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INDIAN MARITIME UNIVERSITY

MUMBAI PORT CAMPUS

(Marine Engineering & Research Institute,Former D.M.E.T.)

BRINICLE

Students' Edition of BRINICLE
in Collaboration with

IIRE JOURNAL
of
MARITIME RESEARCH & DEVELOPMENT
(IJMRD)

Knowledge-Humility-Excellence

ISF Institute of Research and Education (IIRE)

MARCH 2019

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IIRE Journal of Maritime Research and Development

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.

Dr. (Capt.) S. Bhardwaj *fics, fni, fcmmi*
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IIRE Journal of Maritime Research and Development (IJMRD)

Volume 3 Issue 1, March 2019

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BLOCKCHAIN IN LOGISTICS MANAGEMENT

Prathmesh Thube
Shivansh Tejashwi
Buddha Siddharth Gautam

Abstract

Globalization has opened new trade routes, technology has changed the way we shop and spend, and so naturally, the demand for shipping has reached an all-time high. It's no wonder that most shipping customers are shocked and dismayed to find their brokers still relying on artifacts like paper records, written manifests and spoken words to get cargo from point to point. It's time for a breakthrough in how we handle freight. Blockchain technology is often characterized as "disruptive" because it can revolutionize the way we interact as a society. Distributed ledgers are disruptive for ancient business models in the same way email disrupted the mailbox. We will explore the use of blockchain technology in Logistic management in this paper.

Keywords- Logistics, Supply Chain, Blockchain, Smart Contract

1. OVERVIEW:

The seamless movement of goods from point of origin to that of consumption aids an economic movement to prosperity. The progress in logistics sector holds an immense value for economy as well.

Here are some stats: -

- The market's global value was $8.1 trillion in 2015 and is expected to grow to $15.5 trillion by 2023, making it one of the largest industries on planet.
- 55 billion tons of freight was transported in 2015, with expected growth to 92 billion tons by 2024.
- In India, freight and logistics market is at US$160 billion currently and it is expected to be around US$215 billion in next two years.

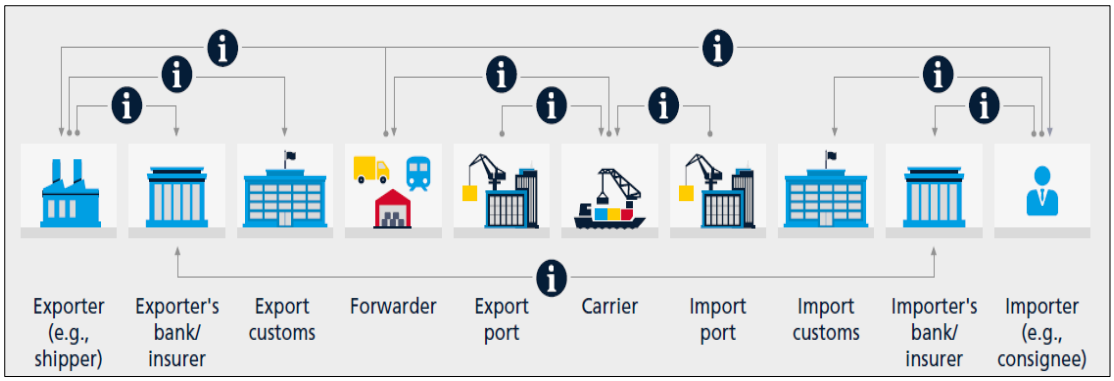
The Logistic management has various drawback such as unified communication platform, outdated ways of tracking etc. According to **KPMG** 40% of global manufacturers lack information and material visibility across their supply bases. In some cases, companies are still using paper ledgers to track their products. These outdated systems result in tremendous amounts of wasted time, resources and money.

But as freight volume increases, so do customer expectations. Both industrial and individual customers expect faster shipments with more flexibility, more transparency and lower prices. Shippers can find it challenging to handle all the complexities of booking, tracking and regulatory compliance, unless they hire teams of full-time, experienced staff. This is where the concept of blockchain technology in logistics management comes in the role.

Blockchain is a digital, distributed ledger that keeps a record of all transactions that takes place across a peer-to-peer network. It is an interlinked and continuously expanding list of records stored securely across a number of interconnected systems. This marks block chain technology resilient since the network has no single point of vulnerability. Additionally, each 'block' is uniquely connected to the previous block via a digital signature which means that making a change to record without disturbing the previous records in the chain is not possible, thus rendering the information tamper-proof. The key innovation in blockchain technology is that it allows its participant to transfer assets across the internet without the need for a centralized third party.

2. HOW LOGISTICS MANAGEMENT WORKS TODAY:

The logistics management, the management of flow of goods and service, involves the movement and storage of raw material of work in process, inventory and of finished goods from origin to point of consumption. The process of shipping freight can occur across many channels, including air, sea, rail or truck. Four major entitles make up the lifecycle of any shipment, regardless of the channel being used. Shippers are the customers of the logistics services; they are the actors who have freight and need it transported.



Shippers are the customers of the logistics services; they are the actors who have freight and need it transported. Brokers coordinate carriers to organize multimodal orders. Carriers provide freight transportation services and drivers are the operators of a single vehicle in a fleet.

3. PROBLEMS WITH CURRENT LOGISTICS MANAGEMENT:

- Bad tracking- For the end user the regulatory and reliability of shipping status update is primary concern in the perceived quality of a shipping experience. If a package late or low, but has regular update, customers are less likely to complain or file chargebacks against merchants. But the shipping industry has not kept up. Tracking problems lead to confusion among carriers, failed handoff, failed deliveries and even lost shipments. Economically, this is a disaster, lost efficiency, wasted fuel and missing products combine to cost the shipping industry billions of dollars per year- costs that broker rarely cover and ultimately pass it to the shippers.
- Lack of transparency- The current supply chain management lacks transparency. The shippers are not known how their freight are being carried due to broker involvement. According to the supply chain resilience report 2015, 31% business said that they did not analyze the supply chain to identify the original source of any disruption they experienced because of the supply chain lacking transparency. This failure means that many are sleepwalking into their potential destruction.
- No accountability- The US Federal Bureau of Investigation estimates annual cargo theft losses exceeding $30 billion USD in 2016 and rising, with an average theft value of $190,000. Cargo theft raises prices across the industry approximately 20%, negative impacting all customers of the shipping industry –nearly every person on

earth. The combination of tracking and transparency failures together lead to a lack of accountability. As brokers withhold information on who is moving which cargo and fragmentation amongst carrier causes uncertainty where the cargo is at any given time, shippers often have no way of knowing who is responsible for the cargo. Handoffs are one of the largest sources of error in freight, with neither side wanting to take responsibility for a container that didn't make it from the ship to a truck.

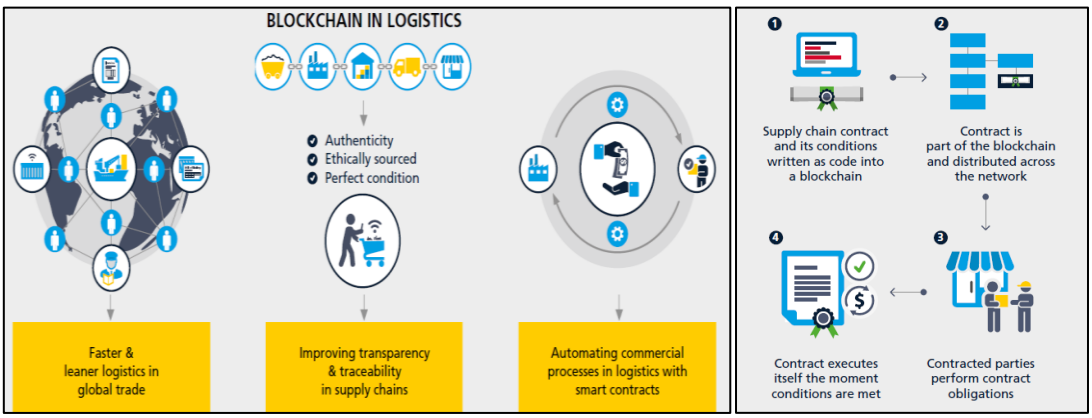
- Middleman Markup- Brokers and forwarders are largely to blame for all of the above issues, acting as gatekeepers to the industry and incentivizing poor transparency and tracking practices and yet they typically charge a significant premium sometimes 30-50% for their claim of making freight easier to manage and ship. In reality, their high maintenance increases the cost of freight and decreasing what carriers get paid.

4. HOW BLOCK CHAIN WILL SOLVE THE ABOVE PROBLEM:

- Tracking and Transparency- The blockchain will create individual encrypted geographic waypoints across each small contract. With this system, the meaning of each waypoint will be encrypted, accessible for interpretation by only the parties involved. This will give shippers more visibility across their logistics chain and allow carriers to communicate with ease, reducing delays and miscommunications. Information about loads, geo-waypoints and basic compliance information will be recorded and publically validated. Upon delivery and conformation, the contract will be completed and recorded on the main blockchain, releasing any payment. By using blockchain, smart contract could completely eliminate the need for all these administrative steps cutting costs and virtually removing all possibilities for error. If we consider the fact that administrative costs can make up 20% of the overall costs of transportation, the amount of money saved by using smart contract could be staggering.

  **Smart Contract are essentially self-executing task that are coded through the blockchain and executed when a certain condition is met. To use a basic example if a company wants to release payment to shippers when an item reaches its destination that company can program a smart contract to automatically pay the shipper when the item has reached specific location.

- Decentralized Brokerage-In the current system, freight brokers exist to facilitate the transactions of loads from shippers to carriers; they are typically asset-light and focused on sales. Brokers find loads, mark them up and sell them to a carrier, which increases the cost of shipping and reduces profile for carriers and their crew.
  Blockchain will supplant the need for brokers by allowing carriers the ability to find shipments and intelligently route their team for multimodal transportation based on factors such as distance, traffic, weather conditions fuel use and more. This load system will generate a smart contract upon pick-up and will hold payments in escrow until conditions for release are met while using the blockchain and side-chain for tracking and cargo security monitoring
- Asset Security- Deploying blockchain technology into freight industry to encode geographic data will increase cargo visibility and thereby dramatically decrease theft. By using barcodes or hardware RFID integration, assets can be automatically verified each time electronic logs are reported, increasing security and providing peace of mind for all parties. Per missioning, immutability and encryption are inherent benefits of blockchain technology, allowing select individuals to access, examine and add critical transport data but no one will have the ability to change or delete existing data. By bringing accountability to every step of the process, the blame game between carriers, brokers and shippers is mitigated.
- Trustless Incentives- By encoding and encrypting waypoint information and data about which loads belong in a shipment, digital escrow can be used to fairly assess whether goods actually arrived in a particular shipment. Conflicting accounts of the whereabouts of goods are eliminated and individual players can be rewarded for their participation in a system that operates without trusting any particular party's story about what happened.



5. HOW BLOCKCHAIN WILL INFLUENCE THE LOGISTICS SECTOR OF INDIA:

- If there is any one impediment that's coming in the way of India in becoming a super economic power that is logistics. India' s logistics sector is highly defragmented and costs around 14% to GDP currently and India ranks 35 in LPI (Logistics Performance Index).
- Blockchain has significant potential to increase efficiency along entire logistics and settlement process including trade finance and help to resolve disputes in the logistics industry. As digitized document and real time shipment data become embedded in blockchain based system this information can be used to enable smart contract. These contracts can automate commercial process the moment that agreed are met.
- With validation of electronic contract in India the smart contract of blockchain can also be considered valid and enforceable.
- With collaboration and co-operation between various public and private entities of all kinds-government agencies, industrial organizations, regulators, partners and even competitors, blockchain technology can be implemented in logistics sector. It will make easier for the regulator agencies such as CUSTOMS, DGFT, FSSAI and CDCSO etc. to provide clearance to the goods as every information about freight will on a smart contract. It will drastically decrease the cargo release time and will further bring down the logistics cost.
- The blockchain in logistics can help India in achieving dream of bringing down GDP logistics cost to 10% and improving India's ranking in world bank LPI (Logistics Performance Index).

6. CONCLUSION AND OUTLOOK:

- Blockchain technology is emerging from its deployments in crypto currency and is now likely to have significant impact across almost all industries. Like a pebble dropped into a lake, the ripples from this technology are beginning to expand outwards in all directions including the logistics industry, where blockchain

promises to make business processes more efficient and facilitate innovative new services and business models.

- Already many projects are underway to apply blockchain technology to global logistics, adding value by boosting supply chain transparency and automating administrative operations. In future we can anticipate blockchain technology will intersect with other innovations to amplify impact. Imagine how physical flow of goods can be more effectively orchestrated and synced with information and financial flow when blockchain is combined with the IoT, artificial intelligence, robotics and more.
- Moving from today's era of providing concepts and piloting applications to actually deploying productive solutions at scale will require further technology development, organizational transformation and crucially collaboration between all stakeholders. Success depends on all parties working together to transform legacy processes and to jointly adopt new ways of creating logistics value. In the highly fragmented logistics industry, consortia that bring together stakeholders will play key role in achieving blockchain's potential in the industry.
- Despite all the hype surrounding blockchain today, we believe that the logistics industry needs to leverage new technologies and embrace ways of rethinking old processes in the digital era. While there are still many challenges to overcome, we invite you to explore with us the opportunities that blockchain presents. By joining forces, we can create the right foundation for successful industry adoption of blockchain and we can ultimately unlock new value in logistics.

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DISTRIBUTED DATA NETWORK OF INTELLIGENT SHIP BASED ON ARTIFICIAL INTELLIGENCE

Cadet Avishek Ankit

Abstract

Based on the requirements analysis of data storage and application, the paper proposes a new design of the distributed data network platform of intelligent ship. Furthermore, the paper also discusses the application of distributed database and the pre-processing of ship data in ship network platform. And the design will provide powerful data support for intelligent ship management and application.

Keywords- Intelligent Ship, Network Platform, Distributed database, Data pre-processing

1. INTRODUCTION:

With the increasingly diversified and complicated functions of the intelligent ship system, the ship data presents the characteristics of massive and high-dimensional, which make the traditional ship data network management platform cannot meet the need of modern ship applications. In addition, networked, refined and intelligent management has become an essential condition for the survival and development of Marine transportation industry, and the key to this trend development is the reasonable management and application of ship data, thus promoting the continuous development and innovation of ship data management mode. The proposed intelligent ship distributed data network management platform combined with the inherent characteristics of intelligent ship system and the diversity of ship application demands in this paper can improve the ship data management efficiency to a certain extent.

2. STRUCTURE OF INTELLIGENT SHIP'S DISTRIBUTED DATA NETWORK:

The data of the ship is heterogeneous and multi-source, including ship position, speed, course, wind direction and wind speed, water depth, steering Angle command, operating condition of the main engine,

alarm of the main engine, cargo temperature, humidity, etc. The above data correspond to the ship's GPS, gyrocompass, log, detector, host monitoring system and refrigerated container sensor, etc. These equipment models and interfaces are various, which bring great difficulty to data collection. In addition, for the host status parameters, alarm

information and cargo information that must be obtained, the signal quantity and signal type of different ships vary greatly, and there are problems such as large space distance, long communication distance, more signal points and more cables between them.

Therefore, the distributed data network platform of ship discussed in this paper will be based on the above problems. In addition, the intelligent ship's distributed data network platform integrates data collection, fusion, analysis and remote transmission. Through data collection and analysis, the intelligent network platform management, intelligent energy efficiency management, intelligent navigation management, intelligent engine room management and other comprehensive management can be achieved.

The distributed data network platform of intelligent ship adopts three-layer and four-level structure. From the perspective of data, it can be divided into four parts: data collection, data transmission, data storage and data application. (As shown in figure 1)

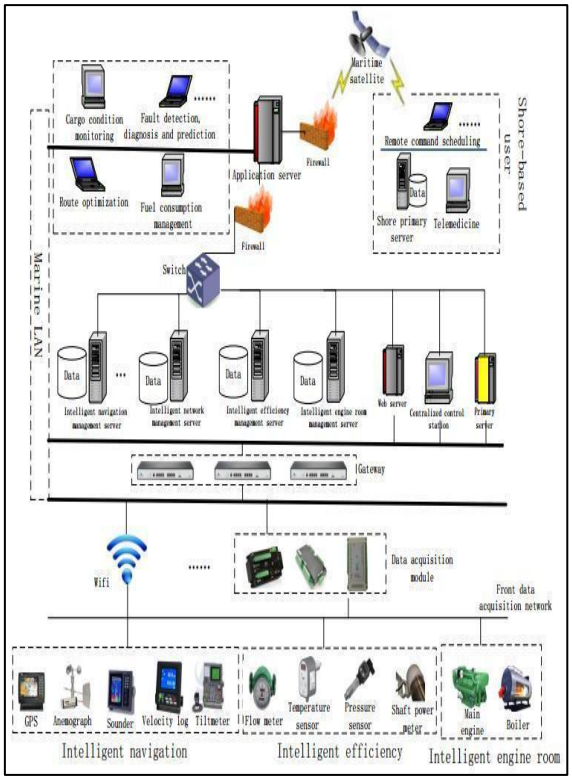

Figure. 1: Distributed Data Network Platform

(Source-ddbnic.in)

Using sensor technology, wireless access technology, embedded data acquisition module and video monitoring equipment, the ship data can be comprehensively

collected. The specific collection objects and contents include: Navigation parameter (the ship location information, speed, track, wind speed, wind direction, steering commands and to respond to and echo sounding, etc.), engine room monitoring information, the host system, fuel system, oil system, cooling water system, exhaust system, air system, steering system, anchor system, boiler system and auxiliary system, etc.), Marine environment information (typhoon path and sea condition, etc.) and reefer container temperature information, video monitoring, etc. Taking ship engine room for example, as the most concentrated part of ship system equipment, the data collection and processing of ship engine room is a relatively large work. This process often involves processing hundreds of thousands of digital, analog, and frequency signals at the same time, as well as providing alerts and control commands for specific situations. The platform directly acquires the engine room monitoring data from the intelligent engine room management application through the data interface, and outputs them in a standard format and stores them in the database. For intelligent navigation, the sensor converts the meteorological data into the digital signal required by the data collector for the measurement. The data acquisition module connects various functional plates through the bus to collect and process each sensor signal of distributed configuration, and the processed data is transmitted to the database in a wired way.

The data transmission of the equipment on the ship and the data transmission between the servers are mainly connected via wired and wireless LAN. And when the ship is near the shore, wireless LAN, radio and 3G/4G are used to access Internet communication. The communication between ocean-going ships and shore-based mainly relies on the maritime satellite communication system: after the analysis and processing of relevant data through the shipboard application server, data packets will be transmitted via the satellite ground station to the onshore network data network platform via the Internet through the Web server and maritime satellite communication equipment.

In order to improve the storage capacity and security of ship data, the platform establishes distributed database. After collected, the ship data is stored to each storage node through the data transmission network, and then the storage node makes reasonable data backup and data pre-processing order to improve the utilization efficiency of data, the original data will be preserved reasonably in each storage node,

and the pre-processed data will be stored in layers. According to different data models corresponding to basic applications (such as fault detection of engine room equipment, etc.) and advanced applications (such as ship dispatch, etc.), the required data are stored to corresponding layers.

Data applications are mainly divided into two parts: ship application and company application. At the ship end, the data collected by the sensing layer can be transmitted through the network layer to expand the application related to ship navigation and cargo monitoring and management. The application of the company terminal can be divided into two parts: the secondary company and the parent company. Each secondary company receives the information transmitted by the ship terminal through the network layer to carry out the operation level of ship dynamic monitoring and scheduling, cargo monitoring, emergency disposal, remote medical treatment, ship fuel consumption management and so on. In addition to the functions of secondary companies, the group head office system can also carry out macro management applications such as comprehensive analysis and auxiliary decision-making.

For the intelligent ship's distributed data network management platform, data storage is a crucial part. The optimization degree of data storage will largely determine the efficiency of data management and application.

3. DISTRIBUTED STORAGE OF SHIP DATA:

Distributed database is an important part of the ship distributed data network platform and its optimization degree is the key to the ship data management efficiency. The common ship distributed database is a relational database, which is easy to use, easy to maintain and can be used for complex queries. However, with the increasing of ship data volume, the relational database gradually reveals many problems that are difficult to overcome. For example, due to the diversification and refinement of ship function application services, concurrent load increases during database op damage. In order to satisfy the secure storage and management of intelligent ship system data, the database should have high availability, high performance, autonomy and centralized.

Control operation. If the database cannot withstand such high concurrency, it may cause database crash, user data loss or damage. In order to satisfy the secure storage and management of intelligent ship system data, the database should have high availability, high performance, autonomy and centralized control structure.

The intelligent ship's distributed data network platform adopts distributed database, and its structure is shown in figure 2, including distributed data storage node and database engine.

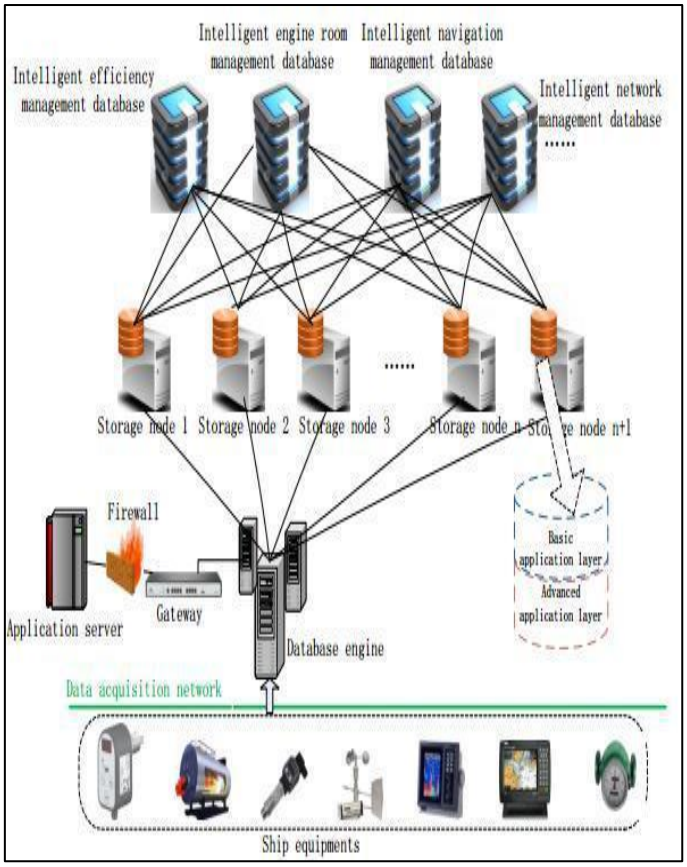

Figure.2. Structure of distributed database
(Source: marinetech portal)

The distributed database engine is the core of the system, which is responsible for SQL parsing, rewriting, execution and other operations, while managing the underlying storage nodes. Distributed storage nodes use relational databases and are mainly responsible for data storage, processing and synchronization. In the process of ship data management, database clusters of different sizes can be flexibly constructed. By dividing business data into different database storage nodes, the pressure of ordinary database on massive data can be greatly reduced. Requests that have been passed

through SQL will be distributed to each node's idea workstation for execution, which will take advantage of the compute resources of each node to improve the efficiency of the ship system server cluster.

Based on the distributed database infrastructure, each data storage node under the distributed database cluster is divided into several layers. Both layers of the database should have the same standard configuration. The data collected by the data collection network of the vessel equipment is stored in the real-time library, sequence library and relation library respectively after the data pre-processing. The sequential database belongs to the extension of the real time library in memory, and mainly holds the data sequence that changes rapidly in order. Some individual measures can be changed over a period of time all the data stored in the real-time library. For the stratification of the storage node, one of the layers serves the ship foundation applications, such as the host speed control, cabin temperature regulation, etc. The other layer serves the advanced applications of the master station or shore-based users, such as cargo status inquiry, shore-based ship dispatch and emergency command. This classification method can realize more refined, efficient classification management of ship data, and differential treatment of system security, professional business, advanced application and rapid response of business analysis.

The advantage of this design is built on the premise that the sub-station server, the master server and the application server and other related servers are well configured with the corresponding data model. When shore-based users or ship workstations send application requests, they can quickly and efficiently extract data from distributed database accurately, so as to avoid the disadvantages such as congestion and time consuming of ship data network caused by traversing data.

