INDIAN MARITIME UNIVERSITY
MUMBAI PORT CAMPUS
(Marine Engineering & Research Institute, Former D.M.E.T.)

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of
MARITIME RESEARCH & DEVELOPMENT
(IJMRD)

Knowledge-Humility-Excellence

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Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food and manufactured goods across international borders. Shipping is truly global in nature and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

Recognizing the importance of research in various aspects of maritime and logistic sector, IIRE through its Journal of Maritime Research and Development (IJMRD) encourages research work and provides a platform for publication of articles, manuscripts, technical notes, papers, etc. on a wide range of relevant topics listed below:

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ABOUT INDIAN MARITIME UNIVERSITY – MUMBAI PORT CAMPUS

Indian Maritime University – Mumbai Port Campus comprises of two premier institutes, Lal Bahadur Shastri College of Advanced Maritime Studies and Research (LBS CAMSAR) & Marine Engineering and Research Institute (Former D.M.E.T.). LBS CAMSAR is the post sea training institute whereas MERI Mumbai is the pre – sea training institute.

LBS CAMSAR was founded in October, 1948 under the recommendations of the Merchant Navy Training Committee as Central Government premier post sea training institute for Merchant Navy Officers of Navigation & Engineering. And since then, it is offering the comprehensive range of courses for Merchant Navy Officers.

Marine Engineering and Research Institute (M.E.R.I.), formerly known as Directorate of Marine Engineering Training (D.M.E.T.), was established in the year 1949 by the Govt. of India, when the need was felt to train Marine Engineers separately. And since then, it is imparting the education and training to the cadets with a goal of producing the best marine engineers and nautical officers for the world with adopting the latest technology to meet the latest and demanding requirements of the shipping fraternity.
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MESSAGE FROM THE CONVENER

It is very heartening to note that Indian Maritime University – Mumbai Port Campus (Marine Engineering & Research Institute) is organizing a two days Technical Fest Brinicle in association with Maritime Training Trust, D.G Shipping on 28th & 29th March, 2019. This fest is an initiative taken by Maritime Training Trust with an objective of enhancing the maritime knowledge of the participants and to provide all the stakeholders of Maritime Industry an opportunity to gain a great deal of insight into the “emerging technologies”.

I am thankful to IIRE Journal of Maritime Research and Development for collaborating with us. It is pleasing to note that the twelve accepted papers dwell on maritime subjects ranging from Artificial Intelligence, IoT, Inland waterways in India, Sustainable Development, which will dominate the industry in the coming years.

As the success of the event depends ultimately on the people who have worked in planning and organizing it, so I would like to thank the members in all the committees for their great efforts on this success.

Hare Ram Hare
Convener, Brinicle
**Editorial**

IIRE efforts to ingrain culture of research continues unabated.

A specific seminar is planned in March 2019 at Mumbai bringing researchers, industry and academia together to discuss and highlight the importance of research in the maritime sector.

Yet another opportunity arose when the Indian Maritime University – Mumbai Port Campus invited IIRE to collaborate in the presentation and publication of research based papers of their young cadets pursuing graduate maritime courses. Twelve papers were selected after a process of review which are now being published in a Special edition of the IIRE Journal of Maritime Research and Development. It was heartening to see papers dwelling on some contemporary themes like, Technology inroads into shipping, Sustainable Shipping, Coastal & Inland Waterways that is finding lot of thrust in India. Block-chain technology, Artificial intelligence, Energy efficiency are the areas covered in some of these selected papers. Papers chosen for publication in the Journal was the reward propagated and this brought in much encouragement and healthy competition. The moot idea was once again to engrain the discipline of research in the impressionable minds of the young cadets finding their sea-legs in a dynamic and highly operationalized and challenging shipping environment.

![Image](image.png)

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MAGNETIC FUEL ENERGIZER

Rohan Tyagi

Abstract

The combustion efficiency in most marine internal combustion diesel engines do not exceed (90%) so that part of the fuel does not burn and comes out with the exhaust gases, leading to increase fuel consumption and increasing emissions in the atmosphere. Therefore, several works have been made to increase the combustion efficiency engine and reduce emissions through engine exhaust. In this era of increasing fuel prices, here a device called Magnetic Fuel Energizer help us to Reduce fuel consumption in IC engines and reduces exhaust emission gases. When fuel flow through powerful magnetic field created by Magnetic Fuel Energizer, the hydrocarbons change their orientation and molecules change their configuration. Due to which molecules get realigned, and actively interlocked with oxygen during combustion to produce a mean complete burning of fuel in combustion chamber. As a result, it gives more complete burning of fuel in the combustion chamber of the engine and reduces amount of hydrocarbon, CO & NO emissions.

