:	0.000
RPM	:	0 rpm
CENTER ADDRESS	:	

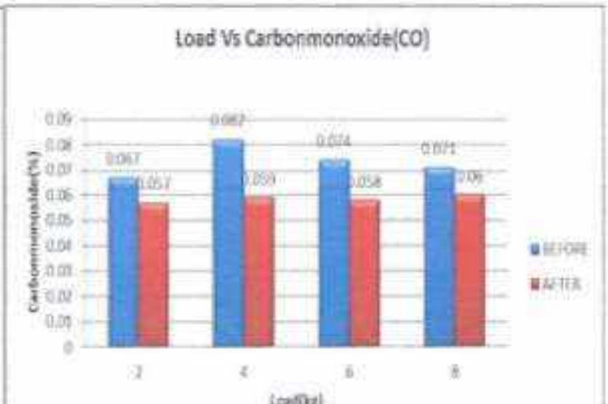
HEPHZIBAH CO. Ltd.,

Fig.9 after Using Magnetic Field

a. COMPARISON OF EMISSION PARAMETER:



Graph.4 Load VS hydrocarbon



Graph.5 Load VS carbon monoxide

Graph. 4. Drown the load VS Hydrocarbon there is significant changes in before & after value of hydrocarbon. Here is gradually increase load & similarly reduction in between the difference before & after value of hydrocarbon, is showing in the graph. Averagely 7 to 8% hydrocarbon value are decreased after using electromagnetic kit. Hydrocarbon emission is less, which relies the burning of fuel completely. In the graph 5. Which is drown the load VS carbon monoxide fluctuating difference is obtained at the variable load at 4kg load maximum difference is obtained clearly shows the changes in value due to variation of load.

VIII. CONCLUSION

Internal combustion engine is getting maximum energy per liter as well as environment with lowest possible level toxic emission. The resultant fuel burn more completely, producing higher engine output, better fuel economy, more power & most importantly reduces the amount of HC, CO, NOx in the exhaust.& therefore control the emission at low cost. Avoid clogging problems in Diesel Engine, Cost saving, Eco friendly, provides extra life for expensive catalytic converter & Reduce maintenance of engine. That increase the 10-30% mileage of vehicle. Complete combustion improve the life of engine cost of maintenance reduced

ACKNOWLEDGEMENT

Nitin Karande thanks Prof. S.K. Kumbhar (Project Guide) and Prof. S.D.Jagtap (Head, Mechanical Engineering Department, walchand, sangli) for their beneficial guidance, suggestion, support and constructive criticism.

REFERENCES

[1] Shweta Jain, Prof. Dr Suhas Deshmukh: "Experimental Investigation of Magnetic Fuel Conditioner (M.F.C) in I.C. engine".Vol.2, Issue 7(July 12), PP 27-31.

[2] P. Govindasamy & S. Dhandapani: Reduction of NOx Emission in Bio Diesel Engine with Exhaust Gas Recirculation & Magnetic Fuel Conditioning.Vol.8,No.5,(2007),PP.533-542.

[3] Okoronkwo C. A & Dr. Nwachukwu: The Effect of electromagnetic Flux density on the ionization & the combustion of fuel. ISSN – (2010),2153-649.

[4] Ra'ad A. Khalil: Reduction of Pollutant Emission in Ethanol-Gasoline Blends Engine with Magnetic Fuel Conditioning.

[5] Houtman P. Siregar & Rufinus Nainggolan: Electromagnetic Fuel Saver for Enhancing The Performance of The Diesel Engine.

[6] Marshall, S.V., and Skitek, G.G. 1987 : Electromagnetic Concepts and application. Englewood Cliffs, N.J: Prentice-Hall, Inc., New Jersey; 25-150

[7] Ali S.Faris, Ali Salim, Jaafer Sadeq: Effects of Magnetic field on Fuel consumption and Exhaust Emission. (Science Direct) – Energy procedia 18 (2012) 327 -338.

[8] Gary t jones "the effect of molecular fuel energizer on emissions and fuel economy". The study done in the year 1981 for "environmental protection agency"

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Energy Procedia 18 (2012) 327 – 338

Energy Procedia

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

Ali S. Faris[a], Saadi K. Al-Naseri[b], Nather Jamal, Raed Isse, Mezher Abed, Zainab Fouad, Akeel Kazim, Nihad Reheem, Ali Chaloob, Hazim Mohammad, Hayder Jasim, Jaafar Sadeq, Ali Salim, Aws Abas

[a] *Department of Physics, College of Education, Aliraqia University, Baghdad, Iraq*
[b] *Environmental & Water Research & Technology directorate, ministry of science and technology, Baghdad, Iraq*

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.

* Corresponding author. Tel.: +9647801673748; fax: +0-000-000-0000 .
E-mail address: shynier2004@yahoo.com

1876-6102 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of The TerraGreen Society.
doi:10.1016/j.egypro.2012.05.044

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.

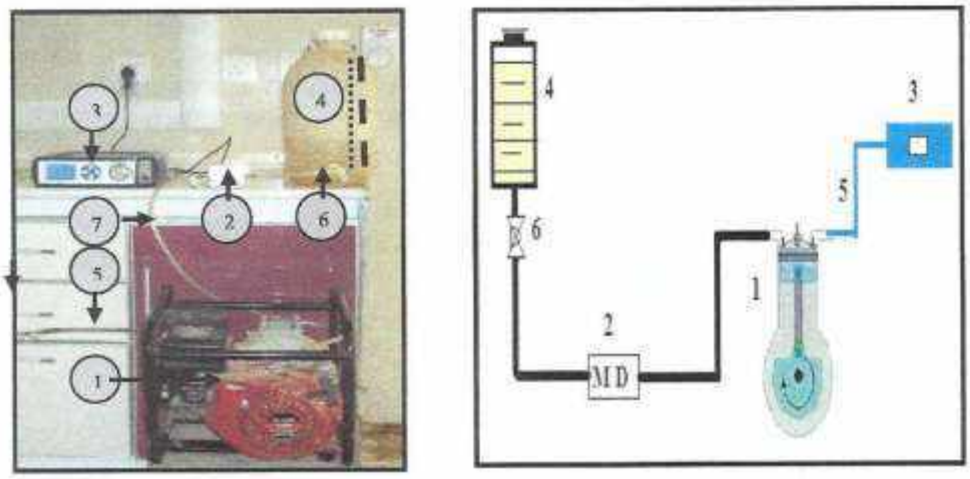


Fig.2. a photograph of the fuel magnetization unit (1. Engine, 2. Magnetic device 3. Measuring device for exhaust gases, 4. Fuel tank, 5. Gas sensor, 6. Valve, 7. Flexible tube for fuel)

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.