4. PREPROCESSING OF SHIP DATA:

The data collected by ship monitoring and acquisition equipment will be stored to each storage node under the distributed database by the pre-data collection network and the SQL engine. Due to the inherent problems of ship monitoring equipment and impurity factors of data transmission channel, the "dirty data" inevitably exists in each storage node. Ship "dirty data" mainly includes missing data and redundant data. The existence

of these two kinds of data will lead to the incompleteness and reproducibility of data sets. While wasting valuable data storage space, it will also cause great deviation to ship fault diagnosis and other applications.

At present, a relatively simple and effective missing data method is the nearest neighbour filling algorithm based on clustering analysis, which combines Mahala Nobis distance and Grey analysis to calculate K nearest neighbours. This method can improve the accuracy of numerical filling, reduce the limitation of recording attribute, and expand the application scope.

For the problem of ship data redundancy, the existing methods of detecting similar repeated records are mostly based on the idea of ranking records in the database. The main methods include key generation to sort records, n-gram method, priority alignment algorithm and so on.

In order to meet the demand of potential application for raw data, the original data is not fully covered in the process of data pre-processing. The original data were selectively covered with the data with high integrity and validity after data pre-processing.

The application server will be extracted from the distributed database according to the requirements. The process of ship "dirty data" pre-processing is shown in figure 3.

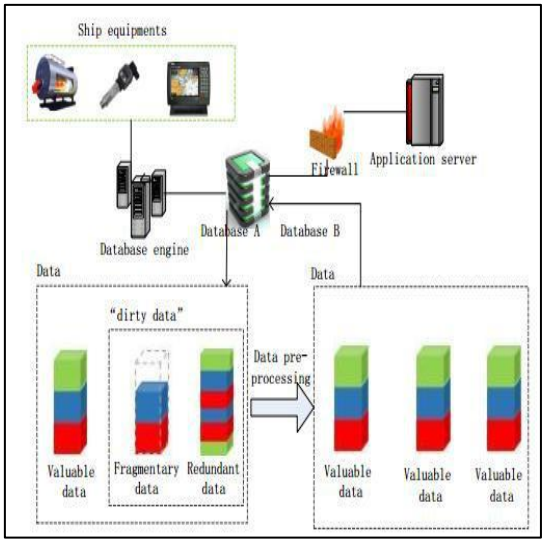

Fig.3. Pre-processing of ship data
(Source: intelligent ship archives)

For the intelligent ship distributed data network platform, reasonable data pre-processing can not only improve the ship data storage capacity, but also greatly boost the data utilization efficiency. Taking intelligent energy efficiency management as an example, due to the complexity of influencing factors of energy efficiency management data model, the direct extraction and management of relevant raw data not only consumes database management resources but also greatly reduces the reliability of energy efficiency management scheme. Therefore, reasonable data pre-processing is also an essential part of the intelligent ship data network platform, which combines with distributed database to facilitate the efficient development of intelligent ship data network management platform.

5. CONCLUSION:

The distributed data network management platform of intelligent ships discussed in this paper takes ship application demand as the fundamental starting point and conducts targeted research according to the inherent characteristics of intelligent ship system.
This platform not only makes up for the defects of the traditional data management platform, but also has the advantages of "comprehensive perception, reliable transmission and intelligent application", which can be applied in the management of ocean shipping. It can establish a security monitoring platform integrating various departments of shipping enterprises and ocean shipping.

In addition, the distributed data of ship data network platform will greatly enhance the ocean shipping goods transportation safety, navigation safety, the monitoring and control system and the fuel consumption and other aspects of security, reliability, efficiency, become the vessel intelligent management and application provides powerful data support.

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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.

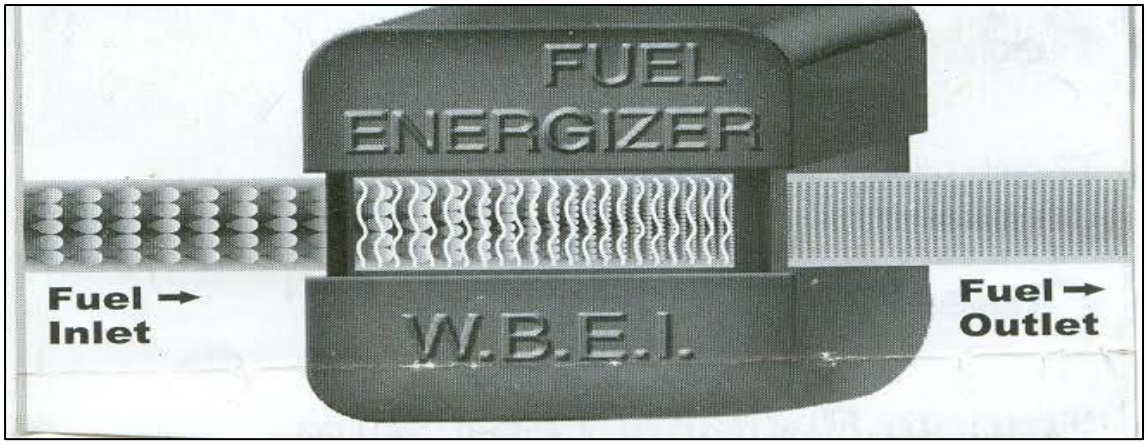
Keywords: MFE – Magnetic fuel energizer, HC – Hydro-carbon, CO – Carbon mono-oxide, NO – Nitrous oxide, Co2 – Carbon di-oxide, IC – Internal combustion, HFO – Heavy fuel oil

1. INRODUCTION:

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 CO_2, water vapor and nitrogen from air which does not participate in combustion. Practically the exhaust gases contain CO, H_2, HC, NO_X 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 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

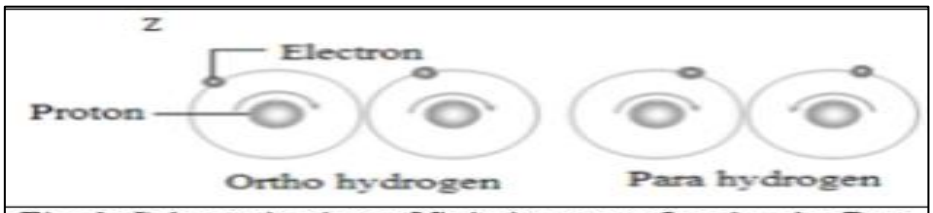


Fig. 1: Schematic view of Spin isomers of molecular Para and Ortho state of Hydrogen

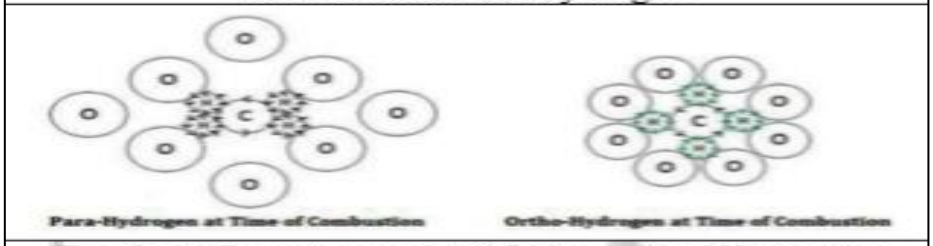


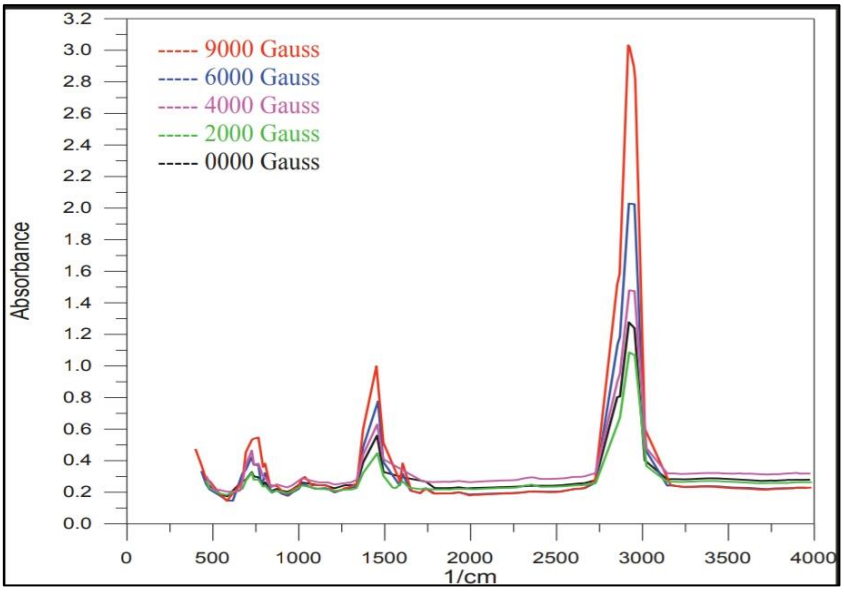
Fig. 2: (a) Para state and (b) Ortho state of Hydrogen

When the fuel passes through a magnetic field, created by the strong permanent/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 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:

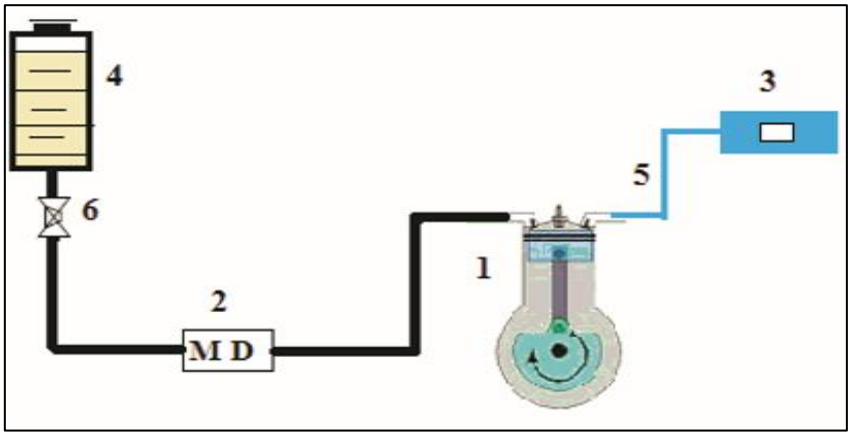
- INSTALLATION POSITION- The location of MFE should be as close to the engine as possible in order to prevent loss of magnetizing action of the fuel into the surrounding environment. The best suitable location is between the fuel pump and the fuel valve/fuel injector, precautions should be laid by installing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



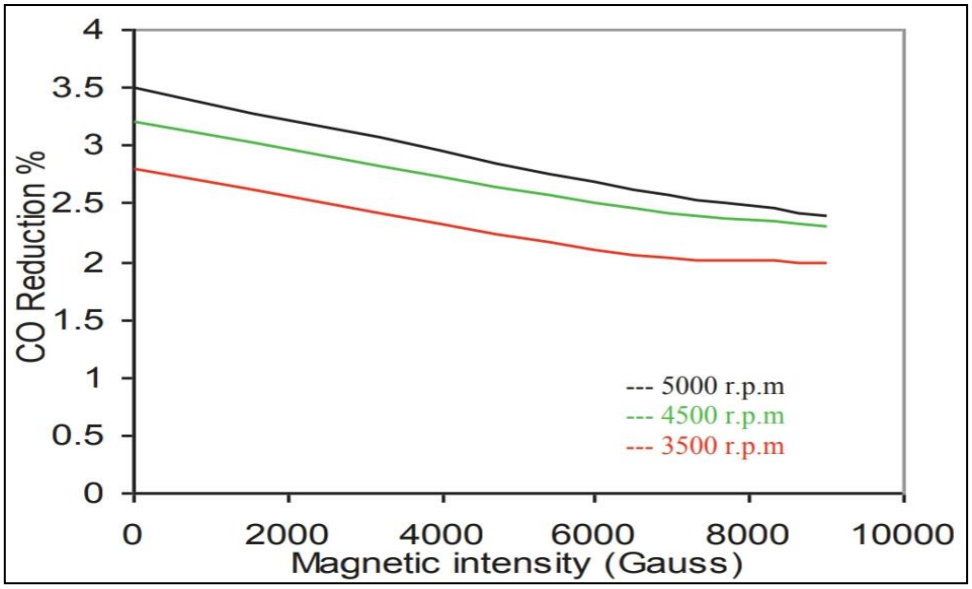
The above set-up shows a single cylinder 4-stroke diesel engine with the power rating of 5.5 HP. This set-up was meant to be made in order to find out the efficiency enhancement in the system by including MFE. The system was run on three distinct speeds termed as low (3500 rpm), medium (4500 rpm) and 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-

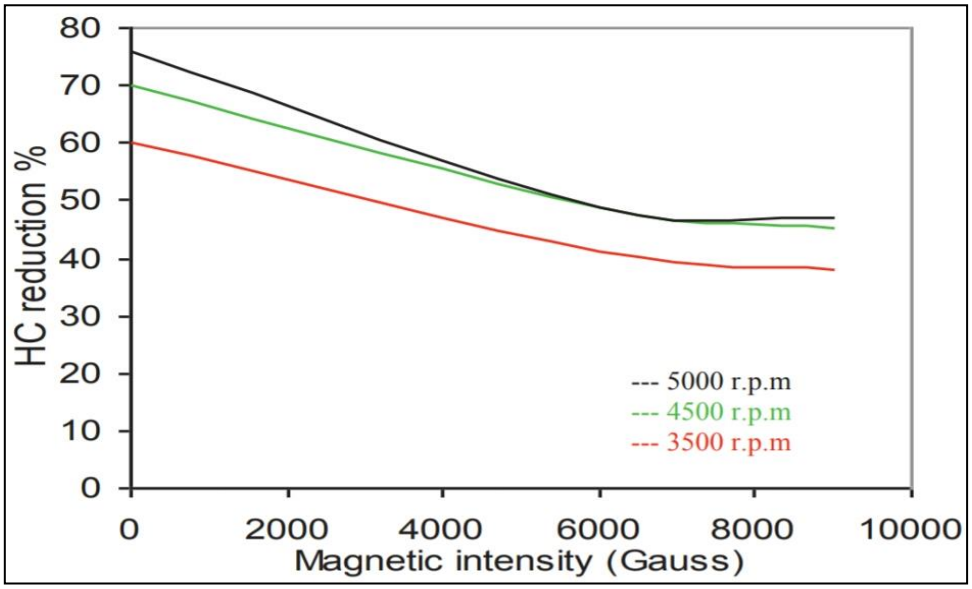
1) Single cylinder engine.
2) MFE.
3) Exhaust gas analyzer.
4) Diesel oil tank.

5) Exhaust piping arrangement.
6) Diesel oil feed valve.

Amount of Reduction in HC and CO Emissions-

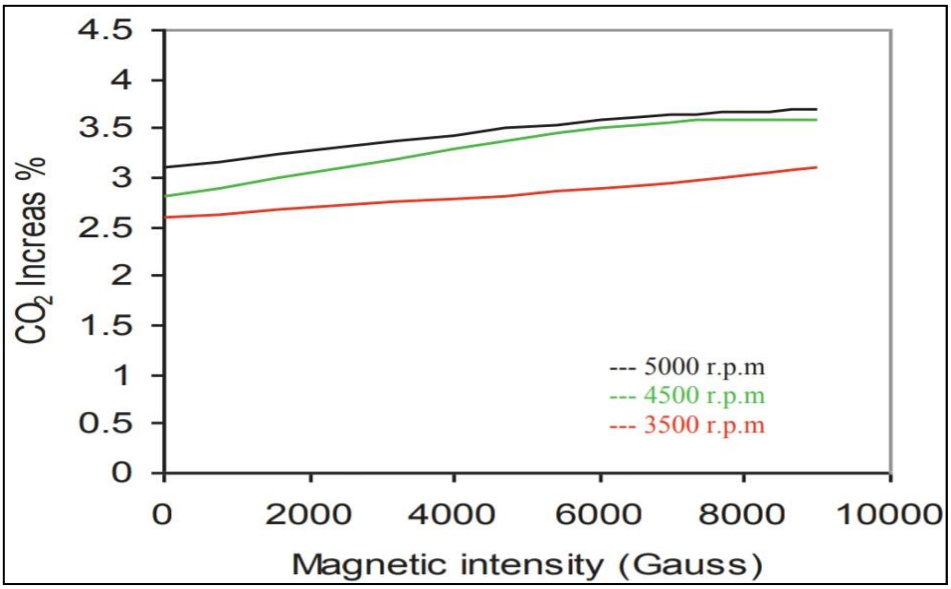
The percentage of exhaust gases which measured during the operation of the engine for three distinct speeds before and after magnetic treatment has been shown in the given below graphs. It was found that the reduction percentage of the gases (HC and CO) is up to 30-40% respectively.





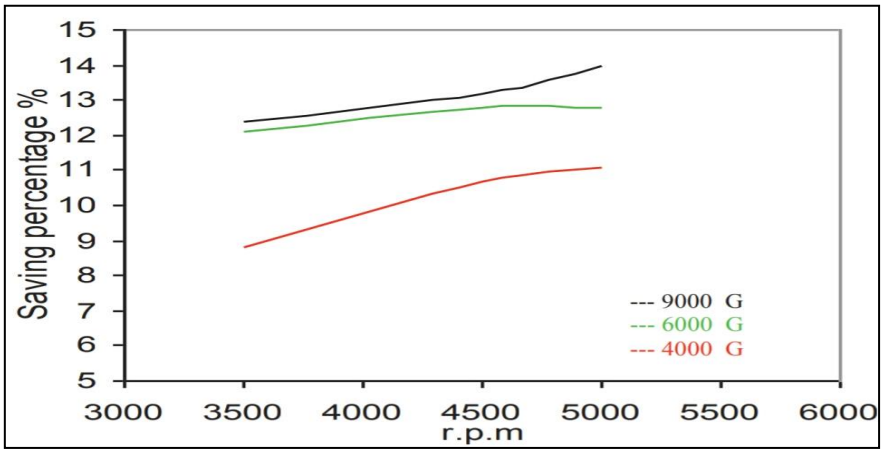
Increase in amount of CO_2 production-

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 CO_2.

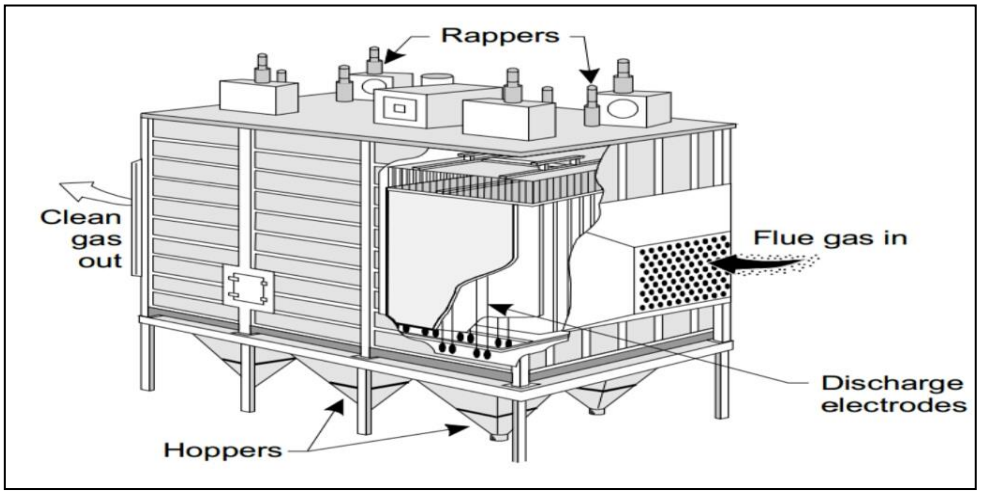


SAVINGS ACHIEVED BY THE INCORPORATION OF MFE IN THE SYSTEM-

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 ship-owners 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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USE OF ENERGY EFFICIENT OPTIONS FOR EMISSION CONTROL

Angit C. Anil
Bhanu Sudheer
Avik Halder

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.

NO_X EMISSION CONTROL

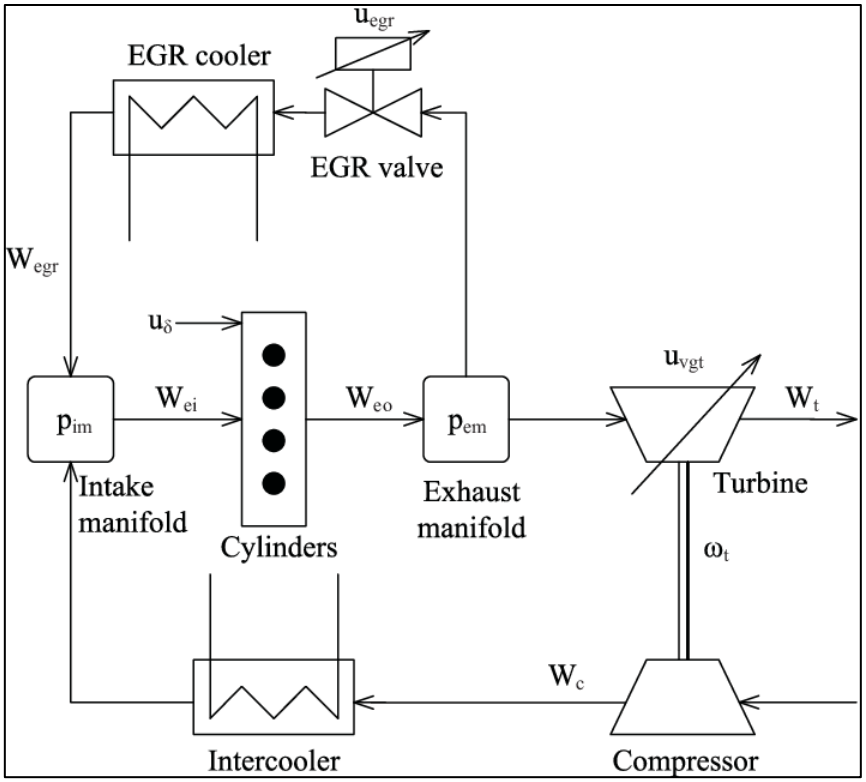
- Exhaust gas recirculation
- Selective catalytic reduction
- Humid air method
- Water injection and water emulsion

SO_X EMISSION CONTROL

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

1.1. Exhaust Gas Re-Circulation (Egr):

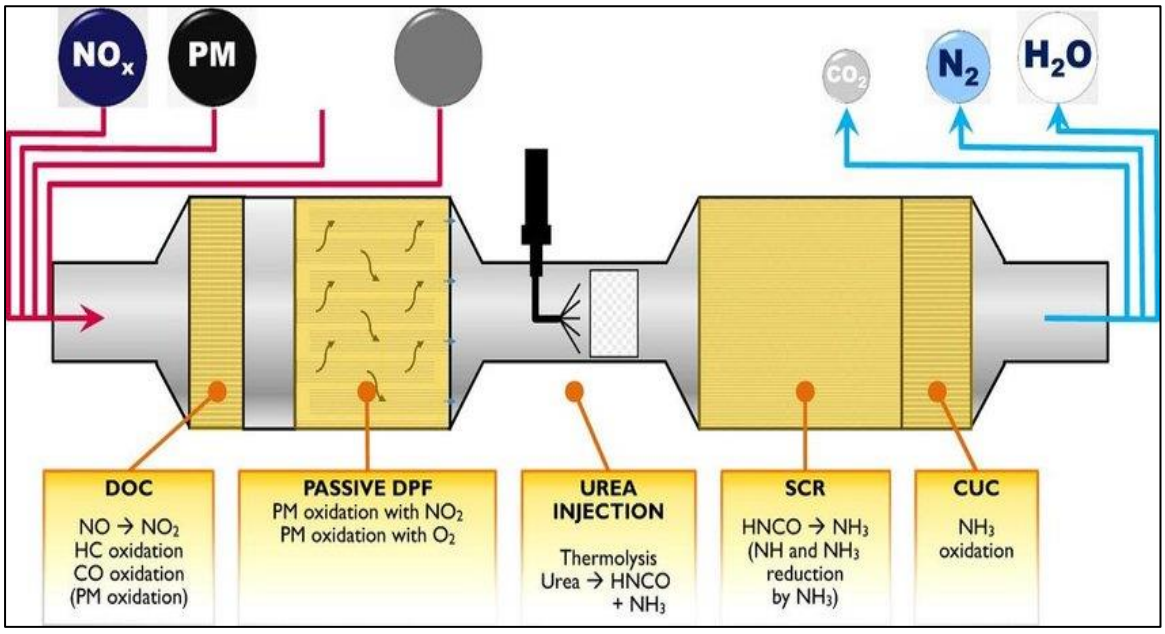
Exhaust gas recirculation is an emission control technology allowing significant NO_X emission reductions from most type of diesel engines. EGR is a method in which a portion of engine exhaust gas is recirculated to combustion chambers through inlet system. This method involves displacing some of the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



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 Catlytic Reduction:

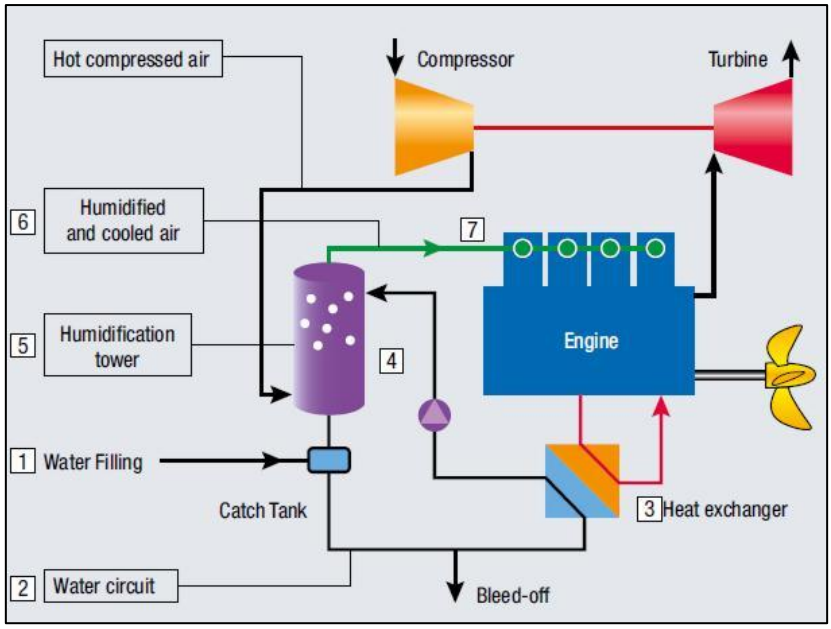
Selective catalytic reduction (SCR) is an advanced exhaust after treatment system to reduce NO_X. The engine controls the formation of particulate matter (PM) by increasing the combustion temperature thus limiting it with in the permissible level. SCR spreads aqueous urea solution (AUS 32) into the exhaust stream using a dosing pump. Ammonia from AUS 32 combines with NO_X in presence of catalyst to form harm-less by products like nitrogen and water vapor. AUS 32 is also known as diesel exhaust fluid (DEF).