Keywords: MFE – Magnetic fuel energizer, HC – Hydro-carbon, CO – Carbon mono-oxide, NO – Nitrous oxide, Co2 – Carbon di-oxide, IC – Internal combustion, HFO – Heavy fuel oil

1. INTRODUCTION:

Generally, fuels for internal combustion engine are compound of molecules. However, these molecules have not been realigned, the fuel is not actively inter locked 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 created by ‘Fuel Energizer’. An objective of the Magnetic fuel energizer is to provide significantly improved molecular excitement and turbulence in a diesel-based fuel so that re-polymerization is more effectively resisted and improved fuel efficiency is achieved. A magnetic fuel energizer is nothing but a magnet which is used to alter atomic construction and organize fuel molecules of fuels so that proper combustion occurs in I.C. engine. As magnetic field is applied to ionizing a fuel feed to the combustion chambers which enhance combustion process and gives out lower emission and improved fuel economy. Magnetic field applied to fuel line atomizes fuel properties which get adhere to more oxygen molecules and enhances fuel air mixture. In 1989, Hans Dehmelt of University of Washington was awarded noble prize in physics for his great contribution in fundamental properties of electrons. According to that electrons having ability to store up energy within itself similar to flywheel called spin. When it provides small amount of magnetic field, it absorbs the energy and...
properties will change which is based on the below theories i.e. Chemistry theory – Covalent bond, Physics theory – Barnett effect, Math’s theory – Quantum mechanics.

Many 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. For pollution due to merchant seagoing vessels emissions, it is of concern more, particularly due to the upcoming IMO SULPHUR 2020 CAP.

2. TECHNICAL BULLETIN:

Hydrocarbon compounds in fuels generally have a “CAGE LIKE” structure. That is why during combustion process oxidizing of their inner carbon atom 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. The exhaust should theoretically contain CO₂, water vapor and nitrogen from air which does not participate in combustion. Practically the exhaust gases contain CO, H₂, HC, NOₓ and O₂. In reality complete combustion of fuel is never achieved, and the incompletely oxidized carbon is evident in the form of HC, CO, or in deposited on internal combustion chamber walls as black carbon residues. Hydrocarbon compounds in the fuels are magnetically treated which tend to de-cluster, creating smaller particles more rapidly penetrating oxygen thus leading to better combustion.
They become normalized & independent distanced from each other having bigger surface area available for more binding of oxygen.

Hydrogen occurs in two forms which is one of the major constituent in fuels. One is Para which is normally occurs in fuels, second is ortho which achieved by applying magnetic field. The ortho form of hydrogen is achieved by application of strong magnetic field along the fuel line. In the para form of 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, occupies the parallel rotation, the spin state of one atom relative to another is in the same direction as shown in Figure 2.

When the fuel passes through a magnetic field, created by the strong permanent/electromagnets, 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 magnetic field helps to disperse oil particles and to become finely divided. Figure 2 shows the schematic view of para state and ortho state of Hydrogen of clusters of hydrocarbons changed with the influence of magnetic field and they are more dispersed. 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 the emissions of
carbon particles. In our study focus has been laid on understanding of magnetic action modes which have led to the fuel economy and reduce exhaust emissions in engine applications.

3. EFFECT OF MAGNETIC FIELD ON THE MICRO-STRUCTURE 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 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 interactions under the action of the magnetic field.

4. IMPORTANT CRITERIA TO BE TAKEN INTO CONSIDERATION WHILE INSTALLING MFE ONBOARD MERCHANT VESSELS:

- **INSTALLATION POSITION** - The location of MFE should be as close to the engine as possible in order to prevent loss of magnetizing action of the fuel into the surrounding environment. The best suitable location is between the fuel pump and the fuel valve/fuel injector, precautions should be laid by installing a magnetic insulation pipes in this location.

- **POLARITY OF MAGNET** - Two sets of electro- magnets are to be used each having the same polarity which plays an important role in magnetizing action.

- **DIAMETER OF MFE** - It usually depends on diameter of the fuel delivery line and the variants of fuels utilized by the engine.

