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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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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
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.

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USE OF ENERGY EFFICIENT OPTIONS FOR EMISSION CONTROL

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Abstract
Extensive usage of internal combustion engines by shipping industry has certain disadvantages and one of them is its negative effect on the environment. The issue of controlling air pollution from ships was discussed in the lead up to the adoption of the 1973 MARPOL Convention. Sulphur emissions (SOX) from ships were estimated about 4 percent and nitrogen oxide emission (NOX) as 7 percent of total global emissions. Emissions of CFCs and Halon were about 3 and 10 percent respectively of total global emissions. A new draft was made and finally adopted in September 1997. ANNEX VI sets limit on ozone depleting substances SOx, NOX, volatile organic compounds, ship board incineration, fuel oil quality to prevent the air pollution from ships. Sulphur content in the fuel can be reduced by oxidative desulphurization (ODS). Formation of NOx can be reduced by exhaust gas recirculation (EGR) technology. Many in cylinder solutions such as lower compression ratios, modified injection characteristics, improved air intake system etc. are required along with EGR to accomplish the emission norms. Modern combustion techniques such as low temperature combustion (LTC), homogeneous change compression ignition (HCCI), premixed charged compression ignition (PCCI) etc. would be helpful for reducing the exhaust emissions and improving the engine performance. However, controlling of autoignition timing and achieving wider operating range are the major challenges with these techniques. A comprehensive review of emission characteristics and control method is given in this paper.

Keywords: IC Engine, Sulphur Oxide Emission, Nitrogen Oxide Emission, ANNEX VI, Fuel Oil Quality, Exhaust Gas Recirculation, Low Temperature Combustion.

1. INTRODUCTION:

Major emissions produced by IC engines are oxides of nitrogen, carbon, sulphur and particulate matter. Pollutants emitted by engines are a major concerned because of their negative impact on the environment as well as on human health. Hence, stringent emission norms are continuously being imposed on IC engines. Some of the emission control methods have been reviewed in this paper.

NOx EMISSION CONTROL
- Exhaust gas recirculation
- Selective catalytic reduction
- Humid air method
- Water injection and water emulsion
SOx EMISSION CONTROL

- Use of low sulphur fuel oil
- Exhaust scrubber technology
- Cylinder lubrication

1.1. Exhaust Gas Re-Circulation (Egr):

Exhaust gas recirculation is an emission control technology allowing significant NOx emission reductions from most type of diesel engines. EGR is a method in which a portion of engine exhaust gas is recirculated to combustion chambers through inlet system. This method involves displacing some of the oxygen introduced into the engine with inert gases, which absorbs heat during the combustion process, thus lower the combustion temperature and hence reducing NOx.

The EGR system also contains a thermal control valve in vacuum line which prevents the operation of EGR at lower engine temperatures.
1.2. Selective Catalytic Reduction:

Selective catalytic reduction (SCR) is an advanced exhaust after treatment system to reduce NO\(_X\). The engine controls the formation of particulate matter (PM) by increasing the combustion temperature thus limiting it within the permissible level. SCR spreads aqueous urea solution (AUS 32) into the exhaust stream using a dosing pump. Ammonia from AUS 32 combines with NO\(_X\) in presence of catalyst to form harmless byproducts like nitrogen and water vapor. AUS 32 is also known as diesel exhaust fluid (DEF).

SCR system is a simple system that offers better power and high fuel economy due to higher combustion efficiency. Clean combustion ensures higher reliability of engines.

1.3. Humid Air Method (Ham):

It is well known that 90% NO\(_X\) formation results from combustion temperature peaks. It can be controlled by the cooling effect. The principle of HAM is to humidify the inlet in order to lower the temperature peaks.
As shown in the figure, filtered salt water is pumped to the catch tank. Ham system itself circulates the water in a loop between catch tank and HAM vessel. A heat exchanger between the catch tank and the HAM vessel heats the salt water using an on-engine heat source. Three injection stages spray the heated saltwater in to the charge air. At the same time compressed charge air from the exhaust turbocharger bypasses the charged air cooler and is piped in to the HAM vessel. Flowing through the vessel the charge air absorbs the water. Due to high loop capacity of the water all particles will fall back in to the catch tank and over a salinity level are purged. Thus, no salt from the saltwater can enter the engine. This humidification leads to the saturated charge air which is fed into the engine.
1.4. Water Injection and Emulsion:

Two different technologies have been examined for the addition of water in to the combustion chamber:

- Use of water fuel emulsion
- Injection of water into the intake manifold

This is attained using a multi-zone simulation model appropriately modified to stimulate the use of water/fuel emulsion or injection of water into the intake manifold. It provides information concerning the actual effect of water on the NO\textsubscript{X} emission. It is revealed that the reduction is higher using water-fuel emulsion. Even reduction of soot is absorbed using this method. Thus, the simulation is used to estimate the correlation between water percentage, NO\textsubscript{X} relative reduction. This result can be used to define optimum water/fuel ratio.

Similarly, for SO\textsubscript{X} emission control, low Sulphur fuel can be used. But the cost of low Sulphur fuel is higher but much effective.

The scrubber technology works by passing the dirty exhaust gas steam created by the engine through several chambers that contain a scrubbing cloud of water. Inside these chambers, a high number of droplets capture the errant particles in the process.
Proper lubrication of cylinder results in SO\textsubscript{x} reduction. The lubricating oil must be of better quality along with efficient control systems like Pulse or Alpha lubrication systems can neutralize the Sulphur in fuel.

2. CONCLUSION:

In this paper, a detailed review of emission characteristics has been given. The issue of simultaneous control of NO\textsubscript{x}, PM and SO\textsubscript{x} becomes more complex in diesel engine. Both after treatment and in cylinder technologies to reduce emissions in CI engines have been reviewed. It is understood that various technologies to reduce emissions can meet the present emission regulations.

REFERENCES:

Fernando, S., Hall, C. and Jha, S. 2006. Energy and fuels 20,1,376-382

P. Brijesh and S. Sreedhara, International journal of automotive technology

Websites:
www.google.com/wikipedia
www.dieselnet.com
www.yaramarine.com
www.researchgate-net.cdn.ampproject.org

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