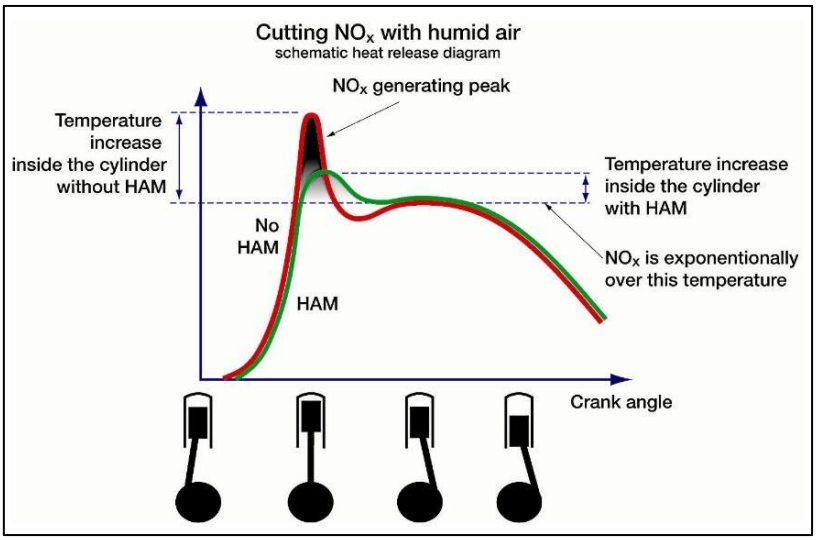


SCR system is a simple system that offers better power and high fuel economy due to higher combustion efficiency. clean combustion ensures higher reliability of engines.

1.3. Humid Air Method (Ham):

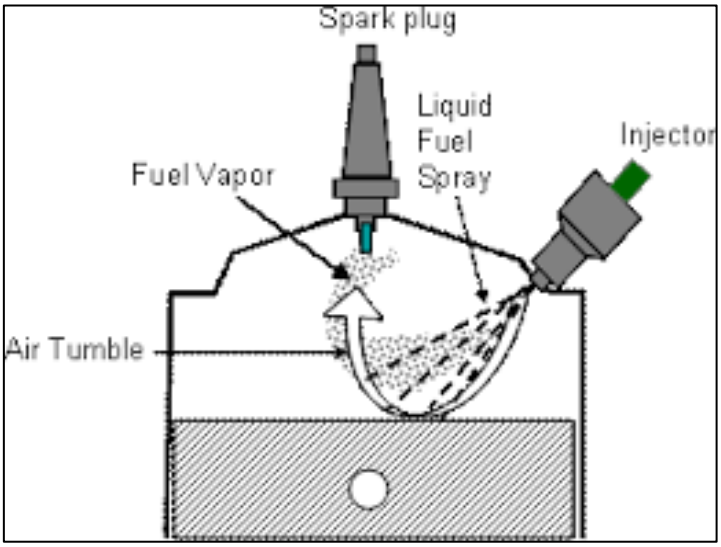
It is well known that 90% NO_X formation results from combustion temperature peaks. It can be controlled by the cooling effect. The principle of HAM is to humidify the inlet in order to lower the temperature peaks.





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_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_X relative reduction. This result can be used to define optimum water/fuel ratio.

Similarly, for SO_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_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_X, PM and SO_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.

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PROSPECTS OF INLAND WATERWAYS IN INDIA

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Parth Raizada
Ajay Kumar

Abstract

With the increasing impacts of the transportation services leading to a lot of damage to the environment, the need to find alternative and sustainable means of transport is at an all-time high. One such method of the task being Transportation through Inland waterways.

India has the potential for development in the sector of inland transportation but the various constraints regarding the geographical conditions in certain areas need consideration before implementation.

Also, considering the implementation barriers, the government also has to calculate appropriately if or not investment in such a high-end project is worth it. Some of the factors that influence the implementation of the Inland waterway transport (IWT) in India are the commercial potential of the system, the operational potential, the traffic or the cargo movement, etc.

For all these factors different steps have to be take but given the growth of major cities (especially port cities), development of water-based transportation has become a necessity. The implementation is also necessary because of the fact that a water-based transport system is not just important for in-city based traffic but also because of its sustainability. Water based transportation today is one of the cleanest modes of transportation and an efficient water transportation system has always boosted the economy of a country as a whole.

This paper aims on discussing the potential of Inland waterway transportation system being developed in India and the various areas that need investments for the same along with the potential of enrichment in all the factors affecting the implementation.

Keywords: Inland waterways. water transportation the cargo movement, Passenger movement.

1. INTRODUCTION:

Water transport is effective in general due to the low cost to the environment and specifically low costs of operation in general as compared to their contemporary travel methods (air and road transportation). The availability of the method of the transportation, waterway is naturally available, which is then modified according to usage. Transportation between port cities has proved to be extremely useful in the long run.

1.1. Policy Motivation:

Even though funds have been allotted in the 9th and the 10th plans to the sector, the sector has not been able to utilize the funds allotted effectively. It still continues to be eyed for investments. For example, an ADB (Indian infrastructure, 2004) planned 300 crore investment. The IWT is recognized as an important segment of the overall

maritime policy of the country. The following can be the main policy questions (in the context):

1. Is the IWT worth investing? Where precisely and to what extent?

2. How do major institutions play a role in this? (IWAI being the most important)

3. Who exactly are the major collaborators in the sector and how are their concerns taken into account?

1.2. Scope of the Research:

Forming about a ton-km movement amongst the countries across the world, this mode of transportations unquestionably holds a lot of potential. IWT holds 32% of the transportation and 20% in Bangladesh (Rahman Mushfequr, 2004). In India however, the usage of the IWT has been marginally reduced to a mere 0.15% (Raghuram G, 2004) of the total transport movement in absolute terms along with sharing of other modes. The research also focuses on pin-pointing the exact reason of this. Though the investments made in this sector are not paralleled to the investments in the railway sector in the former few years or to the investments made in road transportation in the earlier times, proposals for investing in this sector have now started becoming prominent. The research finally provides an opinion for the government and other players on the commercial potential of their investments and involvement both.

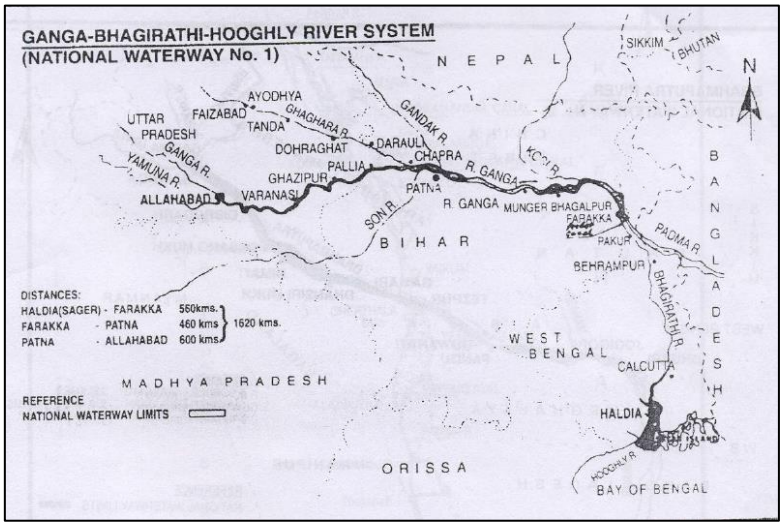
1.3. IWT in India.

In some areas, historically, the IWT has been a viable means of transport. At the present, there exist 3 national waterways in India, namely: NW-1, the Ganga-Bhagirathi-Hooghly system, extending from Prayagraj to Haldia, NW-2, the Brahmaputra system in Assam and the NW-3, the west coast canal system in Kerala. The most important section being the small tidal riverine system in Goa, commercially, consisting of the Zuari and the Mandovi rivers and the Cumbarjua canal. According to the in-principle navigable waterways, there exists a large number of possibilities. But the ones holding potential are the inlets of the riverine along the coast. These also consist of the ports and some of the canal systems that belong to large water development projects. If the

river interlinking project in India is found of consisting of potential, an opportunity is possible. Though this seems to a long stretch at the moment.

Quite a number of studies (some being listed in the references) have revealed that for the waterways to be considered as an environment friendly mode of movements of freight on inland waterways.

Figure 1: National Waterways 1



Source: IWAI, 2004

Figure 2: National Waterways 2

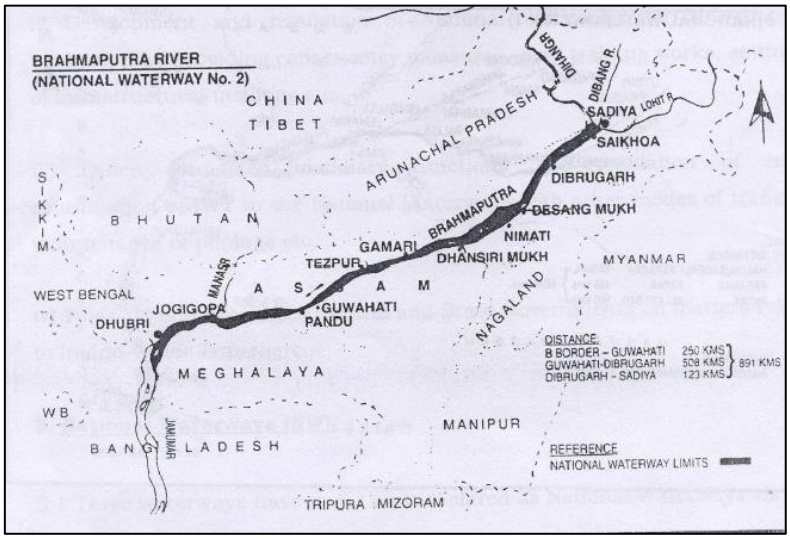
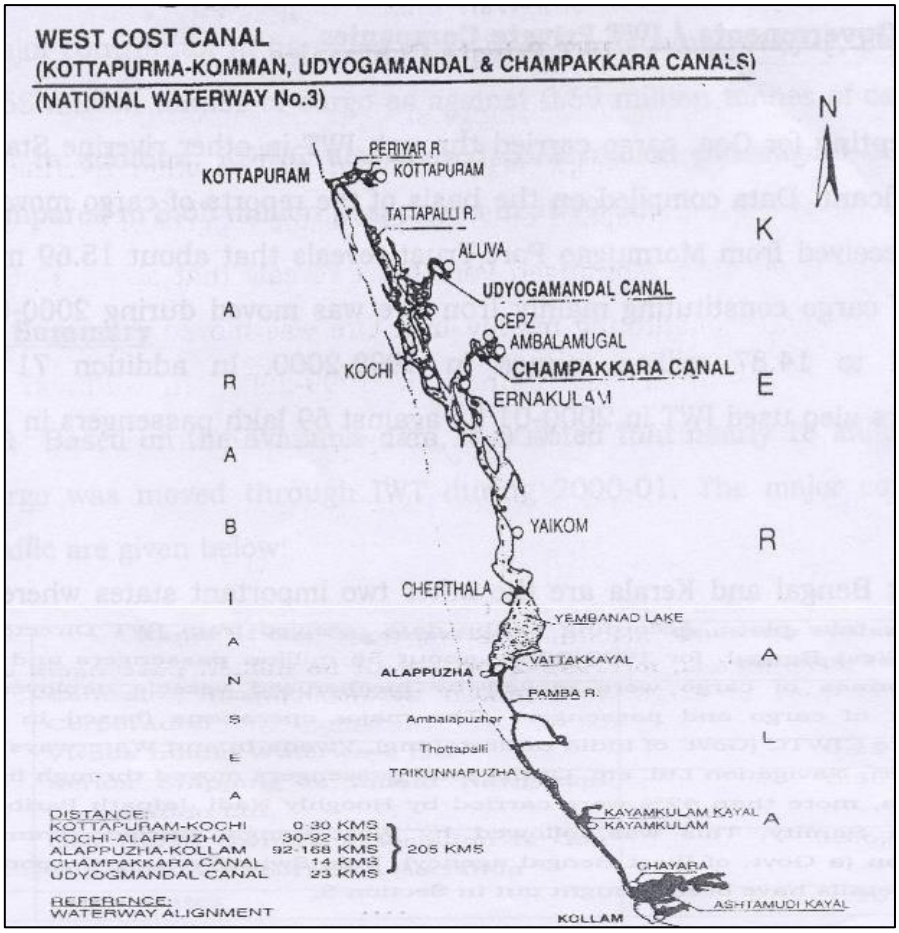


Figure 3: National Waterways 3



Source: IWAI, 2004

			Cargo Moved		
	Details of National Waterway	**Distance** (kms.)	**1998-99** Lakh Tons	**1999-00** Lakh Tons	**2000-01** (P) Lakh Tons
1	National Waterway 1 (Allahabad - Haldia stretch of Ganga -Bhagirathi-Hooghly river system)	1620	8.52	7.31	3.52
2	National Waterway 2 (Sadiya-Dhubri stretch of Brahmaputra river system)	891	0.09	0.06	0.04
3	National Waterway 3 (Kollam-Kottapuram stretch of West Coast Canal along with Champakara Canal and Udyog-Mandal Canal)	205	10.27	11.12	10.85
	Total	**2716**	**18.88**	**18.49**	**14.41**

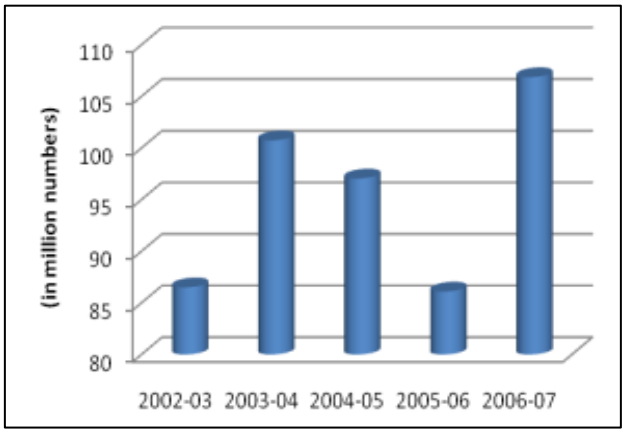
(P) : Provisional
Note : Cargo handled in Calcutta –Bangladesh-Calcutta route is taken in National Waterway 1. This route is a link between NW-1 and NW-2 through Bangladesh
Source : Inland Waterways Authority of India

2. PASSENGER MOVEMENT:

The main passenger movement in India is carried out by ferries on the inland waterways at numerous locations, on short stretches for the purpose tourism (Northern regions of Sunderban, Goa, Kerala).

The information and details about the statistics on the topic in the summary produced by IWAI, The Ministry of Shipping and state level authorities like West Bengal (TRW, 2001; TRW, 20014), Kerala, etc. Some of the factors affecting passenger movement are discussed below.

Figure 4: Passenger Carried by IWT



Travel time of the alternate land-based route*:* Though time by land-based routes is generally reduced, the construction of more routes for a single destination and the construction of bridges, etc. can lead to quite variable ETA's, in which case, it is both easier and feasible to travel by ITW for areas connected directly by water. Faster ferries is an opportunity of increasing traffic on this mode.

Cost*:* Even though for passengers the cost of travelling by ferries is not high, it has to be added to the cost of subsequent mode of transportation which can be used to achieve the end to end requirement of transport.

Interchange convenience The other modes of transportation should be able to work fluently with the waterway transportation.

Quite a number of studies have convincingly depicted the use of inland waterway transportation to play a major role in the transportation planning in urban areas. In Cochin, a study suggested that the use of Inland waterway for transportation is a method that cannot be ignored for traffic management in light of the growth of the city in the recent times.

Mumbai has already been able to experiment with faster transport such as hovercrafts but still needs a mix of sustainable transportation system.

Inland transportation can also be used for providing easier services and related activities, some of them are listed below.

Carriage of vehicles*:* A number of states (example Kolkata and Kerala) already have inculcated this service and ferries for the same matter. But the sector still stands at the potential for development for more with faster mode of transport.

Tourism: With the economic potential in tourism given the rich culture of the country, this has become a growing area with a lot of potential. Boats that provide music and dining are becoming increasingly popular in Mumbai and Goa. In Kerala, Alappuzha and to some extent, Kozhikode are centers of this activity, especially houseboats. Long distance river cruises, both as per schedule and as per a group demand are also available, though they retain an exclusive flavor. (Outlook Publishing, 2004).

Water sports This is a new sector that has some possibilities and potential in Northern and Eastern India. White water rafting and trekking on iced mountainous stretches of river are examples. (CMYK, 2005).

3. CARGO MOVEMENT:

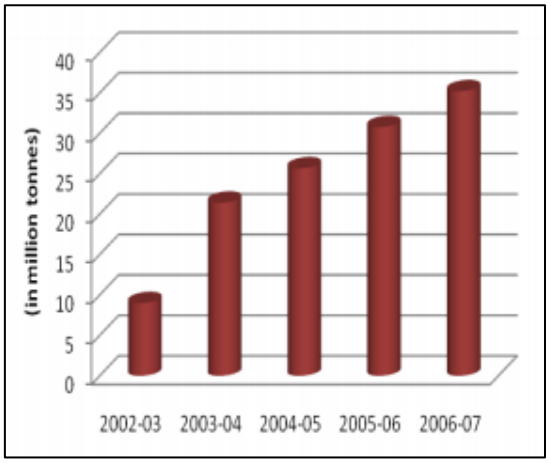
Location of industries and related activities have always been determined by the availability of water-based transport for obvious tasks, especially at a time when roads and land transport were not so well developed. As of today, though the road transport is well developed, but the consideration of availability of water-based transportation is still an important consideration.

The potential of movement of goods through the IWT has to be calculated by the potential of technology and physical potential along with commercial potential. As in the case in any mode of transport, there are factors that affect the economics and operation are the availability of canner, service at both the ends of a channel along with the management structure and other infrastructural support offered by that mode of transport to manage the flows. In the case of Inland based transportation, it comes down to the availability of the waterway, necessary facilities like the availability of smaller boats and ports and finally the management component.

Well before the rail and road transportation, in India, the transportation through the Ganga provided us with an organized transport movement and the earliest as well. Although the issue is not being discussed here, Movement and export of commodities like tea, jute, spices in the eastern parts connected to the port of Kolkata has been one of the earliest methods of commercial drivers even before the pre-independence era.

The aggregate statistics clearly state that the sector has only been growing very steadily in the National Waterways and remaining major waterways. One exception being the tidal river-canal system in Goa, which saw an unprecedented growth and saw about 30 million tons of iron ore being moved by barges on the Mandovi-Zuari-Cumbarjua system in 2003-04 (GMOEA, 2004). Providing insights and learning in the matter, this example is individually enough to state and demonstrate the potential in the sector and exploration in different dimensions.

Figure 5: Cargo Carried by IWT



Sl No	Name of the organization	Quantity of cargo moved (million tonnes) in 2000-01
1	Central Inland Water Transport Corporation	0.11
2	Vivada Inland Waterways Ltd.	0.25
3	Kerala Shipping and Inland Navigation Corporation Ltd.	0.55
4	Goa Barge Owners Association & Goa Minerals Ore Exporters Association	15.69
5	Other States	1.26
	Total	**17.86**

Source: TRW, 2002.

4. TECHNOLOGICAL AND PHYSICAL POTENTIAL:

Water flow: The only basic pre-requirement of a water-based transport comes down to the availability of water flow. In the major waterways though, this flow has decreased due to the growth of habitat, industrial and agricultural needs. Construction of dams has also been a major factor in the decrease of the extent of regular flow.

River training, dredging and navigation: The next requirement comes down to the river being trained to provide an appropriate depth especially for the type of vessels expected to ply on it. Some types of river beds need this along with maintenance of banks and periodic dredging of the river bed, in order to help maintain the required depth. Recent cost estimates of river training on Sabarmati river provide a figure of about Rs 10 to 11 crores/km (SRFDCL, 1998) on each bank. In rural areas the figures may be lower, say 8 to 9 crores/km.

In principle, the IWAI is committed to maintaining, along the National waterways, a complete year-draft of 2m. (Planning commission, 2001). Though in reality, this is not the case. One possibility stands at providing this draft strategically on appropriate channels by the calculation of potential commercial traffic on each waterway. The other method being the trail method.

Locks: The river cannot have too much of a physical drop, or else in order to manage the high difference locks have to be provided. For example, Three Gorges on the dam of Yangtze will have 5 locks for descent. (www.travelchinaguide.com)

Access of Cargo: In the waterway, cargo has to be provided at both ends in order to ensure fluent movement.

5. COMMERCIAL POTENTIAL:

From a supply point of view, inland waterway system is also efficient because of the fact that it effectively reduces cost when used for end to end logistical requirement for cargo movement.

Geographical advantage of water bridging: When the movement is across river, this is the strongest. Passenger ferry system is an example.

River based origin/destination: When the place of origin of a commodity and the destination are both on a river location, the advantage is increased.

Project based requirement of commodities: The materials required for a specific project are the requirements that lie in this area. It consists of construction material and materials related to that project. This is especially viable when the project is river based itself.

Service requirement: Physical handling is the basic requirement from door to door as far as freight is concerned. The IWT Involves the loading and unloading of cargo from the ships as well as its movement through the IWT along with the storage of the cargo on the docks.