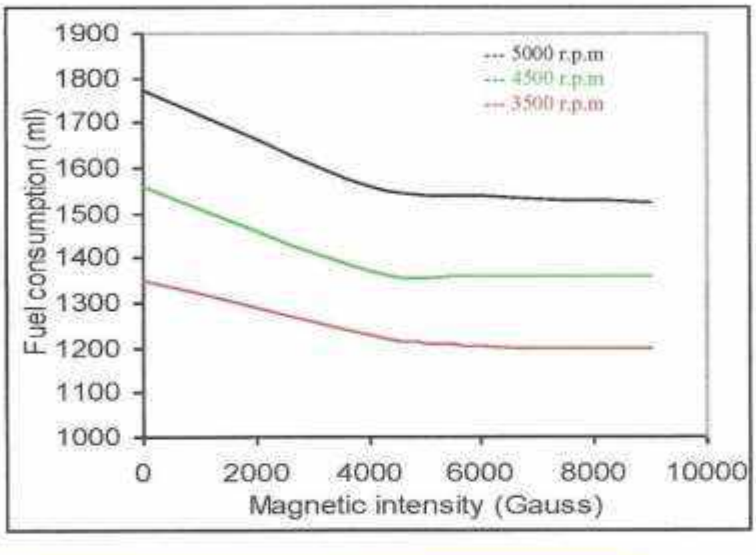


Fig. 3. Reducing the amount of consumed fuel with increasing magnetic field intensity

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

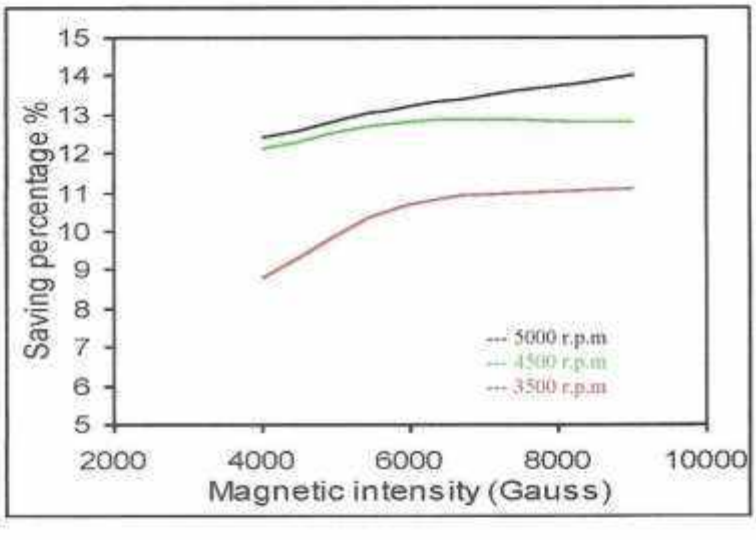


Fig. 4. Increased rate of fuel saving with increasing magnetic field intensity

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.

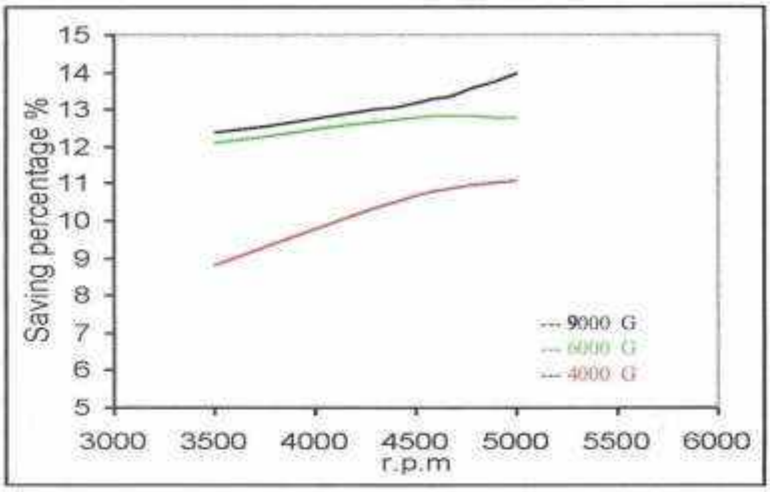


Fig. 5. Increased rate of fuel saving with increasing engine speed

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.

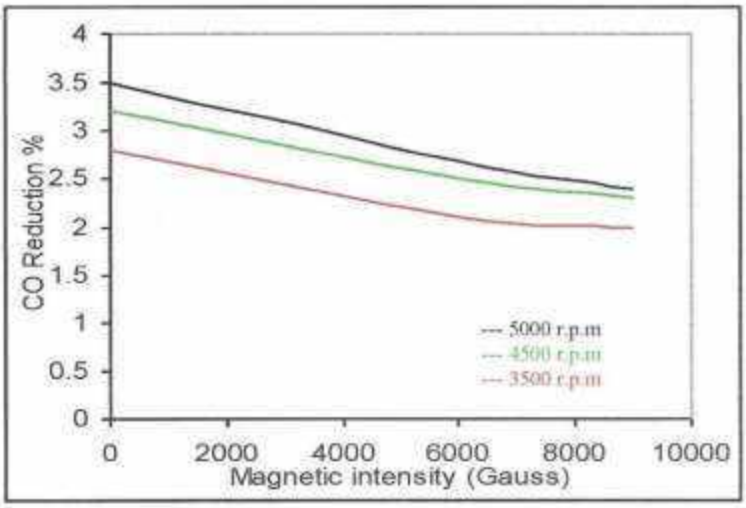


Fig. 6. Decrease rate of CO gas with magnetic intensity

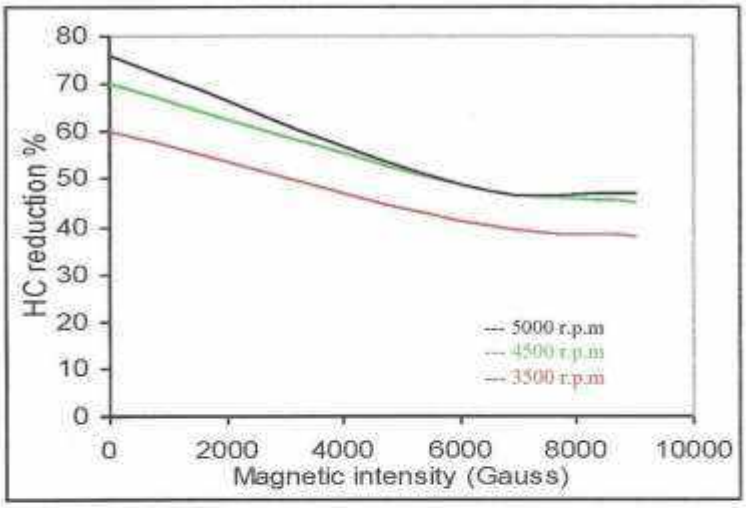


Fig. 7. Decrease rate of unburned hydrocarbons HC with magnetic intensity

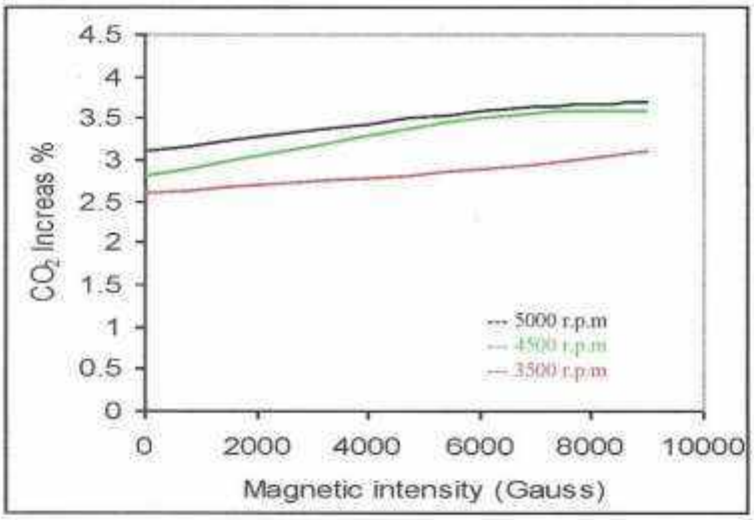


Fig. 8. Increase rate of CO_2 gas with magnetic intensity

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.