- **LENGTH OF MFE** - Typically for an engine running on Diesel as main propulsion fuel the MFE length should be around 12 to 17 cm where else in case of Gas fueled engines 5 to 8 cm length is best preferable. Here our main area of focus should be type of fuel because more degraded is the fuel quality, the longer hydrocarbon chain the fuel has and hence which results in more intense and lengthier MFE unit incorporated. Thus, this is the only aspect where MFE falls a minor drawback i.e. for engines operating on HFO are practically non-feasible to install MFE.
• **MAGNETIC FIELD STRENGTH** - For an engine operating on DIESEL FUEL, 1800 gauss of magnetic field is sufficient where else in case of gas fuels 800 gauss of magnetic is suitably prefer.

5. **POSITIVE TRAITS OF USING MFE ONBOARD MERCHANT VESSELS:**
   - Increase fuel economy per liter.
   - Reduces detonation of engine.
   - Reduce engine noise.
   - Decrease in harmful gases emission.
   - Increase in time between overhauls.
   - Complete combustion of fuel.

6. **EXPERIMENTAL SET-UP:**

   The above set-up shows a single cylinder 4-stroke diesel engine with the power rating of 5.5 HP. This set-up was meant to be made in order to find out the efficiency enhancement in the system by including MFE. The system was run on three distinct speeds termed as low (3500 rpm), medium (4500 rpm) and high speeds (5000 rpm). Two trail modes was run in the set-up first with MFE and second without MFE, the results were compared and the being plotted in a graph of certain important aspects. In the above figure the following parts were marked as given below-
   1) Single cylinder engine.
   2) MFE.
   3) Exhaust gas analyzer.
   4) Diesel oil tank.
5) Exhaust piping arrangement.
6) Diesel oil feed valve.

**Amount of Reduction in HC and CO Emissions:**
The percentage of exhaust gases which measured during the operation of the engine for three distinct speeds before and after magnetic treatment has been shown in the given below graphs. It was found that the reduction percentage of the gases (HC and CO) is up to 30-40% respectively.
Increase in amount of CO₂ production-
Magnetization of fuel breaks down the bonds between hydrocarbon chains which results in decreased density and surface tension and hence smaller particulars and droplets during atomization or injection within an internal combustion engine. Smaller particles and droplets caused increased evaporation rate, increased mixing of fuel with the charge air and improved promotion of oxidation. The net effect would be increase in rate of production of CO₂.

SAVINGS ACHIEVED BY THE INCORPORATION OF MFE IN THE SYSTEM-
The fuel saving percentage was ranged between 9-14% depending on the magnetic field intensity as well as engine speed. In the same context leads to increase in profit for shipowners because of high rising fuel pricing in the merchant shipping market.
7. ELECTROSTATIC PRECIPITATION DEVICE:

An electrostatic precipitator is a complete device that not only filters out the particles but is also removing them completely out of the gas flow. Figure shows what the device would look like. The gas will flow into the device and along the high voltage discharge wires. Works on the same principal as MFE.

When the layer of solid particles on the collecting plates is relatively thick, 0.08 to 1.27cm, it will be removed. The so-called rappers will remove the solid particles by shaking the collecting plates. The solid particles will fall into containers below. These containers are called hoppers. From there, the solid particles will be carried by conveyor to a storage container. During this process, the gas can continue to flow without creating backpressure. This would be an advantage when the ESP is positioned in the exhaust gas stream of a diesel engine.

The collecting plates are usually made of carbon steel, but ship’s diesel engines emit corrosive gasses. Especially when the engines run on heavy fuel oil (HFO). For use on board of seagoing vessels a better material would be an alloy steel that is more resistant to corrosion. The spacing between the collecting plates and discharge wires is important because with high voltage and little space between the discharge wires and collecting plates, sparks can occur. These sparks cause a loss of the electric field for a short period of time. So, for high collecting efficiency the plates and wires should be as compact as possible without creating too many sparks when operating.
8. CONCLUSION:

In shipping industry it’s not about grand inventions and innovations, it’s about a lot of innovations every day that is making something a bit better. This industry has faced a constant change right from the early days till the modern era, as a seafarer we need to keep ourselves updated and in process of constant learning in order to trigger the sustainable trade in this industry. When fuel is exposed to a magnetic field, we find that its properties are changed. Magnetic treatment of fuel is 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 10%. 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%. Ship-owners these days are looking for the most economical way to operate their vessels and this device can readily help them to sort off with their problems leading to less investment and earning more profit in the future.

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