IWT's are generally slow in movement, hence expensive cargo does not move through the IWT's unless there are physical constraints through the other modes of movement.

Competing modes: In case of the IWT's the competing modes are mainly railways and the road. In the case of load management, roads provide much lesser options though movement is faster, but the movement rates are also high. Rail provides much broader load carriage, faster movement and about medium rates.

There are examples in Kerala where load management has shifted from the IWT to other modes in the last decade.

6. OPERATIONAL POTENTIAL:

Costs: IWT is considered an intensive capital investment industry as a huge amount of investment is required in the number of vessels to start at the very beginning. Investments in infrastructure are also required to maintain and develop the waterways too. Along with the IWAI, only a few Large customers can participate in the investments.

Operating costs can be categorized as below.

- Vehicle costs
- Fuel costs
- Crew costs
- Maintenance costs.
- Loading unloading costs.

Costs regarding the contingencies are also required like running aground and the damage to vessels. These are not rare, under current given scenarios of insufficient draft, even in the national waterways.

Systems perspectives: A detailed study presented by the authors Raghuram and Rangraj in 2005 provides the insight on emphasizing the analysis of the IWT mode. This study, drawing illustrative examples of Goa and scenarios over NW-1, highlights the principles of supply chain management and the possible use of network flow models for analysis.

Fleet planning: The movement of freight also depends upon the scale of movement, as the fixed costs of the crew as well as the vessels are high. Larger vessels more draft and hence the higher water depth, but have lower operating costs. The traffic considerations are also limited by the type of traffic. Larges vessels may lead to operating restrictions and smaller vessels can cause too much congestion. This leads to a different range of sixes ad costs being offered to the customers.

7. ENVIRONMENTAL IMPACT:

Water, for some time now, has been a scarce resource in the country. A justifying explanation for facilitating transport through such a resource can be difficult. The drawing of water for drinking, construction, irrigation and other activities can lead to a decrease in the overall flow in some downstream regions, making the transport very difficult. Given such constraints, IWT mode of transportation is no more the first choice of bulk transport, a position it has enjoyed for centuries.

Although, in the all the areas it is physically possible, it is the most economical and environmental option available. Low costs of operation, low fuel usage, the ability to carry commodities in bulk and low fuel emissions back this argument.

8. CONCLUSIONS:

Freight and passenger movement, being the earliest mode of transportation The potential is sufficient enough for justifying a national body like IWAI about the nurturing of this sector. The conclusions of are study are stated below:

- **Should the government invest in the IWT?**

The sector turns up about 110 crores annually, the investments made by the government in the past decade has not been economically viable. A sufficient volume of driving cargo stream has to be developed in order to justify the investments where the natural depth of water and the navigability of the route are not adequate.

Faster vessels and goods interchange facility is required for passenger movement, which is viable in cost, but the technology lacks in the specified area. Launches carrying road vehicles offer a good opportunity and is a cost-effective proposition for the country.

With appropriate local investment, tourism and related possibilities offer good opportunities for the sector, wherever possible.

Answering the question finally, the Government should invest in the sector with considerations of the traffic and the geographical area potential. A tie up with the industrial location policy to drive demand would be essential.

- **Where should the government invest?**

The possibilities and potential for each major waterway are as follows:

1. Investment on the NW-1 should be based on integrated water use for irrigation, drinking and industry and for controlled flow.
2. NW-2 investment should be strategically planned for the NW-2 to act as an alternate route for bulk carriers.
3. NW-3 tourism and related activities.
4. New canal systems.
5. River linking projects, if pursued by the government, should explicitly provide for the IWTs.

Because of the interface with ports and a huge marine supply chain, freight traffic on some locations is successful on the IWT. A greater potential lies if the vessels are both capable of inland and coastal waters or if there is a good interlinking between the vessels of the above-mentioned areas.

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NAVIGATOR/ OOW FATIGUE DETECTION AND ALARMING SYSTEM

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Tushar Mehta
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Project Overview

Abstract

Fatigue "concerns the inability or disinclination to continue an activity, generally because the activity has been going on for too long" example (4 hours watch on bridge). The causes of fatigue can be physical, physiological, or psychological (Lal & Craig, 2001). There is no standard fatigue measurement, because the direct measures are few (Williamson & Chamberlain, 2005). Most measures are of the outcomes of fatigue rather than of fatigue itself. To overcome fatigue, human beings need to sleep. Sleep is essential and inescapable solution for fatigue. In case of fatigue, sleep will overpower any effort to remain awake (NCSDR/NHTSA, 1998). Therefore, the best fatigue measurement is drowsiness which is the clearest outcome of fatigue. Detecting drowsiness and taking action to prevent it while navigating is not an easy task. Moreover, detecting fatigue/drowsiness depending on visual information only, adds more restricts on the reliability of the fatigue measurement. This is because it depends mainly on pattern recognition of facial gestures. One of the bottlenecks challenges of object recognition, in general, is finding efficient and discriminative descriptors that are invariant even in difficult illumination.

Keywords: Safe Navigation and Operator Vigilance, Navigator/OOW Safety Assistant System, Opencv Algorithm

1. WHY DO WE NEED THIS?:

Collisions involving sleepy OOW tend to be particularly serious since the sleepy OOW doesn't have a quick enough reaction time, and is too slow to attempt to avoid an accident. Giving OOW early warning that they need to take a break is vital for safe voyage. Following are two case studies reflecting the need of this project;

CASE STUDY 1:

Helmsman's Fatigue Held Factor in Louisiana Tug Crash Killing 6
OCT. 6, 1964
Washington, October. 5 (AP) —The Coast Guard said today that the tugboat-bridge-bus accident on Lake Pontchartrain last June that resulted in six deaths was caused by the tugboat helmsman's fainting or falling asleep. The helmsman was Clifford Miley, mate on the tugboat Rebel Jr.

Although the Coast Guard officer who conducted the investigation said no Federal laws had been violated, the Coast Guard commandant, Admiral E. J. Roland, said the manning of the tugboat had been inadequate and the working hours of the crew unreasonable.

The Rebel Jr. was pushing two steel barges early on the morning of June 16 when it collided with the 24-mile-long structure that spans the lake in Louisiana. It swept away a small section of the bridge, and within seconds a bus carrying eight persons plunged from the bridge into the lake. Two survived.

The Coast Guard said Mr. Miley and the tugboat master, Ned Palmer, had been aboard the vessel almost continuously

Mr. Miley slept on June 15 but was awakened late in the afternoon and worked with Mr. Palmer and a deck hand until after midnight. The others were asleep, with Mr. Miley at the helm, when the collision occurred about 1:20 A.M. Admiral Roland ordered the report turned over to a United States Attorney "for such action as he deems appropriate."

The Rebel Jr. was owned by the Ace Towing Company, Inc., of Gretna, La., and was operated by the Louisiana Materials Company, New Orleans.

CASE STUDY 2:

Human error due to fatigue is the prime reason for the collision of two cargo ships near Ennore Port in Chennai in January last, a report of the investigating team of the Directorate General of Shipping said.

The mishap occurred at 4 a.m. on January 28, when MT BW Maple with a flag of Isle of Man was leaving the port after emptying Liquefied Petroleum Gas and MT Dawn Kanchipuram, loaded with petroleum oil lubricant was on its way to berth at the port.

Human factor due to fatigue appeared to be the prime reason for the collision, for the mishap, it said.

"Fatigue is apparent on the team of BW Maple, since the vessel had an inspection the previous day [of the incident] and the ship's master and his team rest hours were near violation," the report submitted recently said.

The Master of BW Maple was also "psychologically stressed" and that adversely affected his decision-making ability, it said.

"On verification it was revealed that he had received a discouraging mail from the managers on the vessel's performance in an audit, that was held in the same port and was not in good frame of mind," it added.

Suggesting regulation of the rest hours of the pilots and other port officials following the mishap, the findings said the draft Indian Maritime Pilots Regulations, which have been drawn by the National Shipping Board's committee may be "ratified and implemented."

The master of BW Maple did not alert the master or duty officer about the presence of another vessel which was just right ahead in close range, leading to human error and the mishap, it said.

The report also recommended that one of the lapses in the probe of the incident was the "incorrect assessment of the quantity of oil spill" and said more methods and equipment may be identified and deployed for assessment of extent of spillage.

According to the report, that the final quantity of oil spill following the collision of the two ships was estimated to be 251.46 tonnes.

2. TECHNICAL AND DESIGN CHALLENGES:

The complex interaction of the major physiological factors responsible for sleepiness – circadian rhythms and the homeostatic drive for sleep – pose formidable technical challenges to the design and development of fatigue detection systems. The technology must be robust and capable of high accuracies in diverse operational environments with constantly changing conditions and varying customer needs.

To meet the requirements of efficiency and functionality the technology should comply with the following guidelines:

1. It should measure what it is operationally and conceptually intended to measure and be consistent in these measurements over time. Thus, a device designed to measure eye blinks (operationally) and alertness (conceptually) should measure these all the time for all OOWs.
2. The software technology used in the device should be optimized for sensitivity and specificity. False negatives should be minimized through accurate and reliable detection of reduced alertness levels. False positives should be minimized through accurate and reliable identification of safe navigation and operator vigilance.

3. The device should be robust, reliable and capable of continuous operation over extended periods, such as a shift. Maintenance and replacement cost should not be excessive.
4. Be capable of real time monitoring of navigator or operator behavior.
5. The device should be capable of accurately operating under various operational conditions during the day, at night and under illuminated conditions. Accuracy should not be compromised by conditions in different climatic conditions, such as humidity, temperature, vibration, noise, etc.
6. Audible warning signals should not startle the operator and should be adjustable over a reasonable range. The signals should be distinct and audible under operating conditions to not be confused with other alarms and signals.

3. HOW DOES THE SYSTEM WORK?:

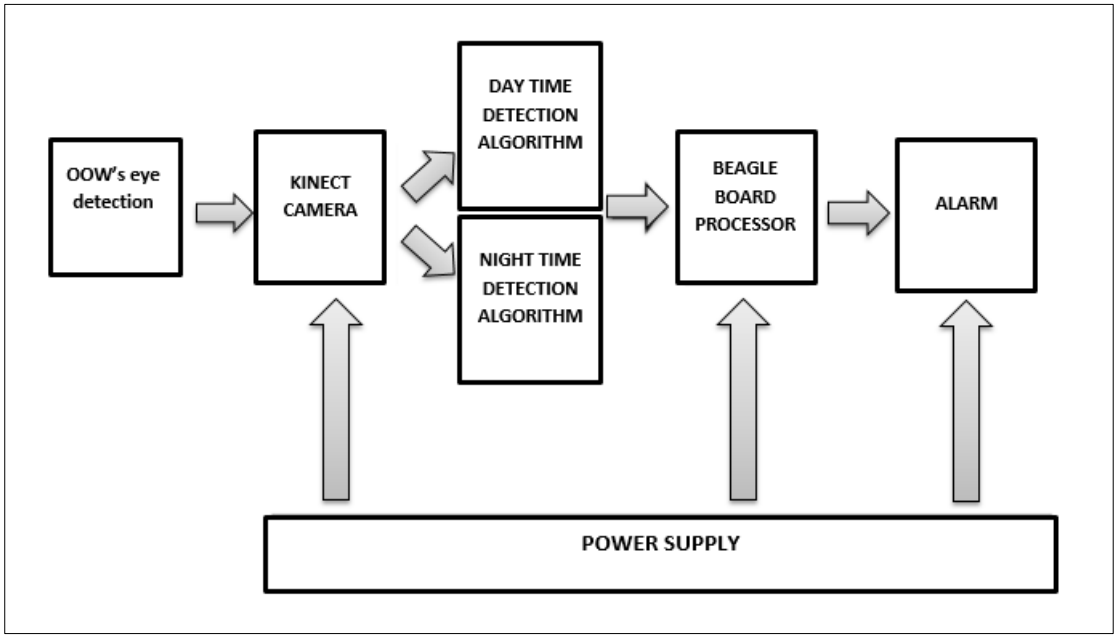
It monitors navigator's behavior closely, noting any erratic eye movements, so that it can judge the moment when OOW start to feel sleepy and need to stop and take a break. It continuously evaluates OOW eye movement, and works out when it may be time to take a break.

There will be a Kinect camera that constantly takes image of OOW, a beagle board that implement image processing algorithm, and a feedback circuit that could generate alarm and a power supply system.

FEATURES:

1. Daytime eye detection using RGB mode of Kinect.
2. Night time detection using IR mode of Kinect.
3. Eyelid distance tracking to detect the sleepiness.
4. Real time image processing more than 1 frame/second
5. Start of general alarm on ship.
6. Sleepiness detection is efficient, and alarms will be generated.
7. Enhanced algorithm to ensure the darkness detection ability

Block diagram



Block Description

i. Kinect Camera

The Kinect Camera (Microsoft Kinect Xbox360) is used in monitoring/helmsmen capturing their pictures, facial expressions the images are then sent to the Beagle board for processing. The camera will be placed near the helm and on different positions on bridge which will be ship specific. Three modes are available for the Kinect: the RGB mode, IR mode, and Depth mode. Only the RGB and IR mode is required in this project. For navigator the camera will be rotating, and the Kinect will keep the track of the OOW Motion-sensing technology as implemented in Kinect currently requires a sizable area for use (0.8m minimum to 3.5m maximum user distance).

ii. Detection Algorithm

The coding and algorithm part will be built using Open CV. The algorithm includes two parts: daytime detection and night detection. For daytime detection, the RGB mode is used; while for night detection, the IR mode is used instead. If IR mode fails to work, however, histogram equalization method will be used for night detection. The histogram equalization is a method to greatly expand the color range of the image. In this case, we need a light that will slightly illuminate the helmsman. The sleepiness is

determined based on the change of helmsman's eyelid distance or the black of eyes or by the change sequence. For both daytime and night, the helmsman's initial eyelid distance will be recorded as long as they get on the helm. The record will be removed after person leaves. During the watch, the camera will take 2 or 3 frames per second. Then the eyelid distance will be analyzed: if the distance remains small for several frame, the navigator will be treated as fell sleepy. Same will be done with the officer on watch, for him the action detecting kinect camera will be used so that OOW's mobility is not restricted.

iii. Main Processing Unit: Beagle Board

The Beagle Board would operate as the controller for all other components. First, it will send and collect information from the Kinect. Then it would perform algorithms to determine the status of the helmsman by comparing the incoming data with the normal graph.

iv. Power Supply/Control Unit

System runs on a simple 12-24v power supply which will be connected to our ship power supply.

v. Alarming system

If the system detects that OOW might be starting to lose concentration, for first line of alert, in accordance with IMO Res. MSC.128(75), sufficient number of visual (flashing lights) and audio indications will get executed.

The visual indications will be visible from all operational positions within the bridge where the OOW (Officer of the Watch) may be stationed to perform his duties.

These positions are made up by, but not limited to, Conning work station, Navigation support work station, steering work station and 2 x docking work stations

The buzzer stops when the officer presses the [RESET] button. The Main Alarm Panel will reset the timer and return to the dormant period, when the alarm is acknowledged by the watch officer if there was repetition of the same situation there will be an alarm in captain's cabin for recommendation to assess the situation and change OOW if required.

vi. Schematics and Simulation

The coding and algorithm part will be built using Open CV on the Ubuntu System. The algorithm should work all the time to detect the sleepiness of the navigator. While daytime detection is accomplished by taking RGB images, nighttime detection is done by taking IR images. If IR mode fails to work, however, histogram equalization method will be used for night detection, which could effectively expand the color contrast of a local area in the image. In this case, we need a LED to slightly bright the OOW.

vii. Histogram Equalization

Histogram Equalization will be used at night detection if IR mode fails. Basically, this method increases the global contrast of images, by effectively spreading out the most frequent intensity values. The basic idea of it is to spread the low contrast image pixel values to the entire 0 to 255 color range, according to the frequency of each pixel value in the image.

viii. BeagleBoard

Our BeagleBoard will power and communicate with Kinect camera
board and open CV to run our algorithms. Then the output will be send to our alarm system if danger is discovered by the algorithm.

4. EXPERIMENT AND DATA ANALYSIS

Our system (experimental system) runs on a PC with Intel Core (TM)2 Duo 2.10 GHz CPU and 2 GB RAM, using the third-party library OpenCV to perform system tests in Visual Studio 2008. Racing game was used as driving conditions. Nine subjects took part in the experiment with simulate driving environment. The resolution of these videos is 352 × 288 pixels and the frame rate is 25 fps. Each frame contains human face.

We recorded ten groups of video streams in this experiment. The videos are divided into two categories. The first category (i.e., 1st–4th groups) shows various facial expressions which occurred in three subjects simulate driving experiments. There are 1630 frames in each group of videos. These videos are used to test the performance of face detection and eyes detection.

The second category consists of the remaining 6 groups (i.e., 5th–10th). Six subjects were asked to implement driving tasks for long enough time to become fatigued finally.

These videos are used to extract fatigue index. In order to collect valid videos for assessment of driver fatigue, subjects are involved in training and experimental sessions. The whole experiment duration for one subject may last two or more days, it depends on his training performance. Before experiment, subjects are asked not to eat chocolate and drink coffee or alcohol. The length of each video is about 70 minutes. There are 105,000 frames in each group of videos. In the first 55 minutes of experiment, subjects are asked to take intensive simulate driving. Many curves and steep slopes are presented in driving conditions. And extra tasks of alert and vigilance (TAV) were exerted in order to ensure subjects concentrating on driving highly during the experiment. In the last 15 minutes, we relieved subjects' stress by declining missions and using a flat road with fewer curves. The monotony of driving induced driver to be fatigued. Obvious features of fatigue for subjects in this simulate driving can be summarized as increased blink times, blinks frequency, and duration of closed-eyes state.

In order to distinguish detection results, the result of front face classifier was marked as a white rectangle and the result of deflected face classifier was marked as a green rectangle. The first row shows the results which were detected by the front face classifier marked with white rectangles. Face was lost because the right deflection angle of face is too large in 3rd frame. The second row shows the results which were detected by deflected face classifiers marked with green rectangles. And in the second row, face was lost by the deflected classifier in the first and fourth frame because the faces were in the state of looking straight ahead. The third row shows the results detected by the two classifiers. Hence, all faces including front and deflected conditions were detected successfully. This method can carry out real-time detection with a high accuracy.

5. CONCLUSIONS:

This paper provides a practical driving fatigue detection system based on Open CV algorithm. We proposed a new strategy to detect eye state instead of detecting eye directly. In our detection strategy, we first detect face efficiently using classifiers of both front face and deflected face. Then, candidate region of eye is determined according to geometric distribution of facial organs. Finally, trained classifiers of open eyes and closed eyes are used to detect eyes in the candidate region quickly and

accurately. As a result, PERCLOS escalating rate could be calculated and used as the index of fatigue. When the PERCLOS escalating rate increased more than 200%, the OOW could be considered in fatigue state. Moreover, this paper implemented a Fatigue Detection Warning System. The system makes decision of fatigued or not according to PERCLOS and duration of closed-eyes state. Experiments demonstrated that the proposed system has a high accuracy. Meanwhile, the processing speed can reach 30 fps on PC and 14 fps on tablet, which meets the requirement of real time.

Of course, this system could make further improvement on accuracy and speed of detection by using discrete cosine coefficients and covariance feature, respectively. In addition, this paper has dodged the conditions under poor illumination. It should be perfected in the future research.

Acknowledgment

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POTENTIAL OF INLAND WATERWAYS IN INDIA.

Saksham Singh
Varun Pandey

Abstract

India has a total coastline of 7551 km with 13 major ports trust, approximately 200 minor ports. The country has extensive network of inland waterways in the form of rivers, canals, backwaters and creeks. Total Navigable length is 14,500 km, of which about 5200 km of rivers and 4000 km of canals can be used by mechanized craft and cargo. The Purpose of this paper is to find out the Potential and growth in Inland Water Transportation in India and also find out the major problems faced by the organizations involved in this field in India. This paper shows the detailed information about the Inland Water Transportation in India. The paper reveals that how since past few years the growth of Inland Water Transportation have been taken place in India. As per study done in some countries Inland Water Transportation has been known as most cost effective and fuel efficient mode of transportation which attracts the attention of scholars to make some efforts relatively to study of growth and challenges of Inland Water Transportation with reference to India since efforts has been made in this paper to highlight present status, growth, opportunities and problem of Inland Water Transportation in India

Keywords: Inland Water Transportation, Ports and Transportation.

1. INTRODUCTION:

A sound and efficient transport infrastructure is the key to boosting economic growth and in turn, to alleviating poverty and promoting sustainable development. Inland water transport system ensures both, by way of providing access, mobility and connectivity and generating employment at the grassroots with lesser environmental footprint and cost.

In our civilization, rivers have played a crucial role as a mode of transport in carrying people and goods. Even in the present era, many countries depend heavily on inland water transport, especially for large and bulky cargo.

India is a land of rivers. It has 7500-km long coastline with approximately 14,500 km of navigable waterways. This offers a huge potential for developing a cheaper and greener mode of transport. But only a very small percentage of trade is currently being carried out through these waterways and coastlines. Coastal shipping accounts for only 6 % and inland water transport for about 0.4% of trade.

Nearly 60 % of goods today travel by congested roads 25 % by rail networks. This slows down the movement of cargo, adds to uncertainties, increases the costs of trade, and leaves deep environmental footprints. It has been found that logistics costs in India account for about 18 percent of the country's GDP, which is much higher than China, USA, UK and many other countries. This makes Indian goods costlier and hence less competitive. As per World Bank analysis, the cost of transport of one ton of freight over a km by road is Rs.2.28, by rail Rs.1.41 and Rs.1.19 for waterways. So, logistics costs in the country can be brought down considerably by transporting more and more goods by waterways.

2. INLAND WATERWAYS AUTHORITY OF INDIA:

In this era of energy crisis, waterways have been found to be a fuel efficient, environment friendly and cost-effective mode of transport, besides having the capacity to ease pressure on rail and road sectors. Inland Waterways Authority of India (IWAI), which came up in October 1986, acts as the nodal agency for optimum utilization of the vast untapped potential of our inland waterways.

National Waterways (NW) declared through Acts of Parliament come under the purview of Central Govt/ IWAI; other waterways under the respective State Governments.

2.1. IWAI is mandated to take up: -

- Infrastructure development & regulation on NWs
- Techno- economic feasibility studies
- Advise the Central Government on IWT matters
- Assistance to States in IWT development

3. OBJECTIVE OF RESEARCH WORK

The research paper is prepared for the purpose of determining the Potential of Inland Water Transportation in India. At the end paper will cover each objective comfortably followed by conclusion.

4. RESEARCH METHODOLOGY AND FINDING:

This paper is based on secondary data and information that has been sourced from various books, trade journals, government publications newspapers etc. and research is descriptive in nature.

It is a difficult task to determine the economic efficiency of any process, and inland waterways transportation is no exception. Three factors need to be considered for determining total costs - capital, labor and operating expenses - which, when combined, forms an operating system. The productivity of a system, however, depends on the system used, the extent of mechanization, the use of the latest technology and overall management. In India the analyses carried out by the National Transport Development Policy Committee of the Government indicate that the cost of operation of inland waterways transportation, computed for a 500-tonne self-propelled unit working at 75% load factor working for 300 days a year, is significantly lower than rail and road transportation of bulk products like coal and fertilizer. In order to regulate inland waterways in India Government of India constitutes a Inland Water Authority of India [IWAI] The organisation got functional in 1986 with a mandate to facilitate the commercial and non-commercial use of channel system.

5. NAVIGABLE WATERWAYS AND INFRASTRUCTURE:

Length of waterways along with its navigable length is an indicator of inland water potential of a state. It is observed that the maximum length of waterways is in the State of Assam with 5290 kms followed by West Bengal with 4741 kms. However, the ratio of the navigable length to the total length of the river/canal better reflects the potential for IWT.

India ranks in 9th in the world in terms of potential navigable waterways (source: the world fact book 2008) Length of waterways along with its navigable length is an indicator of inland water potential of a state. It is observed that the maximum length of waterways is in the State of Assam followed by West Bengal. However, the ratio of the navigable length to the total length of the river/canal better reflects the potential for Inland water transport. Fourteen states have reported river length as well as navigable length for 137 rivers.