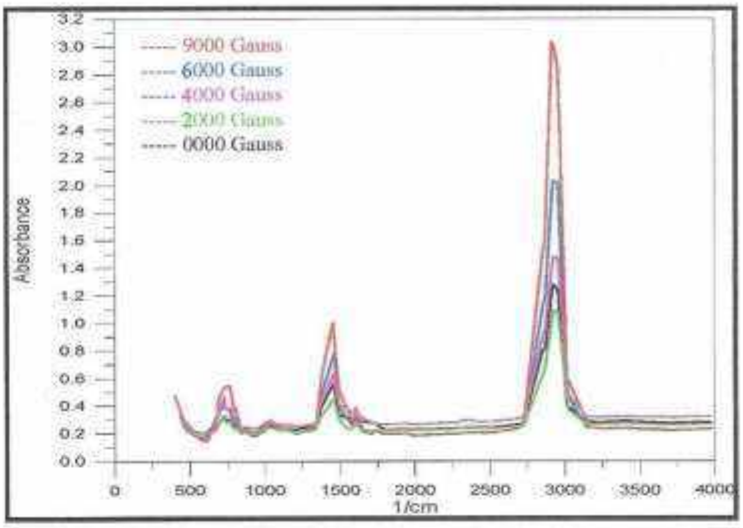


Fig. 9. Variation of strengths of infrared absorption peaks of fuel with magnetic intensity

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.

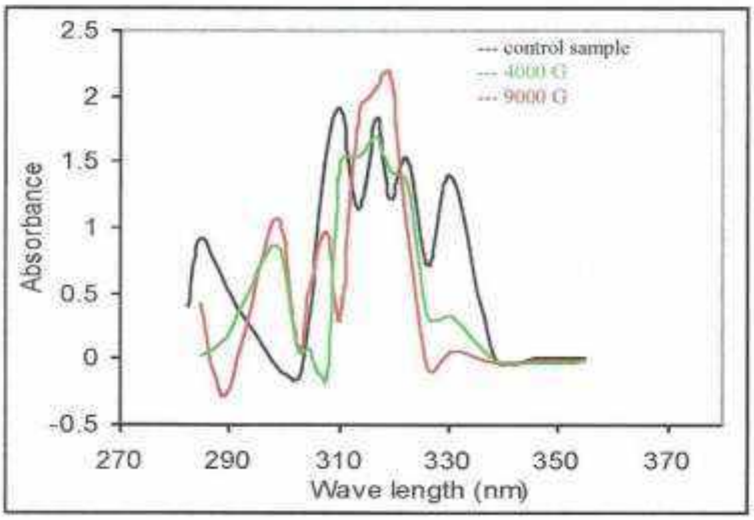


Fig. 10. Absorption spectrum of ultraviolet light for fuel magnetized with different magnetic intensities

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

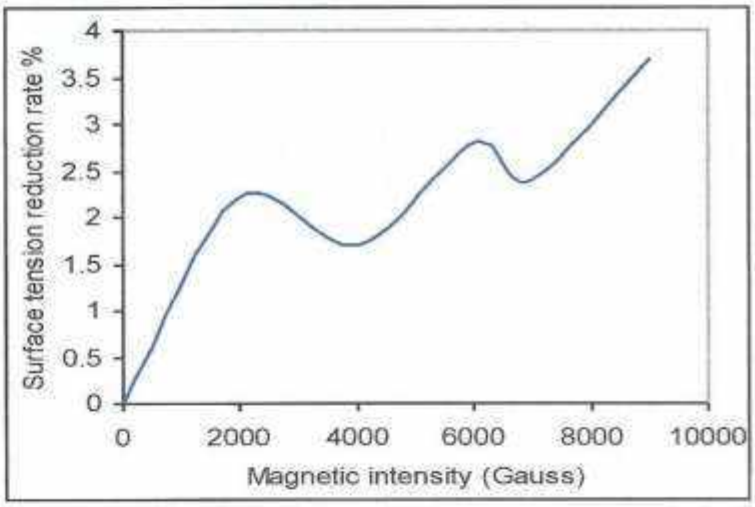


Fig. 11. Change in surface tension of the fuel with the intensity of the magnetic field.

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%

5. Reference

[1] P. Kulish, "Seminar Report on Fuel Energizer" (1984).pp. 1-25
[2] P. Govindasamy and S. Dhandapani, "Experimental Investigation of Cyclic Variation of Combustion Parameters in Catalytically Activated and Magnetically Energized Two-stroke SI Engine" Journal of Energy & Environment, Vol. 6, , (2007), pp.45-59
[3] S. Mingdong et al, "Study on the Combustion Efficiency of Magnetized Petroleum Fuels, Chinese Science Bulletin, (1984), 3.
[4] J. C. L. Cummins, "Early IC and Automotive Engines" SAE paper 760604, Society of Automotive Engineers, Warrendale, Pennsylvania, USA, (1976).pp. 18-26.
[5] R. K. Kiran, K. S. Muley, "Two Stroke Cycle Engine Performance and Fuel Treatment Devices" Overdrive-An Automobile Magazine, New Delhi, , (2006), pp. 23-28.
[6] Y. Yazhong, "The Applied Test of Wax Protection by Intensive Magnetism" Oil and Gas Storage and Transportation (China) , (1990).
[7] C. Yujuan et al, "Reduction of Viscosity of Crude Oil by A Strong Magnetic Field and Its Application". Acta Petrolei Sinica, (1989),
[8] H. *Guo*, Z. Liu, Y. Chen and R. Yao,"A Study of Magnetic effects on the Physicochemical Properties of Individual Hydrocarbons" Logistical Engineering College, Chongqing 400042, P.R China(1994), pp.216-220.
[9] P. Govindasamy, S. Dhandapani, "Experimental Investigation of the Effect of Magnetic Flux to Reduce Emissions and Improve Combustion Performance in a Two Stroke, Catalytic-Coated Spark-Ignition Engine" International Journal of Automotive Technology, Vol. 8, No. 5, (2007),pp. 533-542
[10] I. Pera, P. Pines, "Magnetizing Hydrocarbon Fuels and Other Fluids" U. S. Patent No. 4716024, (1987).
[11] C. A. Okoronkwo , C. C. Dr. Nwachukwu, L.C. Dr. Ngozi and J.O. Igbokwe, "The Effect of Electromagnetic Flux Density on the Ionization and the Combustion of Fuel (An Economy Design Project)" American Journal of Scientific and Industrial Research, ISSN: 2153-649X doi:10.5251/ajsir.(2010).1.3.527.531
[12] R. Z. Hricak, "Air fuel Magnetizer" U. S. Patent No.5,331,807 , (1994).
[13] N. Nedunchezhian, S. Dhandapani, "Experimental Investigation of Cyclic Variation of Combustion Parameters in A Catalytically Activated Two Stroke SI Engine Combustion Chamber", SAE-India, Paper, (1999) , 990014, pp. 1-16
[14] R. R. Bowker, "Permanent Magnet Design Guide", Magnet Sales and Manufacturing & Co, USA,(2000), pp. 11-67.