Some of the important source of waterways, rivers and canals in India are as follows:

1. River Ganga
2. River Brahmaputra
3. Backwaters of Kerala
4. Goa Waterways
5. Mumbai Waterways
6. River Tapi
7. DVC Canal
8. National Waterways

As per the available data on government website, it is observed that the ratio of navigable length to the total length is about 96.88% in the State of West Bengal; by contrast, in case of Gujrat the ratio of navigable length to total length is a mere 15.62%. Other States with good inland water transport prospects are Goa, Maharashtra and Bihar where waterways navigable length is 90.84%, 73.14% and 62.40% respectively of the total length of rivers/lands/lakes reported by these states.

Fourteen states have reported river length as well as navigable length for 131 rivers. These 131 rivers have total length of 27962 Km of which 45.57% is navigable length.

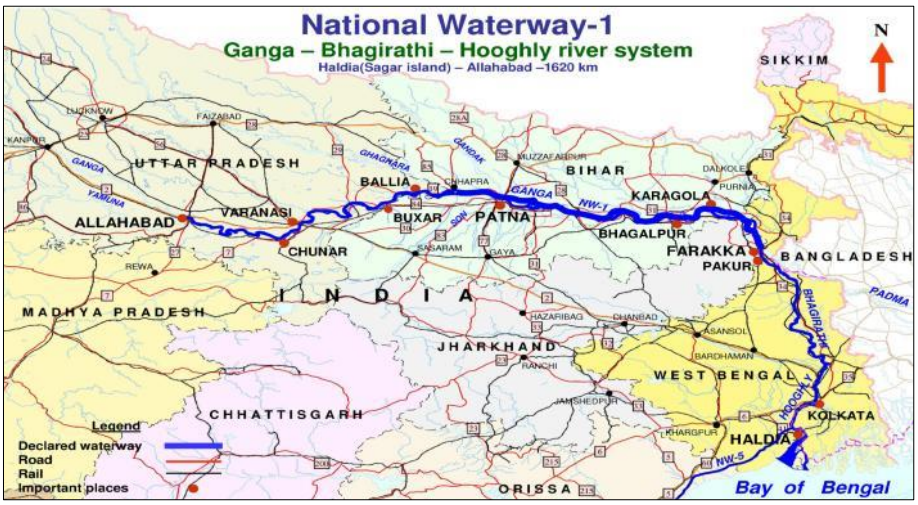
6. PROJECTS UNDERTAKEN FOR THE DEVELOPMENT OF IWT:

To promote Inland Water Transport (IWT) in the country, five waterways have been declared as National Waterways. Out of these five NWs, first three waterways have already been developed substantially with fairway of required depth & width, navigational aids & terminal facilities for loading/unloading of cargo & ingress/ egress of the passengers and cargo & passenger vessels are moving on these NWs. A World Bank aided project for capacity augmentation of NW-1 has been sanctioned and it is under implementation.

7. PROJECTS UNDER IMPLEMENTATION:

National waterway no. 1 and its Salient fweatures

- The objective of the project is to develop the stretch of river between Allahabad and Haldia to make it navigable for vessels with 1,500-2,000 tonne dead weight capacity. This is close to the carrying capacity of a goods train.



- For this, the project will develop a navigational channel of 2.2 to 3.0 meters depth and 35- 45 metre width. Multi-modal terminals are being constructed at Varanasi, Haldia, and Sahibganj, besides a Navigational Lock at Farakka.
- Modern systems of river information, training and conservancy works, night navigation facilities, and other modern facilities like channel marking, navigational lock, etc. are being developed to for efficient and safe movement of vessels.

- Phase-I of the project covers the Haldia—Varanasi stretch of the river. Once operational, the waterway will form part of a larger multi-modal transport network having linkage with the Eastern Dedicated Rail Freight Corridor and also with the area's existing network of highways.
- The cargo from the Gangetic states of Bihar and Uttar Pradesh now takes circuitous land routes to reach the sea ports of Mumbai in Maharashtra and Kandla in Gujarat. The development of NW1 will help these states to send some of their freight to the Kolkata-Haldia complex, thus making the movement of freight more reliable with less logistical costs.
- A joint venture is afoot with Thompson Design Group, Boston (USA) and Infrastructure Architecture Lab of Massachusetts Institute of Technology, to identify the best locations for construction of 18 ferry terminals in six cities, namely, Allahabad, Varanasi, Patna, Munger, Kolkata and Haldia on NW1.

The NW1 has the future of emerging as the leading logistical artery for the entire northern India, which passes through one of India's most densely populated areas and resource-rich regions and generates an estimated 40 percent of India's traded goods. The region's teeming markets also attract goods from other parts of the country. The network of a water- road-rail link will help the region's industries and manufacturing units to have a seamless flow of goods to markets in India and abroad. Further, it will also give wider market access to the farmers of this agriculturally-rich Gangetic plain. IWAI is in the process of developing thirty-seven more NWs in the next three years.

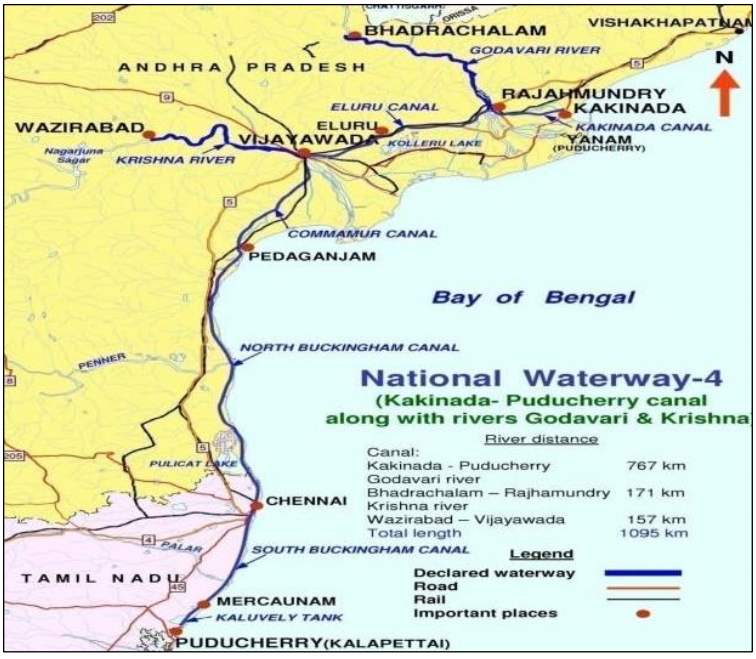
National waterway no. 2

Ro-Ro transportation has started between Dhubri and Hatsingamari and slipway facilities are being constructed at Pandu on River Brahmaputra, or NW-2.

- **National Waterway No.3**

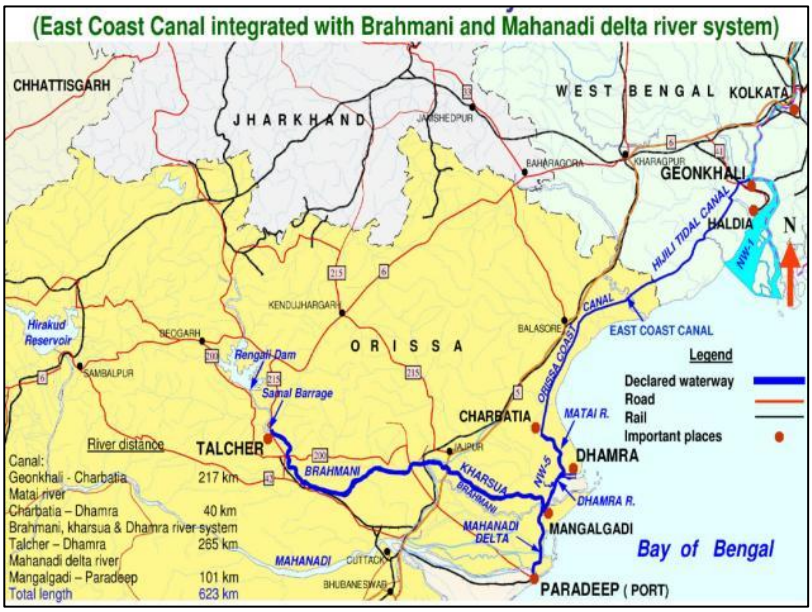
Normal development works are ongoing on NW-3.

- **National Waterway No.4**



The development of NW-4 (Kakinada- Puducherry Canal along with Krishna & Godavari Rivers),

- **National Waterway No.5**



NW- 5 (East Coast Canal with Brahmani & Mahanadi Delta),
NW-16 (Barak), NW-37 (Gandak), NW-40 (Ghagra) and NW-58 (Kosi) also are in progress.

NW No	Stretch	Length
1	River Ganga Haldia to Allahabad	1620Km
2	River Brahmaputra From Dhubri to sadiya	891Km
3	West Coast Canal From Kottapuram to Kollam with Udyogamandal and champakara canal	205Km
4	Kakkinada-Puducherry stretch of canals with river Godavari and river Krishna	1078 Km
5	East Coast Canal with river Brahmani and river Mahanadi" s delta	588Km

While developing the waterways, the legal framework governing inland waterways vessels is also being revamped. Once fully operational, the integrated system of water-road and rail network will herald a new era of inclusive growth and green economy in India.

8. POTENTIAL OF DEVELOPMENT:

i. First Segment: Inland Navigation: Challenges and Opportunities

National Waterways are of significance for their role in inland cargo transportation and as local communication routes. Howsoever, existing navigable waterways lack needed infrastructure, navigational aids, terminals and communication facilities and institutional / policy support. Inland navigation during wet season is regarded crucial, as during this time land-based communication systems (roads) often suffer critical damage from the impact of extreme rainfall, rendering them not suitable for use. At such a time navigation through water is supports transport connectivity for man and cargo.

- National Water Management Agenda: Priorities and Policies: In water resources development agenda of India, navigation is relegated at the end after issues of drinking water, irrigation and power (hydel) sector (Planning Commission, 2006). This reflects the level on importance given to the sector in terms of budget allocation, employment in the sector and policy. The sector deems improved priority to be optimized to its potential.
- Trans boundary issues: structural and political: Most inland waterways, like river systems are trans boundary in nature that means the originating country of river can be different to the country where it finally meets the sea. For example, the NW-1 (Ganges channel between Allahabad-Haldia that stretches 1620 km) downstream closely link with the inland border channel between India and Bangladesh and similar reasoning can make for NW-2 the Sadiya-Dhubri stretch of river Brahmaputra (891 km). Reports suggest, historically the cross-boundary channels were navigated under regional connections and collaborations, the practice that come to almost a close in recent time. At national level, the big challenge is the lack of co-ordination between the state governments and local authorities managing IWT, at cross-country level, stakeholders of river systems such as Ganges, Brahmaputra, Meghna lack cooperation and political agreement essential for the functioning of inland waterways. Dealing with prevailing political bureaucracy, especially hydro-diplomacy in the region [India and Bangladesh], it is interesting to take reference of the historical treaties shared between these countries.

- Knowledge base and Information sharing on hydrology of inland navigation: Least Available Depth (LAD) is a critical parameter driving the navigation hydraulics of inland channels. Strengthening capacity of communities, businesses with scientifically calibrated up-to-date information on changing depth of inland water and hydrological changes (as of seasonality effect or other water regulation, allocation/distribution systems) is an obligatory requirement. Addressing **excessive siltation** in major rivers from erosion of uplands and deforestation are supplementary issues that need attention for improving IWT operations.
- Infrastructural Interventions: Unavailability of low draft high technology vessels is another limiting factor. Installment and construction of better navigational aids could possibly increase long time sailing (also during darkness. Building permanent terminals for adequate and efficient loading and unloading of cargo facilitates trade options. IWAI states mechanized handling at terminals and night navigation facilities as requisite (implementation yet due).
- Involvement of private sector: Private sector involvement is projected to play a key role for IWT. Improved terminal and warehousing facilities, mechanization of the cargo-handling system, installation of the new navigational aids and maintenance of the existing infrastructure are dimensions requiring attention. In addition, maintaining fairway, providing pilot age services, setting up of IWT training facilities are undertakings of equal requirement. Considering, several levels of possible private sector Build-Operate-Transfer (BOT) scheme, can be negotiated under Public-Private-Participation framework. Alternate way of engagement is to leverage from set of defined incentives as expounded in the dossier of the Directorate General of Shipping (2009).

  Private sector players (Hindustan Lever, Ambuja Cements and many others) are currently engaged with IWT. Besides public limited enterprises that include IOCL [Indian Oil Cooperation], Haldia Petrochemicals, FCI [Food Cooperation of India], ONGC [Oil and Natural Gas Commission] and Hindustan Paper Corporation are also in joint operations. With supportive policies, private sector involvement can be expanded.
- Navigational and Operational facilities: IWAI coordinates existing IWT facilities. Presence of lock gate at Farakka and barrage system at Kolkata port ensures navigability for NW-1. However, hydro-dynamics seasonality is a dimension

demanding better attention. For example, during winters, the available depth for Ganges is 4-4.5meter, 6-8 metres during summer and 10- 12m during monsoon. Factoring this variation while designing and operating navigational facilities is important. Like such, floating terminals are preferred for IWT for narrow channel width and for banks inward and outward pushing. Hydrological complexity of inland channels demands tailored requirements for IWT. Taking the reference of an incident where the conventional battery-operated type buoys provided on NW-1 waterway, are often pilfered, rendering these facilities un-available when required, especially during night navigation. To resolve similar situation, beacon type markers (also used in NW III) are less susceptible to thefts. Exchange of experiences between local-level authorities can be effective for maintenance and management of NW's.

ii. Second Segment: Inland Water Navigation and Economic Growth.

To project a strengthened regional trade in South Asia and improve bilateral links, IWT established in coordination with the doctrines of greening the economic growth sounds as a promising option. Take the case of remote industrially (mining) active areas of North-east India (including Bihar, Bengal) that are landlocked and transport mined products mostly by road. NW-1 provides an alternative route for goods to be directly transported to Kolkata (or Mongla) port India (Bangladesh) facilitating national and cross-country trade. Similar possibilities stand for Nepal. Three major tributaries of Ganges: Karnali, Gandaki and Kosi exhibits high probability of connection with NW-1. Main water channel of Nepal, river Kosi River, though non-navigable upstream as of steep terrain can be connected by low-draft barges downstream. To sum, infrastructural arrangements complimented by trans-boundary institutional arrangements is a pre-requisite. Border shared by India and Nepal has Karnali River (or Ghagra in India) flowing to the confluence of Ganges that shows good prospect for navigation. Kayastha (2001) proposed to extend NW-1 (from Allahabad to Hadia) to link with Gandaki River while joining central Nepal, eastern Uttar Pradesh and eastern Bihar. India and Bangladesh have a bilateral protocol, renewed every two years, for India to use the Ganges-Brahmaputra-Meghan river way for water transit between West Bengal and Assam. Taking reference of existing arrangement between two countries further facilitation

can go long way to address above concerns, not just for national level economic growth, also for regional development.

- Low capital and maintenance cost: Estimations show that developing and building an inland waterway costs about 5-10 per cent to that of 4-lane highway/railway, making it a lucrative transportation option with low capital investment. In India, maintenance cost of IWT is assessed at 20% that of road. Department of Shipping (India) states that shifting cargo transport to the IWT mode will reduce transport fuel cost by 5 million USD and overall transport cost by 9 million USD. Other factors: local conditions of river, fuel cost, and maintenance costs will be contributing to operational cost as well. IWT may be cost intensive at the start; it is cost-effective in long term.
- Potential for Integrated design: Integrated transport and trade frameworks/models (ITF's) is discussed for optimisation in efficiency and economics (UNCTAD, 2008). Practically a difficult target, it demands elaborate discussions on multiple aspects (structural and functional).

Let us attempt to understand; (a) Physical integration: refers to connecting different navigable (hydrological) channels (basin, upstream and downstream). For NW-I, a prospective connect between inland water routes regions (as far as Himalayas or as close as Vindhyas) to integrate with marine routes. Infrastructural structures such as dams/ barrages restrain regular water flow (and LAD) needed for IWT. Construction of bridges also restricts vertical clearances of navigation vessels (especially heavy-duty cargo). Despite endowed with numerous navigable rivers only four national waterways are functional in India (that too with low freight traffic). ITF's can address much of this concern.

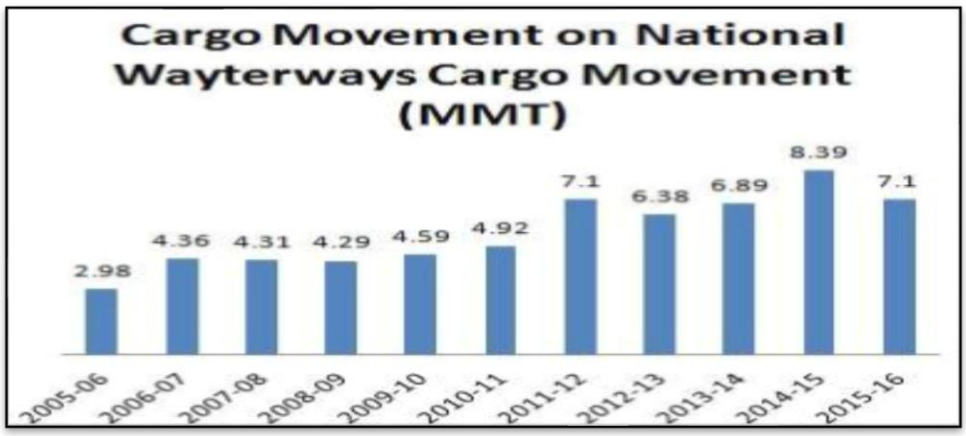
(b) Functional Integration: refers to connection between National Highways, National Railways and National Waterways connecting these modes of transport and trade through a joint regulating authority. For example, the railway freight corridors linked with the waterways by making special tracks up to NW terminals. Haldia Dock Complex (NW-1)-inland water terminal provides possible integration point for coastal shipping with national waterways and re-distributing the cargo in waterways. Extendable to point-based-point connection with road and rail networks, it is expected to have relevant applicability and fuel-cost efficiency;

(c) Structural Integration refers to achieving efficiency in integrated design by improving infrastructural/technical facilities viz., linked roads, channels, permanent berths, handling gears like shore cranes and gantries (for containers), mobile cranes, forklift trucks and trailers, storage sheds and warehouses.

- Carbon Efficiency: The goal of Inland Waterways framework is to minimise carbon footprint of development processes. Fuel efficiency is vital to regulate carbon emission. IWT is exceedingly fuel-efficient transport mode with an estimate that one litre fuel can transport 24 tonne/km freight by road, 85 tonne/km by rail and 105 tonne/km by waterways (IWAI-2008/09). With appropriate regulatory measures, IWT as a transport option bears competitive advantage.

9. CARGO MOVEMENT:

The Cargo moved on the three national waterways, waterways of Goa and Maharashtra which carry most of the cargo traffic on India's Inland Waterways. The total cargo movement on India's waterways comprising the three national waterways and waterways in the State of Goa and Maharashtra was 365.37 lakhs tonnes in 2014-15 as against 322.63 lakhs tonnes in 2013-14, reflecting an increase of 13.3 %. In terms of tonnage, Goa and Maharashtra accounted for 2.2 % and 74.9 % respectively of the total cargo volume in 2014-15 with balance 22.9 % being accounted by the 3 National Waterways. In terms of tonne km (movement of one tonne of cargo over a distance of one km) there was an increase of 17 % in 2014-15 over 2013-14. Maharashtra waterways accounted around 75% of the total cargo movement on inland waterways across India. In case of Goa and Maharashtra, high volume of cargo movement was carried over relatively short average distances of about 42.82 Kms and 17.88 Kms respectively leading to their intensive use. In case of National Waterway II (The Brahmaputra) and National Waterway III (Champakara canal, Udyogmandal canal and West Coast canal) the distance traversed by cargo was on an average around 20.38 Kms and 10.90 Kms respectively in 2014-15. In case of National Waterway, I (Ganga-Bhagirathi-Hooghly) the average distance over which cargo moved was relatively much longer at around 444.73 Kms. Movement of National waterways I, II and III has increased from 3MMT in 2005-06 to 7.1MMT in 2015-16, an overall growth around 137 percent.



10. CHALLENGES OF INLAND WATER TRANSPORTATION IN INDIA:

i. **Water Flow: -** The basic need for the Inland transportation is sufficient water flow. Due to Industrial, Agriculture and habitation the water flows has been decreased over the years this also may have decreased due to impact of dams of on the rivers.

ii. **Inadequate water channel Depth: -**Large vessels cannot traverse without adequate waters in the rivers. This along with the seasonal dependency of rivers makes operation of many ports difficult.

iii. **Storage Infrastructure: -**Other than certain government run warehouses whose main objective is grain storage, most of the warehouse are small in size and lesser in number. There is inadequate security measure, poor racking system and most important of all these is lack of cold storage facilities in majority of the ports.

iv. **Inadequate Air Draft: -**Multiple bridges with low vertical clearance obstruct the passage of bigger inland water transport vessels on waterways No.3.There several navigable canal in the states of Uttar Pradesh, Bihar, West Bengal, Tamil Nadu and Andhra Pradesh: Sarda Canal, Ganga Canal, Yamuna Canal, The Delta canal system of the Krishna, Godavari, Mahanadi and Brahamani. But these cannot be utilised for cargo movement due to air draft restriction.

v. **Shortage of IWT Vessels: -**Vessels buildings is highly capital intensive and faces difficulties in obtaining project finance from banks and financial institutions. The private sector is relevant to invest in barges unless long term commitments for onward/ return trips are made for onward/return trips are made from user's industries.

vi. **Excessive Siltation:-**Deforestation and erosion activity of the river leads of siltation.

vii. **Poor Skills and low technology adaption: -**Lake of automation in processes and low multi operation skills affects efficient utilisation of ports.

Some more challenges

I. Water is a scarce resource in India. It has to first meet the basic requirements of drinking and irrigation before it can be used for navigation. River linkages and water sharing arrangements will have to be worked out between states to estimate the quantum of water required on a time basis throughout the year to maintain the minimum depth of water in the canals for navigability, besides ensuring that drinking, irrigation and other demands of water do not get impacted.

II. The cost savings from water transportation would never be realized unless vessels are able to load to their full tonnage. This is possible only if the rivers are deepened between 2.5 and 4.5 meters and if return cargo is made available for the vessel to avoid wasteful return trips.as we all well aware that most of the Indian rivers are locational, cover small geography and undergo huge seasonal fluctuations even Some of the rivers generally remain dry which rendering them unsuitable for navigation. There is a need to develop water reservoirs for the conservation of rainwater to feed such rivers.

III. Higher water salinity, especially in the coastal regions and estuaries, and constant inflow of silt in the rivers can be problematic. Along with the minimal water flow continuous dredging is desired as the rivers bring a large amount of siltation.

IV. The financing requirement for inland water transportation is huge and open-ended. The heavy investment will be needed for construction of locking barrages to hold water for vessel movement, concretization and building of embankments to create port terminals and procure equipment, including dredgers, shipping vessels, and barges of different sizes and require river ports with their support infrastructure- road and rail connectivity, warehouses and other services.

V. Inland Waterways Transport (IWT) is a slower mode as compared by Rail and Road by its very nature. So Improper navigational aids further hurtb its competitiveness with other modes.

VI. Non-availability of permanent and mechanized handling terminals for loading and unloading with adequate infrastructure, connectivity to the other mode of transport with the terminal is another key factor.

VII. There are road and rail bridges with low vertical clearances which impede the passage of bigger IWT vessel on the waterways. There should be a long-term vision for the development of dams, bridges and other in-way infrastructures.

11. PROMOTIONAL MEASURES BY GOVERNMENT TO SUPPORT INLAND WATER TRANSPORTATION:

The Government with a view to promoting Inland Waterways Transport (IWT), has launched several schemes. Some of the same are listed hereunder:

- Vessel Building Subsidy of 30%
- Equity participation by Govt. in BOT (Build operate transfer) Projects up to 40%
- Viability Gap Funding
- Tax exemption similar to National Highways
- Enhancement in depreciation rate for inland vessels
- Joint Venture by IWAI
- Customs Duty concessions

- Under the Sagaramala project government will identify suitable port locations with deep drafts to enhance shipping and port handling capacity. Specialized ports with focus on handling coal, energy, chemicals, commodities, etc., will be developed.
  In way of some strong moves for Inland Waterways Transport (IWT) the Cabinet Committee on Economic Affairs (CCEA) has approved implementation of Jal Marg Vikas Project (JMVP) for capacity augmentation of navigation on Haldia-Varanasi stretch of National Waterway-1 on Ganga River. The project will be implemented at a cost of over Rs. 5,370 crore rupees with the technical assistance and investment support of the World Bank. It is expected to be completed by March 2023.

  Along with the above initiatives the Government, with a view to promoting public-private partnership(PPP) in IWT sector, has identified several areas which include:

- Construction and operation of river terminals or river ports. Ownership and operation of vessels for cargo and, passenger,
- Provision and operation of mechanized cargo-handling systems
- Fairway development and maintenance
- Putting up and maintenance of navigational aids and setting up and running of training IWT training institution.

12. LADIS PORTAL LAUNCHED BY THE GOVERNMENT:

The Inland Waterways Authority of India (IWAI) launched a new portal LADIS on 16th February,2019 – Least Available Depth to aid in ensuring of optimum use of National Waterways. An assured depth of waterway is required for seamless movement of vessels. The portal will provide real-time data on at least available depths for ship/barge and cargo owners so that they can undertake transportation on NWs in a more planned way. The real-time information in stretches of various NWs will help transporters by guiding them on the suitability of time of movement.

LADIS will better facilitate the day to day operations of inland vessels plying on National Waterways and avoids any hindrance in service and operation. LADIS will enhance the credibility and efficiency of information sharing to achieve seamless operations on National Waterways, besides pre-empting problems that may occur during the movement of vessels.

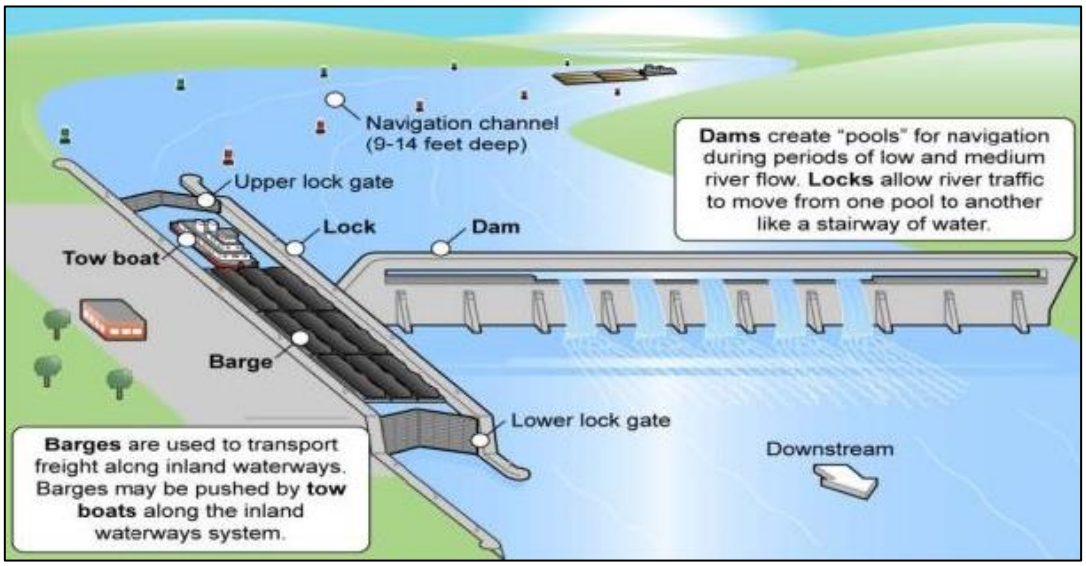
13. MAERSK RUNS CONTAINERSHIP ON GANGA (NW-1):

The world's largest container shipping company Maersk Line moved 16 containers on the Ganga river from Varanasi to Kolkata, the Shipping Ministry said Monday.
"Maersk Line has moved 16 containers on river Ganga (National Waterway-1) from Varanasi to Kolkata. The firm is onboard India's inland waterways for the first time," the ministry said in a statement. On November 12, 2018, Prime Minister Narendra Modi dedicated India's first riverine multimodal terminal on river Ganga (National Waterway-1) at Varanasi to the nation.
The government is developing NW-1 under from Haldia to Varanasi with the technical and financial assistance of the World Bank at an estimated cost of Rs 5,369 crore, the

ministry said. Earlier firms like PepsiCo, Emami Agrotech, IFFCO Fertilizers, Dabur India, had moved their containers on river Ganga, it added.

14. SOME ADDITIONAL ACTION SHALL BE TAKEN TO MEET THE CHALLENGES:

- The Indian Government should focus more and put some special efforts and funds on the development of "commercially significant IWT."
- IWT as a mode will not commercially profitable for operators unless we apply more than 1000 DWT which requires a minimum draft of 2.5 to 3m round the year with night navigation facilities. The construction of dams, barrages, bridges should consider navigation as an important requirement and make provisions for the same.



Source: GAO. | GAO-16-682

Dam arrangements for inland water transport Barges

- IWT being a dependent mode, there is a strong need to provide effective rail, road and coastal connections from the waterways for multi-modal logistics. The terminals should be located close to industrial hubs or consumption centers and should provide connectivity to both rail and Road. Connectivity with Coastal shipping is possible at all National Waterways.

- Strong steps need to be taken to encourage vessel availability in Revival of Vessel Building Subsidy scheme, abatement of service tax, granting of vessel building an "infrastructure status" and ensuring two-way cargo to vessel operators, round the year.
- The government should target specific cargo like Coal, Cement, Fertilizers, Food grains and all the users of these cargoes close to National Waterways need to be met, their requirements to be understood and specific solutions to be developed for them on the long-term basis.
- The pace of project implementation is far from Even after 30 years of its declaration we are still not able to provide the lowest available draft of 3m on the whole stretch of NW1. The speed of Implementation should be increased and the projects need to be time-bound and implemented with urgency.

15. JOB OPPORTUNITY FOR SEAFARER'S.

- More job opportunity for marine floating staff due to increase in the number of the fleet.
- Ships pilots to Guide commercial vessels in and out of bays, harbors, rivers as required
- For port and harbors operation Executive port directors who can oversee the administration, operation and maintenance of an inland port. A person with good leadership, planning, critical thinking and good communication skills, inspirational diplomatic and resourceful skills will be suitable for the same.
- Marine Manager- Oversee daily operation and services of marine facilities, perform supervisory, financial administrative, customer services, maintenance and various other duties.
- Inland water transportation equipment manufacturing industry
- Naval architect –it includes the research, design and construction of commercial vessels, small craft, and marine structure.
- **Design, construction and maintenance of transportation system** involving the construction of locking barrages to hold water for vessel movement concretization and building of embankments to create port terminals. Its further includes regular (high-intensity) capital dredging of river sediment deposition along channel bottoms and margins. It also includes modern river information system and Digital

Global Positioning System for night navigation and Development of water traffic control system.

- Ship and port safety officer
- Port inspectors and ship surveyors
- Cargo managers
- More container depots
- Logistics and multimodal transportation
- Marine environment pollution prevention will further flourish job opportunities.
- Marine chartering and cargo brokers.

16. CONCLUSION:

The Inland Water Transportation has experienced high growth over the last decade with the visible shift towards development of navigable waterways. The cargo movement has been reached at 8.38 MMT in the year 2016-17, with a growth of 181.20 % has been seen over the decade which is good sign for the IWT in India but there are some challenges also associated these are lack the water flow, adequate depth and shortage of vessels etc. which needs the government to pay attention and invest resources as well as increase the navigable length.

Government of India aims to develop and harness the potential of Inland Water Navigation in order to bolster optimal and sustainable use of water systems. Setting up Inland Water Authority and declaration of National Waterways was a first step towards this objective. Even though in a broad sense, growth of IWT sector is not very aligned with development objectives, further development in this sector sounds promising as a carbon efficient alternative. Installment of better navigational aids, and infrastructure facilities remain a key requirement to increase effectiveness of the sector.

In current times, efficient energy consumption and green economic future is a pressing goal, IWT sector assures to be less fuel consuming (making it a best bet to expand and develop). Building essential infrastructure like mechanized handling at terminals and night navigation facilities is pertinent. Other enabling conditions include clear

framework of national level procedures, incentives, policies, and subsidies. Such stimulus can translate into cost reduction per ton-km (TKM) over short and long haul.

IWT sector has immense Potential and promises to sustain, enhance and engage the interaction with people whose livelihoods and socio-economic security depends on inland water resource. One can note that data limitation and lack of up-to-date scientific assessments are limiting factors for timely decision making for IWT.

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POTENTIAL OF BLOCK CHAIN TECHNOLOGY IN THE SHIPPING INDUSTRY

Pranav Sudhir Chakkarwar

Abstract

This paper presents the potential of blockchain technology in the shipping industry. Initially the general idea is to get a better understanding of this technology and its working, finally we try to recognise its potential if implemented in the shipping industry; including its results/impacts on this widespread industry. As the etymology of the name suggests that a blockchain just means many blocks of something (in our case information) connected to one other through connections/chains. Blockchain is one of the best technologies which is used to seamlessly and securely accomplish cryptocurrency transactions. Blockchain technology was first used while designing bitcoin which is a secure and widely accepted cryptocurrency. Our major concern here is about the implementation of blockchain technology in the shipping industry. This technology can be used to carry out financial transactions and track shipments in real time. However, this technology does not limit itself to financial and documentation purposes but it can also be used by an autonomous group of vessels which will privately and securely exchange information for a seamless sailing experience. A blockchain network is also secure against a cyber-attack.

Keywords: Blockchain, Network, Secure, Cryptocurrency, Internet, Exchange Of Data, Autonomous Vessels, Cyber-Attack.

1. INTRODUCTION TO BLOCKCHAIN TECHNOLOGY:

Blockchain has a simple structure yet this technology is considered as a very complex technology because of the techniques/algorithms that keep it going. Structure of a blockchain can be imagined as a number of blocks (of information) connected one other with chains (secure links). Blockchain technology is secure because each block stores an

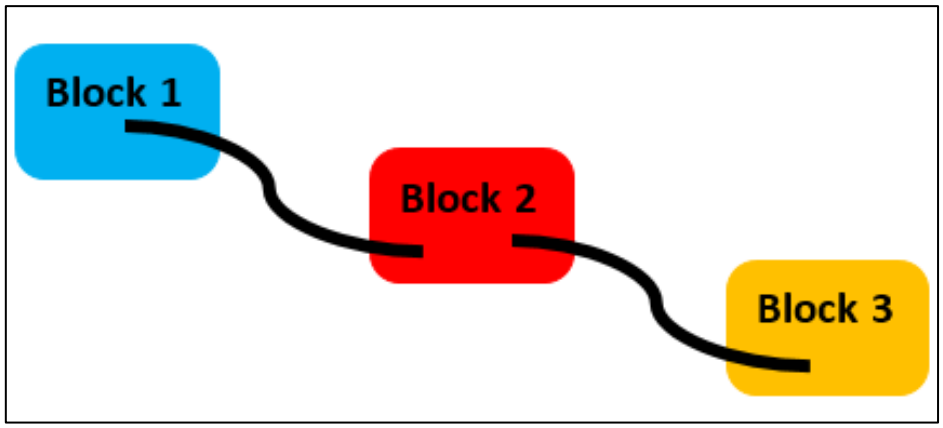

Figure 1 Basic Structure of Blockchain

entity called hash which differentiates it from every other block. Anyone on the network can view the blocks and access all of its information at any time but cannot alter it [1]. Every computer which connects to a blockchain network receives a copy of all the blocks which is continuously updated this makes it very secure. This network is called a hub less network there is no ultimate server or a controller which can manipulate the original data. Therefore, a hacker would have to manipulate every copy of the on this network which is impossible because there can be thousands or even millions of copies of the chain [2].

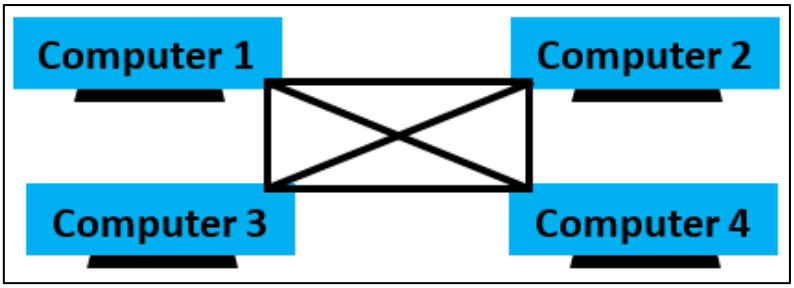

Figure 2 Computer network where blocks are exchanged

1.1. Public Blockchain:

Blockchain networks can be generally categorized as public and private blockchains. The public blockchains can be anonymously accessed by anyone and security is maintained using the mechanism of 'proof of work'. Most public blockchain newworks are used financial transactions. The 'Proof of work' means computational work and this work is done by miners. Miners are the mostimportant part of a public blockchain cnetwork as all of the computional work is done by them [3].

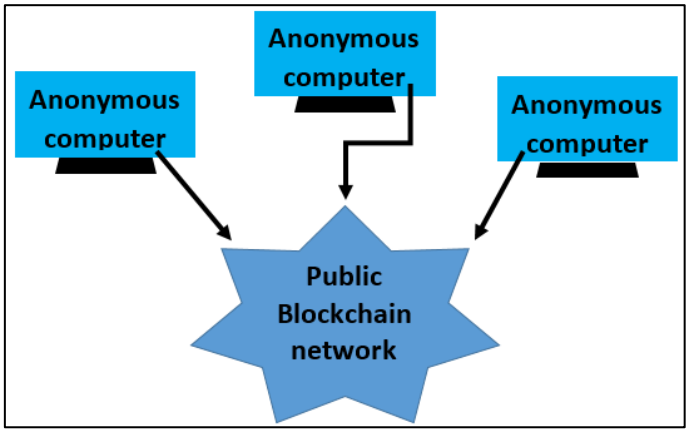

Figure 3 A public blockchain network

1.2. Private Blockchain:

A private blockchain on the other hand can only be accessed with a permission. Private blockchain is the one we are concerned about because in the shipping industry the data should be shared between the vessels and not with everyone. Private blockchain uses a pair of a public and a private key combination, which are used to digitally sign each block which is quite secure [4].

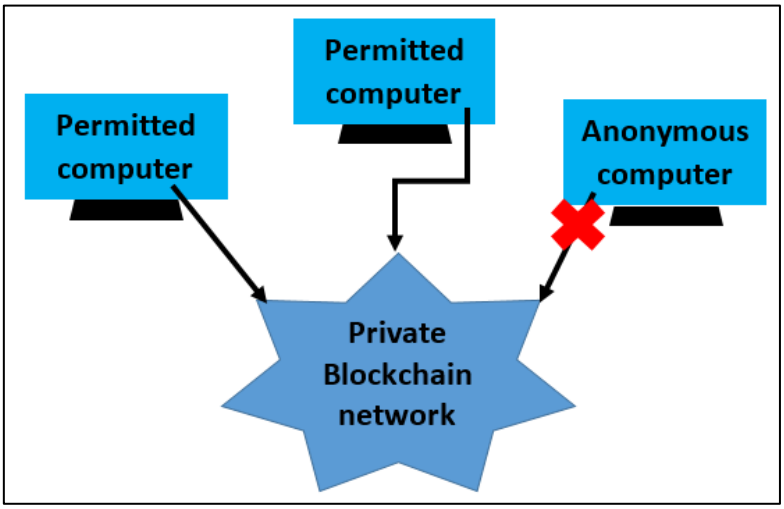

Figure 4 A private blockchain network

2. IMPLEMENTATION OF BLOCKCHAIN TECHNOLOGY IN THE SHIPPING INDUSTRY:

The blockchain has already entered the shipping industry but with an angle of financial efficiency and transparency. IBM and Danish transport with logistics giant Maersk launched a platform based on the blockchain technology which effectively tracks data about shipments in real time. This technology has also helped so as to determine the location of a container in real time without intermediate people [5]. As of today, a lot of documentation is required for transactions in shipping, such as sales contract, charter party agreements, bills of lading, port documents, etc. all these are passed through many parties until they reach the desired person. Blockchain can handle these transactions with ease as they will be easily available and they cannot be changed because of their timestamps and the hashes. To change a transaction, the whole chain has to be altered and the majority of participants should accept the change which is almost impossible [6].

Table 1

Job	Blockchain technology	Current technology
Tracking of shipments in real time	✓	✗
No intermediate person required	✓	✗
Loads of documentation	✓	✗
Reliability	✓	✓

2.1. Smart Contracts:

Smart contracts are digital contracts which are automatically executed thus saving human efforts. For example, if an owner of a restaurant orders raw materials from food vendor he will specify his order in a purchase order. The vendor when receives the order he prepares it accordingly and a bill of lading is made specifying all the details of the order and the food is shipped by the vendor. Once the order is arrived, it is checked by the owner's representative and the bill of lading is sent to the owner so that he completes the payment. This traditional method requires a lot of physical work [7].

Whereas if we use blockchain technology the advantages are-

1. Secure - No central storage which could be attacked by hackers. Global Trade's most important document is encrypted and securely written on the blockchain network, accessible only with traders' private keys.
2. Fast - Smart Bill of Lading is issued instantly and is immediately available to the Exporter. When agreed conditions are met, Smart Bill of Lading is transferred to the legal owner of goods instantly, without couriers in the middle. Just like sending an e-mail.

3. Paperless - A blockchain-based Smart Bill of Lading will be equivalent to a paper one. Having it on the blockchain just takes the pain away. No need to print, send, store and archive it.

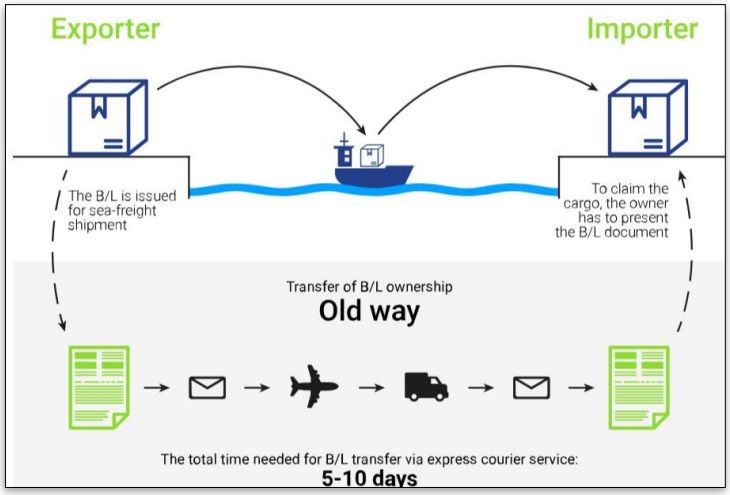

Figure 5 Old way to transfer a bill of lading

Figure 6 New way to trade

4. Cost savings - Each paper Bill of Lading is sent at least three times with couriers making it extremely expensive and slow. The average cost for sending a Bill of Lading three times is around $100 and it takes up to 10 days to reach the final destination. Millions of Bill of Ladings are created every year [8].

2.2. Autonomous Vessels:

Figure 7 Artists impression of an autonomous vessel

Autonomous vessels are being constantly tested for being reliable. Blockchain technology can be used to improve the status of autonomous vessels which are currently being currently tested [9]. A blockchain network can be used to establish a secure connection between all the ships and they can share navigational, survey data or can warn other ships against danger. The network should be open and accessible on the internet, keeping the network open doesn't expose the network to a cyber-attack. Because, to change some information on the network the attacker would have to edit every copy of that block that is present on the network and then find the correct hashes so that it matches with the previous blocks which is impossible. If an unwanted situation arises, we can take control of each of the vessels instantly since we can always access the network and we are a part of it [10].

3. CONCLUSION:

Concluding the paper, its quite obvious that the use of blockchain technology will bring tremendous changes in the techniques and method of trading of the shipping industry. Transactions will be seamless and trading will be faster than ever, it will be easier for the owner to trust he buyer and the buyer will get real time information of the position

of his container (if containerized) and its location in real time, which is not possible with traditional techniques. Finally, it can be used to securely drive autonomous vessels which are interconnected and will result in a lot of profit and safety of the vessel.

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DEVELOPMENT OF INLAND WATERWAYS IN INDIA

Kartikey Malhotra
Tarun Karkera

Abstract

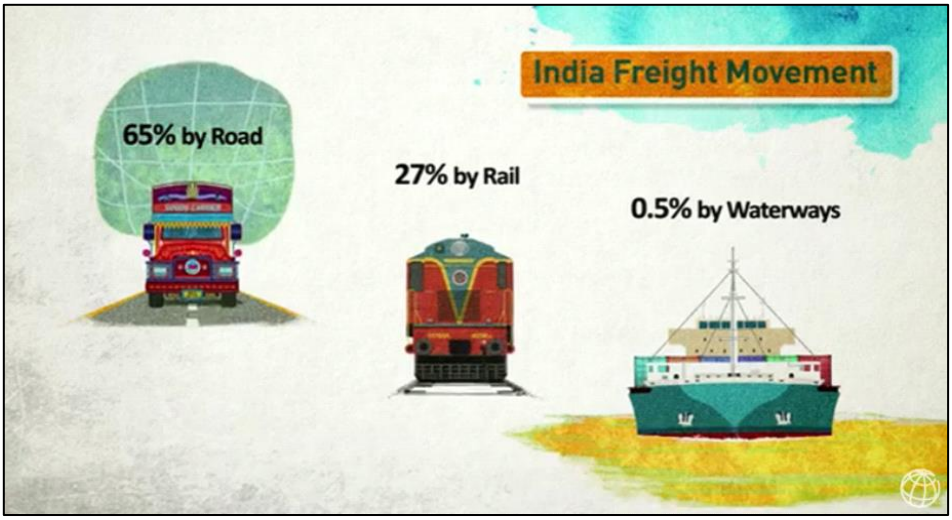
Water-based transport is compelling as a rule, working expenses of fuel are economic and ecological contamination is lower than for relating volumes of development by road, railways and the other hand by air. In India, survey the feasibility of development of travelers and cargo via. Inland water transport. Inland channel alludes to streams, waterways, lakes and so forth. There is a cover of this division with waterfront shipping where tidal streams are included.

Keywords: Waterways, Fuel and Energy Efficient, Cost Saving, Environment, Friendly, Advantages of Inland Waterways, Transportation.

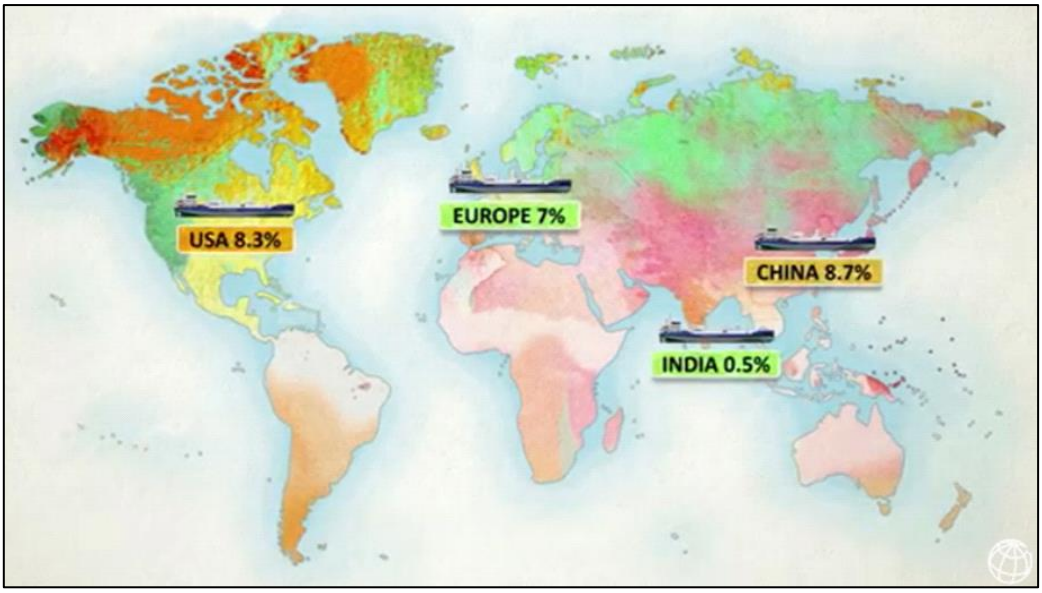
1. INTRODUCTION:

In our civilization, rivers have played a crucial role as a mode of transport in carrying people and goods. Even in the present era, many countries depend heavily on inland water transport, especially for large and bulky cargo.