Journal of Scientific & Industrial Research
Vol. 66, June 2007, pp. 457-463

Performance and emissions achievements by magnetic energizer with a single cylinder two stroke catalytic coated spark ignition engine

P Govindasamy[1,*] and S Dhandapani[2]

[1]Kongu Engineering College, Erode 638 052
[2]Coimbatore Institute of Technology, Coimbatore 641 014

Received 20 September 2006; revised 29 December 2006; accepted 17 January 2007

This paper presents work conducted on a zirconia (catalyst) activated two-stroke spark ignited engine to investigate the effect of high gauss magnetic energy on cyclic variation of combustion parameters. A 9000 gauss magnet, made up of Neodymium-Iron-Boron, is fixed on fuel line before carburetor. The coating is carried out by thermal evaporation technique on the inside surface of combustion chamber walls and piston crown. In-cylinder pressures were recorded for 500 continuous cycles using a piezo electric pressure pickup and PC based data acquisition system. Magnetic flux activates preflame reaction and shortens combustion duration. Cyclic variation of combustion parameters due to magnetic energy were 25.1% less than the base engine and mean value of the peak pressures were found to have upper shift of 13.6%. Magnetically energized zirconia coated engine performed better than the base engine during running.

Keywords: Catalyst, Emission, Energizer, Spark ignition engine

IPC Code: F02P5/14

Introduction

Cyclic variation[1-11] in combustion of spark ignition (SI) engine is influenced by both mixture strength and the turbulence in tile cylinder. Laminar flame speed at the spark plug region was found to be a major cause of cyclic variation in early flame development. Winsor & Patterson[12] suggested that by improving mixture turbulence, cyclic variation of combustion can be minimized. Urushihara *et al*[13] employed combination of swirl flow and tumble flow, generated by swirl control value. Whitelaw & Xu[14] used an intake shroud to create tumble flow and increased swirl ratio. Dhandapani[15] applied copper coating over piston crown and inside of cylinder head wall, and reported that the catalyst improves fuel economy and increases combustion stabilization. Results[16] of a computer model for NiCoCr alloy coated combustion chamber showed a slight increase in peak pressures and the rate of heat release. But most of these studies were aimed to understand the problem of cyclic variation and the influence of either one or more number of parameters such as air/fuel ratio, turbulence inside the combustion chamber and distribution of air/fuel ratio.

*Author for correspondence
E-mail: pgsamy@gmail.com

This study presents variations of magnetic flux on combustion[17,18] of normal lean combustion and catalytically activated lean combustion[19-26] and various other in-cylinder activities using Zirconia as catalyst in a two stroke SI engine.

Magnetic Energizer –Working Principle

Mono Pole Technology

The most important factors in the monopole technology are the magnetic field intensity and the collimation of the lines of magnetic flux[27,28]. Intensity of magnetic field is far superior to that generated by

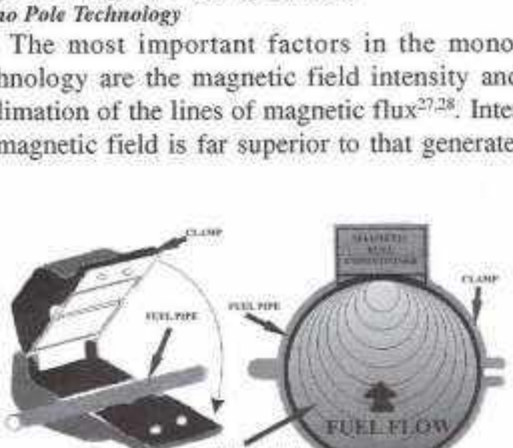


Fig. 1— Magnetic fuel energizer[18]

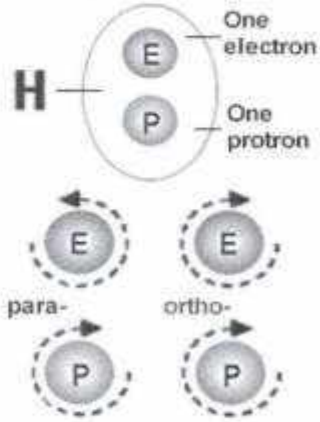


Fig. 2— Atomic orientation

Table 1— Engine specifications

Engine make	Bajaj 150 CC
Cylinder bore/stroke	57.5 /58 mm
Power	4.5 kW @ 5500 rpm
Connecting rod length	110 mm
Compression ratio	7.4:1
Carburetor	Jetex, downdraft
Lubrication	Petroil

regular permanent magnets and the collimation of magnetic fields (Fig. 1) renders the lines of magnetic flux exactly parallel to each other at extremely high densities (to the order of millions of lines of flux per cm^2). These devices are external online installations without cutting or modifying the fuel pipes.

Ortho-Para Orientation

In Para H_2 molecule, which occupies even rotation levels (quantum number), spin state of one atom relative to another is in the opposite direction rendering it diamagnetic. In ortho molecule, which occupies odd rotational levels, spins are parallel with the same orientation for the two atoms, and therefore is paramagnetic and a catalyst for many reactions (Fig. 2).

This spin orientation has a pronounced effect on physical properties (specific heat, vapour pressure), as well as behavior of the gas molecule[29,30]. The coincident spins render o-H_2 exceedingly unstable and more reactive than its p-H_2 counterpart. To secure conversion of p to o state, it is necessary to change energy of interaction between spin states of H_2 molecule[31-33].

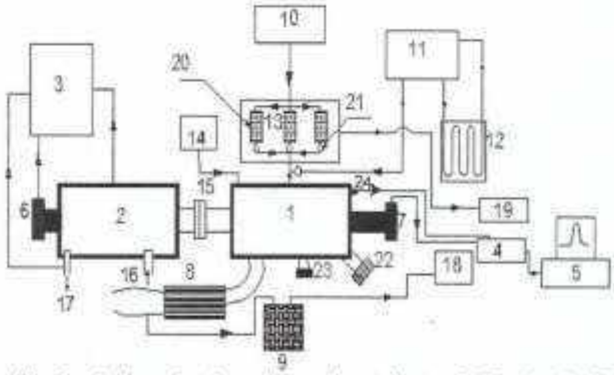


Fig. 3— Schematic view of experimental setup [1 Engine, 2 AVL make eddy current dynamometer, 3 Control panel, 4 Vibro-meter model charge amplifier, 5 AVL data acquisition system, 6 Load cell, 7 AVL crank angle encoder, 8 Muffler, 9 Exhaust freezer, 10 Fuel tank, 11 Fuel recirculation unit, 12 Radiator core, 13 Fuel line assembly, 14 Air consumption box, 15 Coupling, 16 cooling water in, 17 Cooling water out, 18 AVL make (Digas 4000 light) gas analyzer, 19 Fuel line changer, 20 Magnet, 21 Solenoid valve, 22 Fuel metering rod, 23 MBT timing wheel, 24 Kistler make pressure transducer]

Materials and Methods

In a single cylinder air-cooled two-stroke SI engine (Table 1) provisions were fabricated and installed in the engine setup to vary ignition timing and fuel quantity. To facilitate operating the engine under maximum best torque (MBT) timing mode, a timing gear was designed in such a way that for one complete rotation of hand wheel, the timing advance/retard is exactly measures one degree. By adjusting this hand wheel mechanically, spark timing could be varied at will, even at engine in operation. For a given quantity and quality of the mixture under a given load setting, the timing which gives the maximum speed, was taken as the MBT timing. Fuel quantity is varied by adjusting fabricated metering rod, inserted in carburetor jet. These two arrangements help the engine to run on MBT operation mode in each load of its operations.

An AVL Electrical Eddy Current dynamometer has been coupled to the engine. It has the facility to control speed and load externally by a computer and provision to record speed and torque fluctuations (Fig. 3). An automatic fuel flow meter with digital clock allows accurate fuel flow measurements. Commercially available petrol mixed with proper grade lubricant is used as fuel. A separate fuel tank is maintained beside the main fuel tank. Fuel is drawn from the bottom of the tank by an electronic fuel pump

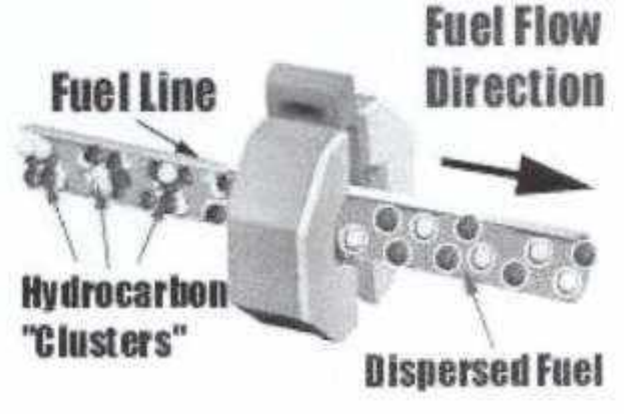


Fig. 4— Location and function of energizer[38]

Fig. 5— Different gauss values of magnets [1) 9000 gauss magnet, 2) 4500 gauss magnet, 3) Radiator core, 4) 3000 gauss magnet]

and discharged to the top of the tank. High gauss magnet is placed facing North Pole[34,35] towards the radiator core surface, which is placed next to the fuel pump. This arrangement is properly shielded for safeguarding the data acquisition system. The pump is operated an hour earlier before commencement of the experiments so as to energize the fuel. This fuel recirculation tank can be accessed as one of the fuel resources in the fuel line changer. Fuel line assembly kit consists of four fuel lines with solenoid valves control and LED indicators to know the fuel line alive. This kit actually receives fuel either from main tank or from recirculation tank but one at a time. All solenoid valves are connected with fuel line changer, which is placed adjacent to the on line data acquisition system. Fuel line selection can be done in the fuel line changer itself. Manually adjustable solenoid valve is also fixed for one fuel line for emergency operation. CO and unburnt hydrocarbon emissions are measured by an AVL make (Digas 4000 Light) exhaust gas analyzer. Exhaust gases are allowed to pass through a water trap immersed in ice bath to separate the condensed water, so that only dry exhaust gas is allowed into the exhaust analyzer.

The cylinder pressure was measured using a Kistler model piezoelectric pressure transducer flush mounted in the cylinder head of the engine. The output of transducer was fed to a Kistler model charge amplifier, which possesses a high degree of noise rejection with ground level current attenuation. For each set of reading, pressure data were recorded using a high speed AVL data acquisition system timed by an optical encoder mounted on the engine crankshaft and after collection, each sample was transferred to a hard disk on a personal computer system for storage and further analysis. A sample size of 500 cycles was selected for further analysis. Fuel line changer with solenoid valves helps to change the fuel line to pass fuel in to variety of energized bank. This magnetic source magnetizes[36-38] the fuel coming through the fuel line and prepares it for better combustion (Fig. 4).

Initially the non-magnetized fuel line has been selected in the fuel line changer and the engine is allowed to run 20 min for warming up before taking readings. The engine has been operated in constant speed mode of 3000 rpm, which represents the average cruising road speed of the vehicle. The exhaust gas analyzer is switched on quite early, so that it will be stabilized before the commencement of experiment. Ambient pressure, humidity and temperature are noted. The fuel flow is varied to supply rich and lean mixtures. Ignition timing is kept advanced to run the engine on MBT operation mode. The load on the engine is automatically controlled by the dynamometer while keeping the engine at constant speed.

After the engine is stabilized for a particular operating point, airflow, fuel flow, and exhaust gas temperature are recorded. The dynamometer readings such as load, speed are also noted. At each operating point, cylinder pressure traces of 500 cycles and their average are measured and stored in a computer hard disc.

Materials Used

Neodymium-Iron-Boron based magnets[39,40] (3000 gauss) is used for initial testing purpose. Rare earth based magnets (4500 & 9000 gauss) have also been used for testing (Fig. 5). The higher gauss magnets need to be shielded to safeguard the encoder, data acquisition

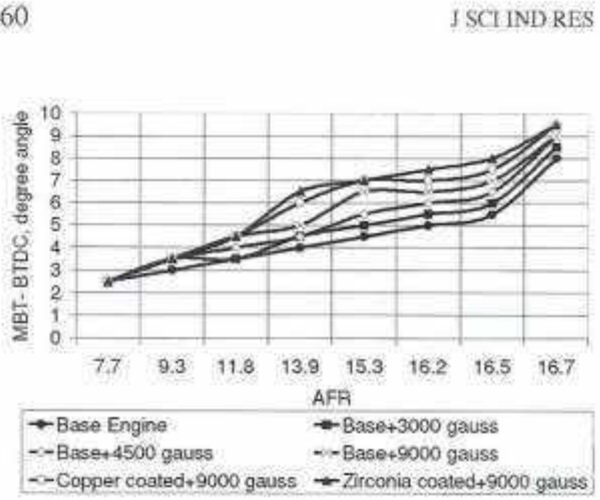


Fig. 6— Optimized MBT for different engine setups

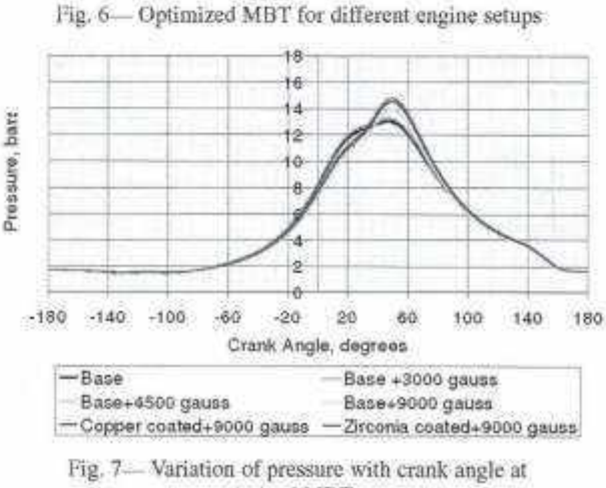


Fig. 7— Variation of pressure with crank angle at optimized MBT run

system and dynamometer. A commercially available radiator core was used as base to keep magnets on both sides and allow fuel to recirculate around the magnets to get energized fuel.