The movement of freight in India is achieved through the means of land approximately 65% and by means of rail approximately 27%.



India is a land of rivers. It has 7500-km long coastline with approximately 14,500 kms of navigable waterways making it the 9th largest waterway country. This offers a huge potential for developing a cheaper and greener mode of transport.



Some real examples of inland water ways in the world:

There are several strategic inland waterways which part of transportation systems are. For example, Manchester ship canal and Gloucester ship canal in the United Kingdom and Erie Canal as shown in Figure 2.

2. INTERNATIONAL COMPARISON:

Inland water transport in India has only 0.5% modal share; China 8.7%; USA 8.3% and Europe 7% (Source: JalMargVikasProject -Frequently Asked Questions and Their Answers, Inland Waterways Authority 0f India)
inland water transport (IWT) accounts for less than 1% of its freight traffic, compared with 35% in Bangladesh and 20% in Germany. (Source: Hindu Buisnessline, 29th March 2018)

- **IWAI and National Waterways Act, 2016**
  Constitutional Provisions
  1. According to item14 of the Central List of the Constitution, matters relating to shipping and navigation on inland waterways, declared by Parliament to be national waterways, as regards mechanically propelled vessels; and the rule of the road on such waterways are the responsibility of the Central Government.
  2. According to item 31of Concurrent List, matters relating to shipping and navigation on in land waterways as regards mechanically propelled vessels, and the rule of the road on such waterways, and the carriage of passengers and goods on inland waterways, subject to the provisions with respect to national waterways, fall under the purview of both the Centre and the States

- **Inland Waterways Authority of India (IWAI)**, which came up in October 1986, acts as the nodal agency for optimum utilization of the vast untapped potential of our inland waterways but was not able to grow the waterway trade.

- **The National Waterways Act, 2016**, was an important watershed in the direction of developing the untapped potential of our inland waterways. Under the Act, 111 inland waterways across twenty-four states have been declared as National Waterways (NWs).

- **Indian Vessels Act of 1917 (amended in 2007):** It deals with the survey and registration of inland vessels, removal of obstructions in navigation, carriage of goods and passengers, prevention and control of pollution etc.

- **Inland Water Transport Policy 2001:** Policy talks about IWT being economic, fuel-efficient and environment friendly mode of transport. It advocates large-scale private sector participation both for creation of infrastructure and for fleet operations.

3. PROJECTS UNDERTAKEN:

IWAI has started taking up projects for developing these waterways as environment friendly and sustainable modes of transport.

The first of such projects is the World Bank aided Jal Vikas Marg project on River Ganga, or the National Waterways 1. The objective of the project is to develop the stretch of river between Allahabad and Haldia to make it navigable for vessels with 1,500-2,000 tonne deadweight capacity. For this, the project will develop a navigational channel of 2.2 to 3.0 meters depth and 35 to 45 metre width. Phase-I of the project covers the Haldia-Varanasi stretch of the river. Once operational, the waterway will form part of a larger multi-modal transport network having linkage with the Eastern Dedicated Rail Freight Corridor and also with the area's existing network of highways. The development of NW1 will help other states to send some of their freight to the Kolkata-Haldia complex, thus making the movement of freight more reliable with less logistical costs.

PepsiCo was the first one to come onboard for testing of the waterway, for which they sent 16 containers from Kolkata to Varanasi on MV RN Tagore. The vessel made a return journey with fertilizers belonging to IFFCO. Ro-Ro transportation has started between Dhubri and Hatsingimari and slipway facilities are being constructed at Pandu on River Brahmaputra, or NW-2.

Pilot movements on National Waterways were also conducted on various stretches, more than 15 waterways have been successfully completed, including integrated movements through NW-1 (Ganga), Indo-Bangladesh Protocol Route and NW-2 (Brahmaputra).

IWAI is in the process of developing thirty-seven more NWs in the next three years.

Normal development works are ongoing on NW-3. The development of NW-4 (Kakinada- Puducherry Canal along with Krishna & Godavari Rivers), NW- 5 (East Coast Canal with Brahmani & Mahanadi Delta), NW-16 (Barak), NW-37 (Gandak), NW-40 (Ghagra) and NW-58 (Kosi) also are in progress.

A joint venture is afoot with Thompson Design Group, Boston (USA) and Infrastructure Architecture Lab of Massachusetts Institute of Technology, to identify the best locations for construction of 18 ferry terminals in six cities, namely, Allahabad, Varanasi, Patna, Munger, Kolkata and Haldia on NW1. The feasibility study takes into account the capacity of freight and passenger movements of each city with a view to integrating these terminals with the existing transportation networks and facilities of each city.

Sagarmala Project: Along with development of coast shipping routes, the project seeks to inland waterways to drive industrial development. It aims to reduce the logistics costs by doubling the share of domestic waterways in the modal mix from current 6 per cent (PIB)

Jal Vikas Marg or National Waterway 1:

The NW1 has the future of emerging as the leading logistical artery for the entire northern India, which passes through one of India's most densely populated areas and resource-rich regions, and generates an estimated 40 percent of India's traded goods. The network of a water- road-rail link will help the region's industries and manufacturing units to have a seamless flow of goods to markets in India and abroad. It will also give wider market access to the farmers of this agriculturally-rich Gangetic plain.

Since the river Ganga occupies a special place in the social, cultural and environmental milieu of our country, the Inland Waterways Authority of India (IWAI) follows the principles of 'working with nature' to protect the river's diverse fauna and aquatic biodiversity. For this, minimum dredging is being undertaken for passage of large barges carrying up to 2,000 tonnes of cargo. IWAI is also ensuring that water traffic does not impact the two aquatic wildlife sanctuaries that fall along this stretch of the river - the Kashi Turtle Sanctuary and the Vikramshila Dolphin Sanctuary.

Currently Operational: According to a PIB release by Ministry of Shipping dated 20th July 2018, the following NWs are operational

National Waterway (NW) No	Stretch	Length (km)	Location (State)
NW 1	Ganga-Bhagirathi-Hooghly River System (Haldia - Allahabad)	1620	Uttar Pradesh, Bihar, Jharkhand, West Bengal
NW 2	Brahmaputra River (Dhubri - Sadiya)	891	Assam
NW 3	West Coast Canal (Kottapuram - Kollam), Champakara and Udyogmandal Canals	205	Kerala
NW 4	(Phase-I : Vijaywada to Muktyala)	82	Andhra Pradesh
NW 10	Amba River	45	Maharashtra
NW 85	Revadanda Creek - Kundalika River System	31	
NW 27	Cumberjua – confluence with Zuari to confluence with Mandovi river	17	Goa
NW 68	Mandovi– Usgaon Bridge to Arabian Sea	41	
NW 111	Zuari– Sanvordem Bridge to Marmugao Port	50	
NW 9	Alappuzha– Kottayam – Athirampuzha Canal Boat Jetty, Alappuzha to Athirampuzha	38	Kerala
NW 100	Tapi River	173	Gujarat
NW 97	Sundarbans Waterways	201	West Bengal (through Indo-Bangladesh Protocol Route)

4. PUBLIC PRIVATE PARTNERSHIP:

Government and IWAI are working on two channels to draw private players in **Physical infrastructure:**

(a) Developing navigation, channel operation and maintenance, and external connectivity infrastructure.

(b) Navigable route development.

(c) External connectivity infrastructure.

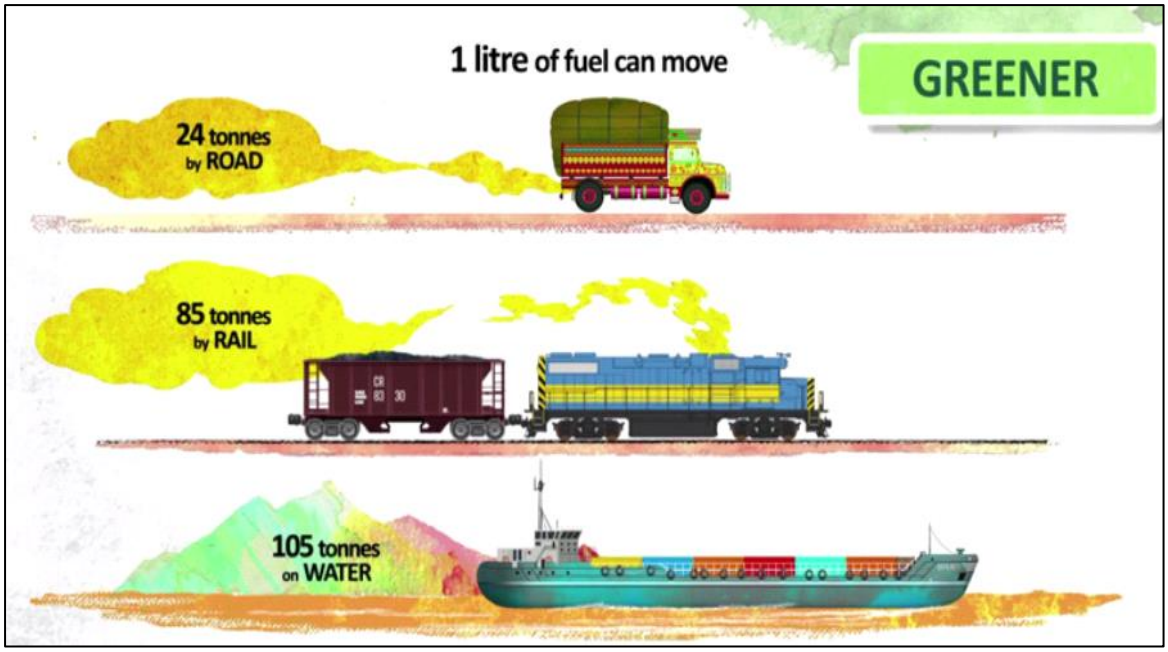
5. ADVANTAGES OF INLAND WATERWAYS:

- **Fuel and Energy Efficient:** It is fuel-efficient compared to the other modes of transport, rail and road. For example, the Integrated National Waterways Transportation Grid Study states that one litre of fuel will move 24 tons through one kilometre on road, 85 on rail and 105 km on inland water transport. Further, 1 HP can 150 kg on road, 500 kg on rail and 4000 kg on water.

- **Cost savings:** Cost of developing waterways is much lower than rail & road. It reduces transportation and transition losses.

- **Environment Friendly**: One of the benefits enjoyed can be efficient means of transport of goods without the emission of harmful gases in the air. In a time where global warming is becoming a leading concern let's see how the introduction of potential inland waterways would help us in creating a sustainable and comparatively less harmful environment. One litre of fuel can move 24 tonnes of cargo via roadways, 85 tonnes of cargo via railways and it moves 105 tonnes of cargo on water.

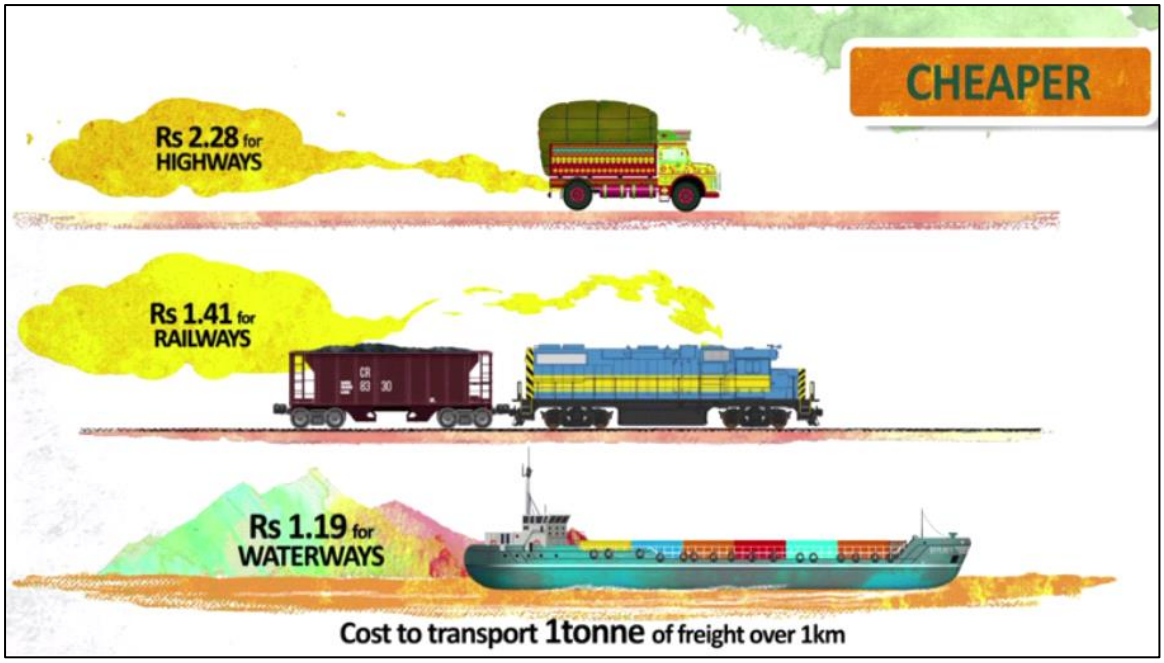
- Carbon dioxide emission is 50% of trucks
- Negligible land requirement as compared to rail and road transport
- Reduces pressure on road and rail
- Reduces congestion and accidents on road
- Optimal Modal Mix: It will provide optimal modal mix by converging river transport with other modes



- Better connectivity: It help create seamless interconnectivity connecting hinterlands along navigable river coasts and coastal routes. Further, riverine routes are likely to play a crucial role in connecting the north-eastern states to the mainland
- Inland Waterways hold huge potential for domestic cargo transport, cruise, tourism and passenger traffic.
- Development of inland waterways will help in the generation of job opportunities

6. ECONOMIC EFFICIENCY:

It has been found that logistics costs in India account for about 18 percent of the country's GDP, which is much higher than China, USA, UK and many other countries. This makes Indian goods costlier and hence less competitive. As per World Bank analysis, the cost of transport of one tonne of freight over a km by road is Rs 2.28, by rail Rs 1.41 and Rs 1.19 for waterways. So, logistics costs in the country can be brought down considerably by transporting more and more goods by waterways. In this era of energy crisis, waterways have been found to be a fuel efficient, environment friendly and cost-effective mode of O



7. ISSUES AND CHALLENGES:

- **Cost estimation:** In respect to operating costs per ton-km, IWT has lower cost than rail and road transport. However, this cost argument is challengeable. There are two factors which distinguishes how freight moves on land versus on water

- **Inadequate depth:** To be viable for a navigable inland waterway, river needs enough depth throughout the year However, in their natural state; many Indian rivers simply do not have that level of water which will necessitate extensive dredging. Moreover, Indian rivers (especially rivers in the northern plains) face severe problems of siltation round the year

- **Impact on other activities:** Water in rivers has competing demands, including dams and farming. To maintain the water levels in the river to the degree needed for them to function as inland waterways, the water use for such other activities might get curbed.

- **Inadequate Air Draft:** Multiple bridges with low vertical clearance obstruct the passage of bigger inland water transport vessels on many inland waterways such as NW 3

- **Lack of night navigation infrastructure:** Rudimentary night navigational facilities and markings are also a major issue.

- **Shortage of IWT vessels:** Vessel building is highly capital intensive and faces difficulties in obtaining project finance from banks and financial institutions.

- **Shortage of MRO facilities:** There is severe shortage of MRO (Maintenance, Repair and Overhaul) facilities for IWT vessels.

- **Inadequate industries:** Inadequate number of Industrial units on the riverside, especially not along the Brahmaputra is a major discouragement hindering development of inland waterways. At National Policy Dialogue on transboundary cooperation related to the Ganga and the Brahmaputra rivers – states, it was highlighted that due to inadequate industrial units result in no cargo commitments by the private players

- **Lack of funds:** Dredging as well as infrastructure for IWT requires huge investments. However, both public and private funding in the sector is low.

- **Environmental Impact:** Dredging operations will damage river bed and can lead to change in habitats for various aquatic flora and fauna. Dredging may also impact aquifers along the river, damaging the ability of water to percolate underground. In estuaries and creeks of rivers the removal of river bed material during capital dredging can result in the ingress of excess saline water into the creek or rivers. This is one of the reasons why the state of Kerala had opposed many of its proposed waterways, Construction of jetties, river ports will necessitate removal of trees/ mangrove forests in the area. For example, At Dharamtar port in NW10, for construction of a jetty, the mangrove forest belt on the bank has been removed. Other environmental concerns include pollution due to oil and diesel from vessels, leakage and spilling of cargo

- **Social impact:** Ecological impacts can have implications for livelihoods of people dependent on the rivers and creeks. For example: impact on fishing community, people dependent on riverbed cultivation. Displacement is another major concern as land is needed for number of facilities like ports, jetties, and other infrastructure.

8. POLICY INTERVENTION/VISION:

Incentivizing cargo transport through inland waterways. To ensure there is enough freight to make physical infrastructure development viable, the following measures can be taken:

a) Offer incentives, including tax subsidies, for transporting a portion of industry cargo through IWT.
b) The Government can mandate/incentivize industries in the proximity of national waterways to use this mode for a portion of their shipments.
c) Higher road taxes can be levied on transportation of coal and inflammable material over longer distances because they are harmful to environment or pose a danger to those in proximity.
d) Government can promote industrial corridors along riverbanks and foster waterways-based industrialization.
e) Capital dredging, along with different waterways, will also offer opportunities to reclaim land along riverbanks.
f) Promoting passenger transportation and tourism.
g) Resolving the protocol route issue with Bangladesh.

9. CONCLUSION:

It is very much important to incorporate inland waterways into multipurpose transport arrange in the request to reinforce its position available. It is important to raise the level of inland waterways transport unwavering quality and effectiveness by guaranteeing a high caliber of the vehicle base keeping in the mind the end goal to incorporate inland conduit transport to multipurpose transport system. Another improvement cycle has to be started for a percentage of the port foundation. This is primarily identified with

furnishing ports with an essential port base and also with limits fundamental for trans-shipping uncommon sorts of freight taking after business sector request. Every single universal port needs to meet natural security prerequisites, principally by developing separate gathering offices for fluid waste and oils.

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SHIPWRECKS, ITS EFFECTS ON ENVIRONMENT AND SUSTAINABLE SHIPPING

Shubham Bhagat
Muskaan Chauhan

Abstract

In this paper we will review about the causes, its effects on environment and how to prevent shipwrecks which ultimately leads to sustainable shipping. A shipwreck is the remains of a ship that had wrecked, which are found either beached on land or sunken to the bottom of a water body. Shipwrecking may be deliberate or accidental. Ship wrecks can cause damage to the underwater environment through oil spill, hazards materials and can damage corals and natural reefs. The recent global directives suggest an urgent need for a better understanding of causes and effects of ship wreck and find measure to counteract with its ill effects. Despite modern bridge equipment, new technologies, and improved safety measures, maritime accidents still occur, and an analysis of their causes is essential in preventing future accidents. Ship groundings are one of the more frequent types of accidents encountered. In this paper we discuss the remedial measures for finding the ways to control shipwrecks and hence lead to sustainable shipping.

Keywords: Shipwreck, sustainable shipping, wreck corrosion, grounded vessels, human error, marine accident, grounding accident, human factor, accident analysis.

NOMENCLTURE:

NOAA- National Oceanic and Atmospheric Administration

WW11- World war two

ECDIS- Electronic Chart Display and Information Systems

BRM- Bridge Resource Management

1. INTRODUCTION:

By the word ‘wreck’, we usually mean the remains of a Vessel, aircraft or any other object of conspicuous size which, due to various possible causes (from accidental collisions to acts of war or terrorism, or deliberate sinking), is partially or totally submerged by sea body. Most of the ships were sunk in wartime or by pirates in blazing cannon duels. It is roughly estimated that there have been about 3 million shipwrecks worldwide and only less than 1% of these ships has been explored (jay Bennett, 2016). The majority of all shipwrecks are caused by the ship collision, fire onboard ship, poor navigation like running aground on rocks, a coral reef, a sandbar, or even another wreck ship. There are thousands of vessels, aircraft and other commercial and military wrecks located at the bottom of the Sea due to accidents, collision or any other reason, are a cryptic source of pollution, since the ships contain various oils and toxic material of

both organic/inorganic types starts leaking and these pollutants can generate ecological damage, thus modifying the natural arrangement of oceanic floor in seas. There are high number of military ships abandoned on the seabed of the Mediterranean Basin due to accidents during the First and Second World Wars (Sprovieri et al., 2013), it is pressing to increase our knowledge about the causes and preventive measures for controlling and overseeing shipwreck. This becomes crucial and is assuming considerable importance on a worldwide scale. The main aim of this study was, therefore, to study causes of Shipwrecks and its effects on environment.

2. CAUSES OF SHIPWRECK:

2.1. Accident onboard ships:

Marine vessels contain lot of highly sensitive and flammable tanks and machineries which are prone to explosion, like auxiliary engine, boilers, generators, fuel bunker tanks and cargos. Due to mishandling of these various onboard equipment's and lack of knowledge these machineries leads to big explosion which ultimately leads the ship to wreck.

2.2. Collision of ships:

Due to globalization there is increase in global trade and thus increase in number of ships, due to this there is more chances of collision of ships. These collisions may be sever depending on the speed of the vessel during collision and can lead to the wrecking of the ship. The reason for collision may vary from poor navigation to machinery failure, ultimately resulting in wrecking of ship.

2.3. Military activity:

Military activity is one of the main reasons for most number of ship wrecks. During wars a very large number of ships are sunken by military in which most of the ships are carrying dangerous munitions and weapons which have oil and toxic material which are pollutant to the sea. still now light military activity like basic and intermediate

military training exercise for navy, if goes wrong or disarming of live mines compromised can cause damage or if a hostile vessel needs to be put out of action, like pirates or illegal ships these damage can cause serious damage to ship resulting in shipwrecks. In such incident, no concern is likely to be given if the ship is destroyed and shipwrecks.

3. EFFECTS OF SHIPWRECK:

3.1. Oil and Chemical spills:

Petroleum entering the marine environment has a negative effect on living organisms. There are three different pathways through which oil can be exposed to receptors; direct contact or ingestion, intake of bio available components through water, and ingestion of prey contaminated by oil. Oil washed up on beaches or covering areas at sea can attract and smother seabirds.

Oil is not the only threat to marine biodiversity. The warships used in the WWII also carried munitions which, over the years, have become corroded to the point where they are liable to start leaking significant quantities of toxic substances. Some of these toxic substances, such as mercury, are not biodegradable and can cause chemical contamination of the food chain. It has been researched that oil released into the marine environment can also effect and cause changes in community structure in meio fauna which is a small microorganism, hence affect marine ecosystem.

3.2. Wreck Corrosion:

It will affect a steel structure on the sea floor. The rate of corrosion is in general affected by e.g. dissolved oxygen, temperature, pH, salinity, current velocity, wave action, marine growth and bacteria (Kuroda et al., 2008; Sender, 2010). The wreckage of WWII threatens to destroy the beauty of the Pacific. Home to hundreds of species of coral - and thousands of fish species, including important tuna habitat, the Western Pacific is the most prolific ecosystems on the planet. For the last sixty-five years, the marine environment has slowly corroded the steel of their hulls; their interior compartments and their ordnance. Shipwrecks are one of among the biggest sources of marine

pollution. These wrecks are estimated to contain nearly 38% of the total volume of oil are still trapped in sunken vessels. Some 75% of sunken wrecks date back to the WWII is corroded and their metal structures are ageing resulting in deterioration of metal plates are thus threatening to release their contents like oils and other pollutant into the ocean due to these effects of corrosion.