Methodology

Engine was operated on constant speed mode and the following cases were considered: 1) Base engine without magnet; 2) Base engine with magnet of 3000 gauss; 3) Base engine with magnet of 4500 gauss; 4) Base engine with magnet of 9000 gauss; 5) Copper coated engine with magnet of 9000 gauss; and 6) Zirconia coated engine with magnet of 9000 gauss. Engine was allowed to run on lean limit with the help of fabricated metering rod. MBT have also been maintained with the help of timing gear wheel to validate experimental data (Figs 6 & 7) with base performance data. Inner surface of the cylinder head was coated with copper chromate and zirconia by thermal evaporation technique in a vacuum coating unit (Fig. 8). Above experimental procedure has been repeated and data were

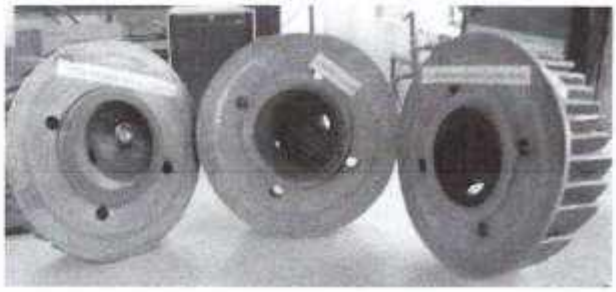


Fig. 8— Coated heads

acquired. Air and fuel are subject to the lines of forces from permanent magnets mounted on the air and fuel inlet lines[41,42]. The magnet is oriented so that its south pole is located adjacent the fuel line and its north pole is located spaced apart from the fuel line (Fig. 4).

Results and Discussion

Engine Performance

For the same amount of air fuel mixture supplied to the engines, base engine gives a lesser brake power (BP) and brake thermal efficiency (BTE) compared to the energized fuel engine. The same trend is maintained between base engine and catalytic coated engine with and without energized fuel. This is due to the incomplete combustion of the charge due to mixture limit inside combustion chamber at a given compression ratio. Actual volume of charge combusted is comparatively less than the volume of charge entering the chamber. Hence, amount of fuel charge to give mechanical power gets reduced and this reduces BTE (Fig. 9a).

Fuel molecules start diffusing from free stream into boundary layer and this fuel concentration at various sub layers and at various crank angle position is found to be different. Fuel level in sub layer near the free stream shows a sudden increase near TDC because boundary layer thickness suddenly decreases near TDC due to the effect of high Reynolds number. Due to this, effective distance that the fuel molecule diffuses becomes lesser near TDC and hence the fuel levels in sub layers were higher. The variation in fuel concentration in sub layers near to the wall was less compared to the sub layers near free stream. This shows that diffusion rate of fuel is the main controlling factor in limiting the reaction rate. In the magnet (9000 gauss) fuel line, diffusion from the free stream to the layers is found to be more and hence maximum mass of charge is combusted for a given actual charge. This leads to a higher mechanical power and hence a higher BTE (Fig. 9a).

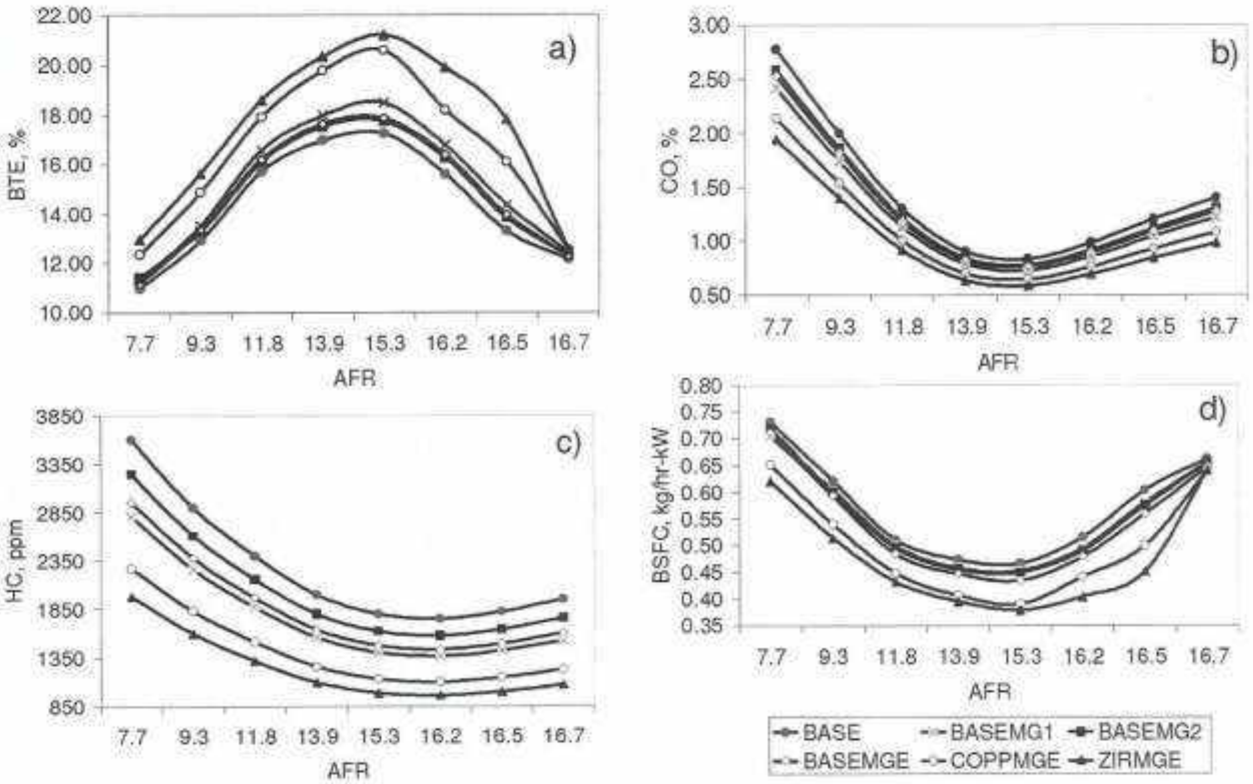


Fig. 9— Variation of air fuel ratio with: a) BTE; b) CO; c) HC; d) Brake specific fuel consumption (BSFC)

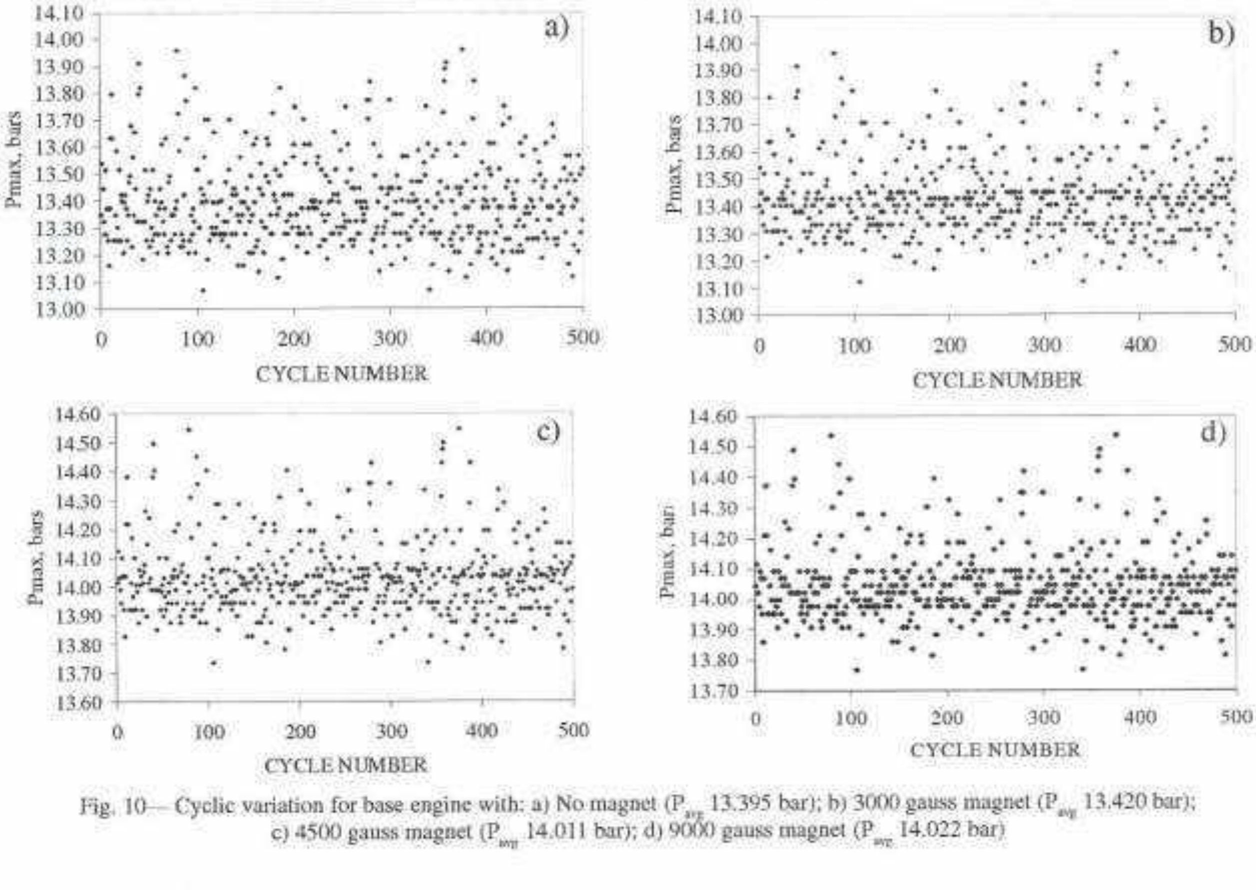


Fig. 10— Cyclic variation for base engine with: a) No magnet (P_{avg} 13.395 bar); b) 3000 gauss magnet (P_{avg} 13.420 bar); c) 4500 gauss magnet (P_{avg} 14.011 bar); d) 9000 gauss magnet (P_{avg} 14.022 bar)

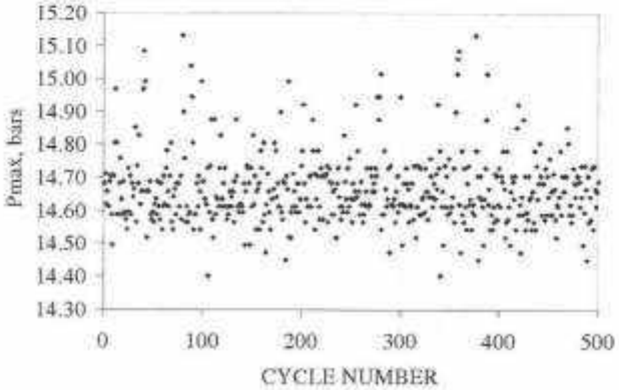


Fig. 11— Cyclic variation for copper coated engine with 9000 gauss magnet (P_{avg}=14.648 bar)

Fig. 12— Cyclic variation for zirconia coated engine with 9000 gauss magnet (P_{avg}=14.857 bar)

Table 2 — Changes in different parameters with base, copper and zirconia coated engine with 9000 gauss magnetic flux

S No	Parameters	Base engine, %	Copper-coated engine, %	Zirconia-coated engine, %
1	Increase in brake thermal efficiency	3.2	6.6	11.2
2	Increase in peak pressure	6.1	9.7	13.6
3	Reduction in cyclic variation	14.1	19.2	25.1
4	Reduction in CO emission	13.3	23.5	29.5
5	Reduction in HC emission	22.1	37.3	44.2

Air-fuel ratio (AFR) for BTE (Fig. 9a), CO (Fig. 9b), HC (Fig. 9c) and BSFC (Fig. 9d) were varied from the minimum to a maximum extent and graphs are drawn with various cylinder parameters against AFR. Improvement in thermal efficiency and reduction in exhaust emissions mainly depends magnetically energized. With increase of load on engine, combustion chamber temperature and air movement increases. Efficiency increases as the engine is made leaner to some extent and then it fails due to the lean misfire limit.

Effect on Cycle Variation

The widely used parameter to analyze the combustion variation in SI engines is peak pressure (P_{max}), measured inside cylinder during combustion. As combustion rate increases due to energized fuel, gas force developed by combustion of the charge inside energized fuel combustion is found more compared to that developed at the base combustion. This increased gas force leads to higher peak pressure for the same supply of air fuel mixture (16.7:1) in energized fuel engine (Figs 10-12). Also, cyclic variations of peak pressures are controlled because combustion rate depends on diffusion rate of the fuel, which further varies with crank angle position. So maximum pressure is developed more or less at a constant crank position in a cycle. So the peak pressure at different cycles is improved.

Conclusions

There is significant increase in brake thermal efficiency and peak pressure whereas decrease in CO, HC and cyclic variation in case of copper and zirconia coated engines as compared to base engine (Table 2). The variation of peak pressures for continuous cycles of coated engine (9000 gauss) is less than that of the base engine.

Acknowledgement

Authors thank the Department of Science & Technology (DST), Govt. of India, New Delhi for funding the project on Development of Catalytic Activated Lean Burn Combustion.

References

1 Young M B, Cyclic dispersion in the homogenous - charge spark ignition engine - A literature survey, *SAE Paper 810020*, 1981.

2 Pundir B P, Zvonow V A & Gupta C P, Effect of charge non-homogeneity on cycle-by-cycle variations in combustion of SI engines, *SAE Paper 810774*, 1981.

3 Kalghahgi G T, Early flame development in a spark ignition engine, *Combust & Flame*, **60** (1986) 299-308.

4 Tagalian J & Heywood J B, Flame initiation in a spark-ignition engine, *Combust & Flame*, **60** (1986) 243-246.

5 Hill P G, Cyclic variations and turbulence structure in a spark ignition engines, *Combust & Flame*, **72** (1988) 73-89.

6 Yamamota H & Misuini M, Analysis of cyclic combustion variation in lean operating SI engines, *SAE Paper 870547*, 1987.

7 Keck J C & Heywood J B, Early flame development and burning rates in spark ignition engines and their cyclic variability, *SAE Paper 870164*, 1987.

8 Kalghatgi G T, Spark ignition, early flame development and cyclic variation in IC engines, *SAE Paper 870163*, 1987.

9 Matekurias F A, Modes and measures of cyclic combustion variability, *SAE Paper 830337*, 1983.

10 Ozdor N, Dulger M & Sher E, Cyclic variability in spark ignited engines, a literature survey, *SAE Paper 940987*, 1994.

11 Grunefeld G, Karim G A & Kibrya M G, A major origin of energy conversion variations in SI engines: Cycle by cycle variations of equivalence ratio and residual gas of the initial charge, *SAE Paper 941880*, 1994.

12 Winsor R E & Patterson D J, Mixture Turbulence - A key to cyclic combustion, *SAE paper 730086*, 1973.

13 Urushihara T, Dulger M & Sher E, Turbulence and cycle-by-cycle variation of mean velocity generated by swirl and tumble flow and their effects on combustion, *SAE Paper 950813*, 1995.

14 Whitelaw J H & Xu M, Cyclic variations in a burn spark ignition engine without swirl, *SAE Paper 950683*, 1995.

15 Dhandapani S, *Theoretical and experimental investigation of catalytically activated lean burn combustion*, Ph D Thesis, IIT Madras, 1991.

16 Nedunchezhian N & Dhandapani S, Experimental investigation of cyclic variation of combustion parameters in a catalytically activated two stroke SI engine combustion chamber, *SAE Paper 990014*, 1999.

17 Fuller M J, Warwick M E & Catal J, Reduction of CO_2 and HC in tin catalyst-evaluation strategy, *Fuel Catalyst*, **29** (1973) 441-442.

18 Janczak Andrew & Krensel Edward, Permanent magnetic power for treating fuel lines for more efficient combustion and less pollution, *US Pat 5124045* 23 June 1992; *Int. Class*, **027/040** (1992) 553402.

19 Kummer J T, Catalysts for automobile emission control, *Prog Energy Combust Sci*, **6** (1981) 177-199.

20 Pfefferle W C, The catalytic combustor: An approach to cleaner combustion, *J Energy*, **2** (1978) 45-62.

21 Thring R H, The catalytic engine engine-platinum improves economy and reduces pollutants from a range of fuels, *Platinum Metals Rev*, **27** (1980) 126-130.

22 Rychter T J, Saragih R, Lezanski T, & Wojcicki S, Catalytic activation of charge in a pre chamber of a SI lean-burn engine, *18th Int Symp on Combustion* (The Combustion Institute, Pittsburgh) 1981, 1815-1824.

23 Hu Z & Ladommatos M, In-cylinder catalysts - A novel approach to reduce hydrocarbon emissions from spark ignition engines, *SAE paper 952419*, 1995.

24 Hu Z & Ladommatos M, A mathematical model for in-cylinder catalytic oxidation of hydrocarbons in SI engines, *SAE paper 961196*, 1996.

25 Ramesh Babu P, Nagalingam N, & Gopalakrishnen K V, Effect of certain catalysts in the combustion chamber of a two-stroke engine on exhaust emissions, *IMechE paper C448/067*, 1992, 241-246.

26 Combustion system development for SI engine, *Proc AVL Semin* (AVL India Pvt. Ltd., Noida) 1988.

27 Vehicle emission control – *A manual* – Magnetizer in Corporation, USA

28 Masaru Hasegawa, Seiya Mukohara & Yoshihara Tachiban, Influence of magnetic field on kinematic viscosity of fuel oil, *8th Int Symp on Alcohol Fuels* (Kobe University of Mercantile Marine, Tokyo) 13-16 November 1988.

29 Skripka N I A A, Litvinov & Tretyakov I G, Influence of operational factors on oxidizability of liquid hydrocarbons, *Operational Properties of Fuels and Lubricants used in Civil Aviation (Kiev)*, Russian, **1** (1975) 11-14.

30 Joe Cheung, *Investigation of the effects of the use of Magno-Flo magnets on diesel engines*, Thesis report, Bolton Institute School of Engineering, 1997.

31 Mcneely M, Magnetic fuel treatment system designed to attack fuel-borne microbes, *Diesel Progr Engines & Drives*, **44** (1994) 16-18.

32 Samuel S, Austin L & Morrey D, Automotive test drive cycles for emission measured and real-world emission levels, *I Mech E Proc*, **8** (2002) 555-563.

33 Tretyakov I G, Rybak M A & Stepanenko E Yu, Method of monitoring the effectiveness of magnetic treatment for liquid hydrocarbons, *Sov Surf Eng Appl Electrochem*, **6** *(1985)* 80-83.

34 Fujita Etuo, Fuel combustion and magnetizing apparatus used, *US Pat 4188296* 12 February 1980; *Prim Class*, **210/222** (1980) 868291.

35 Stanley L Syria, *Report on EPA-13, Mode Steady State Tests* (Emission Testing Services Inc., California, USA) 1982, A85-A160.

36 Kronenberg K J, Experimental evidence for effects of magnetic fields on moving water and fuels, *IEEE Trans Magnetics*, **21** (1985) 2059-2061.

37 www.algae.com - Algae-X International, 1661 Estero Blvd Fort Myers Beach, FL 33931, USA.

38 www.fueldyn.com – Fuel Dynamics, LLC, Cape Canaveral, FL 32920, USA.

39 *Permanent Magnet Design Guide* (Magnet Sales and Manufacturing & Co, USA) 2000.

40 Marshall S V & Skitek G G, *Electromagnetic Concepts and Applications*, **2nd edn** (Prentice-Hall Inc., New Jersey 07458) 1987, 25-150.

41 Richard Z Hricak, Air fuel magnetizer, *US Pat 5331807* 26 July 1994; *US Class*, **123/538** (1994) 161022.

42 Jose Luis De La Torre, Fuel saving device, *US Pat 5664546* 9 September 1997; *US Class*, **210/332** (1997) 500940.