3.3. Ship traffic:

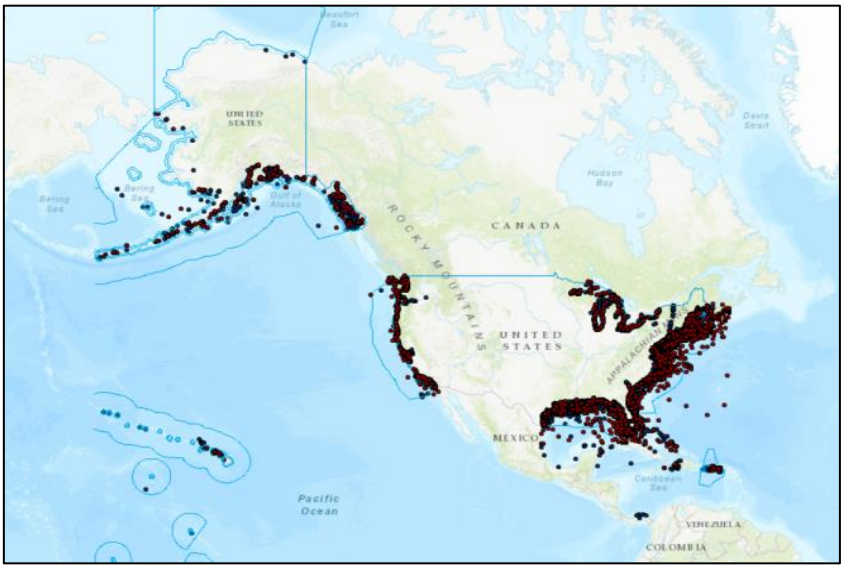
Smaller vessels such as private boats, ferry traffic, tourist vessels, research vessels and coastguard are assumed to have a speed of about 7-20 knots and might anchor in the area of a shipwreck or might get collided dues lack of information of wreck vessels location. Intermediate sized and large sized vessels such as ice breakers, short sea shipping vessels, service vessels, container vessels, bulk vessels, specialized shipping vessels, cruise ships and large ice breakers might also anchor in the vicinity of a shipwreck and can cause both environmental and economic damages. The hazard posed from ship traffic is damage due to anchoring and the squat effect. The squat effect occurs when water is pushed in front of a ship due to its movement forward. This will leave a deficit of water behind the ship and the return flow is speeded up under the ship. This causes a pressure drop and the ship drops vertical in the water. The squat effect is assumed to potentially destabilize a ship wreck.

3.4. Loss of capital and property:

Apart from environmental effects ship wrecks are responsible for major capital and monetary losses of the shipping company as ship sinking cost the ship owners the cost of cargo it was carrying and loss of reputation of company excluding various fines from particular sea/port authority where the ship is sunken. The sum of loss of a ship is in millions or even billions and can easily strain or demolish the shipping company’s bank account.

3.5. Effects on environment:

Governments may not be aware of the oil onboard or its potential impact, environmental protection may not be a priority, or simply, they are not aware of wrecks in their waters. Only recently have nations begun investigating the potential of pollution from wrecks within their own waters. The United States was unable to trace the source of a series of oil spills in San Francisco Bay for years. At the time, these mystery oil spills were the "largest killer of sea birds in North America" (Basta, 2010). Only after several years of collecting oil samples and ruling out modern vessels did government researchers identify the culprit as the wreck of the S.S. Jacob Luckenbach. We can see the NOAA's data of known shipwreck in US coastal area.



In 1952, the freighter Luckenbach struck another ship and sank 17 miles southwest of San Francisco, near the future Gulf of the Farallones National Marine Sanctuary (Monterrey Bay National Marine Sanctuary). Upon discovering this wreck as the source of multiple oiling events in the Bay, and as a wreck capable of significant environmental damage (the ship sank with 457,000 gallons of bunker fuel), the Office of National Marine Sanctuaries began the Resource and Under Sea Threats (RUST) database "to find the next Luckenbach" (Basta, 2010). This database now comprises thousands of wrecks and aims to catalogue data on the more than 150,000 sunken vessels in U.S. waters (Zelo et al, n.d.). Japan, the UK and France have also begun cat aloguing their wrecks.

HFO is likely more persistent on the water surface than lighter refined products, involving the risk that it may drift and impact other areas, for instance coastlines. This is in line with the overall findings from the four Norwegian oil spill incidents that the water surface, upper parts of the water column as well as the coastline is the most vulnerable parts of the environment. (J. F. Rasmussen)

3.6. Analysis of Shipwreck:

Many of these wrecks pose environmental threats, either because of the hazardous nature of their cargoes, presence of munitions, or because of the bunker fuel oils left on board. As these wrecks corrode and decay, they may release oil or hazardous materials. This wreck poses an immediate pollution threat or impede navigation, the vessels are left alone and are largely forgotten until they begin to leak. (D helton, 2010)

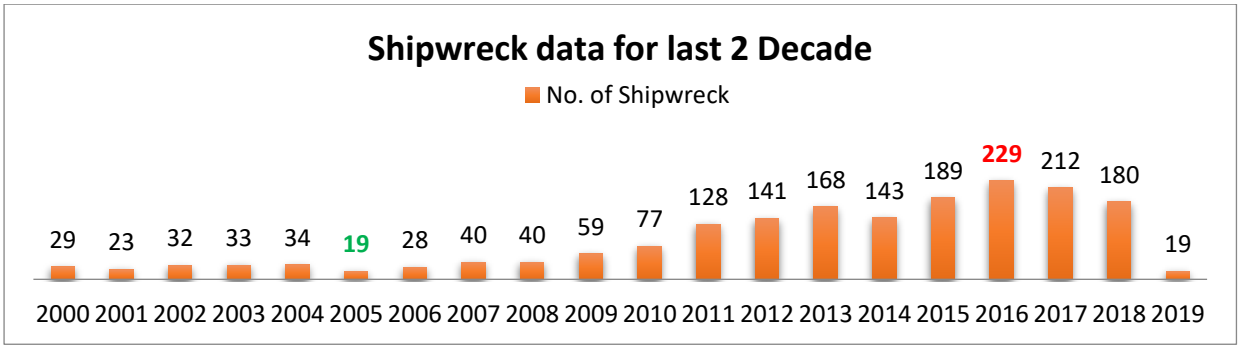


Figure no. 1

We can see in graph no. 1 that there is data of shipwreck of known ships for last 20 years. We can clearly see that at first decade the no of shipwrecks was very less around 41(Approx) ships per year on an average. It is clearly seen that after 2010 the no. of shipwreck has increased. In 2016 there is total of 229 shipwrecks, which is the highest in last 2 decades. The lowest no. of shipwreck was observed in 2005.

Let's study the year when there was most no. of shipwrecks in this past 20 years, i.e; 2016, and last year of 2018. We will classify the shipwreck on basis of nature of accident. We broadly classify the types of accident as fire, collision, grounding, capsizing, natural and others.

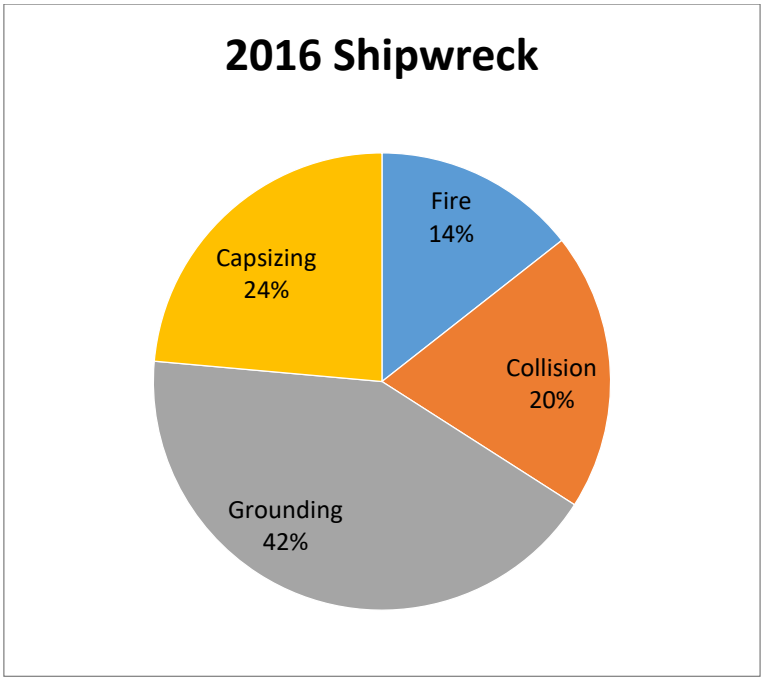


Figure no.2

On compiling the available data, we found out that most percentage of shipwreck on basis of nature of accident. The above figure no.2 shows the percentage of shipwrecks in the year 2016, which had maximum number of shipwrecks in this 20 year. It clearly shows that the maximum shipwrecks are caused due to grounding, followed by Capsizing of ships and collision of ships. Fire comes after that as 4th major cause of shipwreck in 2016.

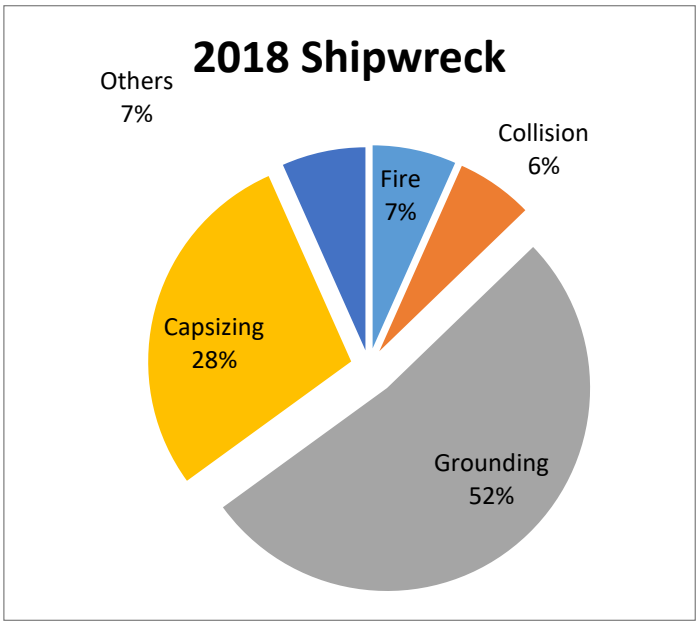


Figure no. 3

Now we will look into the last year of causes of shipwreck. The figure no.3 is prepared by collecting the data of the various known shipwrecks that's has been reported, which clearly pectoris's that within one year the percentage of shipwrecks caused due to grounding have massively increased from 42% to 52%. And therefore it is necessary to find out the reason for continuous increase in shipwrecks due to grounding. Maritime accident analyses aim to determine the root causes of accidents and recommend effective ways to prevent similar accidents. Maritime accidents may involve more than one factor, such as human errors, mechanical failures, adverse weather conditions, and traffic density. Safety measures are therefore essential in preventing accidents; it is vital to learn lessons from previous accidents to safeguard life, property, and the environment at sea.

Causes of grounding accidents		Abbreviations	Frequency
1. Voyage Management Errors	1.1 Faulty or inadequate passage plan	VME-1	18
	1.2 Inappropriate route selection	VME-2	10
	1.3 Use of improper chart	VME-3	24
2. Team Management Errors	2.1 Lack of communication and coordination in bridge resource management	TME-1	62
	2.2 Lack of external communication	TME-2	5
	2.3 Improper look-out	TME-3	20
	2.4 Deficiency in safety management system	TME-4	11
	2.5 Failure of watch arrangements	TME-5	3
3. Application Errors	3.1 Position Fixing Application Errors	AE-1	30
	3.2 Inefficient usage of bridge navigation equipment	AE-2	31
	3.3 Faulty maneuvering	AE-3	14
	3.4 Interpretation Errors	AE-4	41
	3.5 Unsafe speed	AE-5	4
4. Individual Errors	4.1 Fatigue	IF-1	35
	4.2 Alcohol	IF-2	8
	4.3 Stress	IF-3	7
	4.4 Lack of training & education	IF-4	12
	4.5 Watchkeeping officer		

Table no. 1

On researching the causes of shipwreck, we can see that human errors played a major role. This Table reviewed about maritime accident reports related to groundings caused by human error, and the causes were. Categorised to enable interpretation (Mullai and Paulsson, 2011). the causes of grounding accidents attributable to human error are defined by four main categories: team management errors, voyage management errors, application errors, And individual errors. Table below illustrates the causes of groundings and their frequency.

We will now classify the shipwreck on basis of their flag state. On collecting the data of 2018, we found out that major no. of shipwrecks is from china that is 13% of overall shipwreck followed by Indonesia with 10%, PANAMA and Russia are next with 8% of shipwrecks each with USA of 4%. There rest of the countries comprised is at 57% of whole shipwrecks as we can see in figure no. 4.

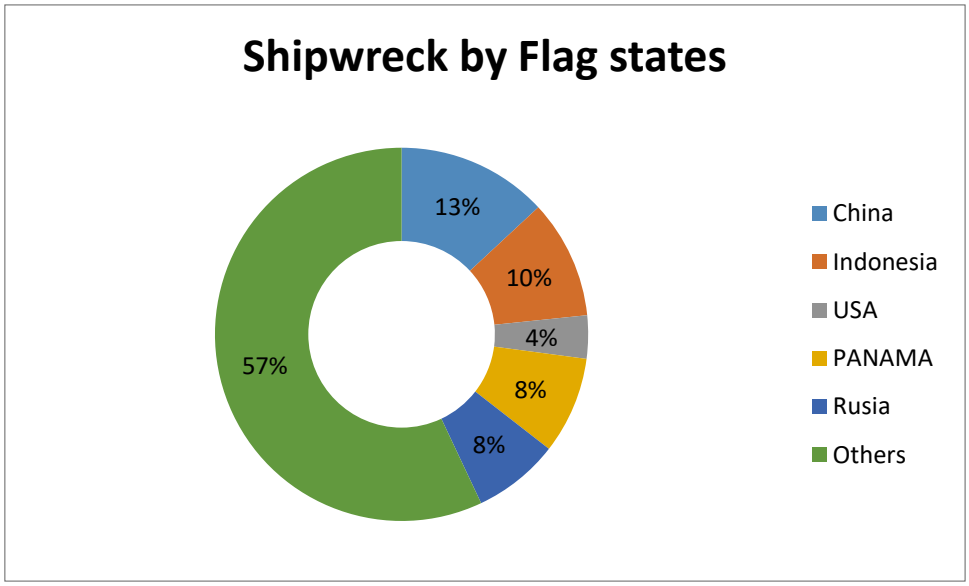


Figure no. 4

4. COUNTERMEASURES:

Countermeasures for ill effects of ship wrecks are:

- Improvising navigation and ship equipment management to avoid/minimize accidents and ship wrecks.

  Also implementing better training and navigational equipment's which enables ship to avoid any collation or grounding in shallow waters.

- More support and research in order to improve knowledge about existing ship wrecks as:

  Location of existing wrecks that are known for creating a no anchor and diving zone to isolate the wreck until unless its wreck conditions been identified.
- New research and study of the ability to predict rates of corrosion and degradation of sunken wrecks for different conditions (water temperature, currents, etc.).

  The technology of remotely operated underwater vehicles (ROVs), with a view to reducing the cost of identifying and locating wrecks, as well as the cost of removing oil or neutralizing toxic or nuclear waste, and/or wreck removal.
- Removal of Wreck by various methods like full removal, partial removal, pulling ashore using ground tackle, refloating vessel to water surfaces, etc.

  Knowledge of the physical properties of oil and toxic and radioactive substances in deep water, cold water and high-pressure seawater environments for safely removal of wreck ship.
- There are technology offers solutions to prevent the ships from releasing their oil known as “offloading”. When ship is sinking the integrity of the hull is established with a process called “hot tapping” is used to drill into sunken vessels and remove the oil. This technique is used on the USS Mississinewa by U.S. Navy with a Salvage teams (SUPSALV) and contracted salvage teams to drill through the hull and install valves for a controlled removal of fuel. A number of taps was drilled to speed offloading of the Mississinewa, with each tap taking 15 minutes to install (U.S. Navy, 2004). Once a valve is in place, a hose is attached and the oil is vacuumed to containment barges at the surface (SPREP, 2002). Once the oil is removed, seawater and other impurities are filtered out and the oil may be reused.

5. CONCLUSION:

The Causes, effects and of ship wrecks has been discussed in this report. A shipwreck shatters all the MARPOL regulation with a huge margin. So it is our prime duty to protect the marine environment from polluting and ultimately lead to sustainable shipping. There is a need for a strong regulation and convention that strictly implies on all major counties. The special measures to be taken are as follows: Improvement of education and training, Obligation to have Electronic Chart Display and Information, Systems (ECDIS) and compulsory ECDIS training for Watch keeping officers.

Amending the working hours of watch keeping officers in Accordance with STCW, not only on records but also in Practice (improvements in seafarers' hours of work and Rest). Improvements in the SMS. Compulsory Bridge Resource Management (BRM) training. For watch keeping officers, captains, and pilots. Increasing the number of seafarers, especially the number of watch keeping officers.

It is over Civic duty to take responsibility of our environment and try and maintain all the rules and regulations. Improve the shipwreck governing system and collect the data on known shipwrecks as there are more than 3 million shipwrecks whose location are unknown. These are a grave danger as its potential harm on environment cannot be reversed. It's our responsibility to learn about past, work better in present and leave a safe and sustainable future for next generation.

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SUSTAINABILITY IN SHIPPING

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Prateek Rana

Abstract

When thinking about the future, envisioning healthier environment and cleaner surroundings is most desirable. That goal can only be achieved by meticulously adopting the principles of sustainability in every way possible. Sustainability is all about utilizing available resources in an environmentally-conscious way and without any form of exploitation, thus greatly minimizing the chance of leaving behind any harmful footprints from our activities. Shipping, being the major means of transporting goods from country to country needs to imperatively, become as sustainable a procedure as possible. The United Nations' 2030 agenda for sustainable development enlists 17 Sustainable Development Goals, one of them being "Conserve and sustainably use the oceans, seas and marine resources for sustainable development"[1] and another one being "Take urgent action to combat climate change and its impacts"[1]. This paper aims to focus on these two specific goals by discussing two innovative methods. The first one is with regards to oil spills and how a specially manufactured cotton batting can help alleviate the negative impact of one. The second one is about reusing scraps from ships that are being dismantled, producing iron-based compounds from those scraps and dispersing those (safe) compounds into the ocean to boost the growth of phytoplankton which will then be able to absorb more carbon-dioxide from the atmosphere and bring the levels of carbon-dioxide, down.

Keywords: Sustainability, shipping, oil spills, carbon dioxide, cotton, phytoplankton, ocean fertilization, sequestering, climate change, marine

1. OIL SPILLS:

1.1. Introduction:

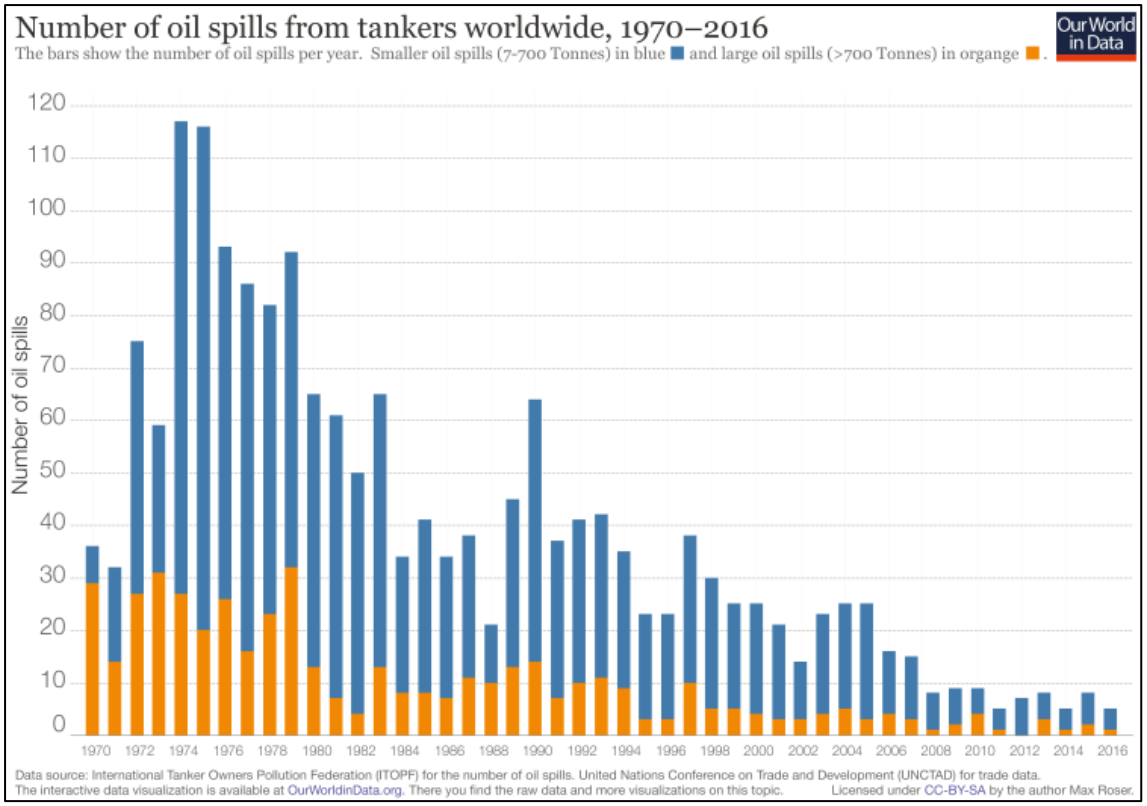
Oil spills are highly damaging occurrences in the world of shipping. An oil spill is the release of fuel or oil into the environment, especially the marine ecosystem from vessels sailing on it and is a serious form of pollution. The lives of people living close to the area where an oil spill occurs are disrupted, a large sum of money is spent on clean-up operations and the surrounding marine life undergoes devastation as well. These points make it clear that oil spills are best, avoided. One of the major reasons an oil spill becomes difficult to clean is that there is usually a large time delay between when an oil spill occurs and when the clean-up operation starts. Factors such as the ocean currents, wind and sunlight can cause the oil to spread or concentrate in unexpected

[1] "IMO and Sustainable Development Goals" (2012) http://www.imo.org/en/MediaCentre/HotTopics/Documents/IMO%20SDG%20Brochure.pdf (last accessed 24 February, 2019)

patterns. Therefore, an immediate step is required that can, in a very short amount of time, control the spread of the spill.

1.2. Action of cotton batting:

A large batting (a thick, layered sheet) of specially manufactured cotton of appropriate size and weight can be designed to be released from the body of the ship at the very moment an oil spill occurs. The material that is to be used to clean up an oil spill should soak up the oil and not the water. The naturally waxy coating of cotton allows it to have a property by virtue of which it repels water and absorbs oil. The best results can be obtained when three actions occur simultaneously, namely *adsorption, absorption and capillary action*. The cotton can let some of the oil cling to the surface of its fibres through adsorption, allow the oil to seep into the structure of the fibre through absorption and finally allow a substantial quantity of the oil to be collected within the thin fibres, in channel like spaces, through capillary action. The last step i.e. capillary action cannot be effective unless and until the fibres are free and detangled. For this, specially combed or 'carded' cotton has to be used. A carding machine has rows of prongs that can stretch the fibres straight and separate them from one another. Low grade cotton that is not mature works 7 percent better than refined cotton because of the comparatively waxier nature and the finer quality of the immature cotton fibres. Low grade cotton is cheaper so this method is cost effective. Since the batting, with oil in it will have a mass lesser than that of an equivalent volume of water, the cotton structure will stay afloat. Ideally, this type of a batting can absorb 50 times its weight in water. From the charts below, an idea of the average amount of oil spilled by a vessel can be calculated, which comes to *5-7 tonnes*. Based on those calculations, the weight of cotton required to be kept on board an average oil-carrying ship can be estimated to be anywhere between 100-150 kilograms. This weight will be divided amongst four or five batting-structures, each weighing 25-40 kilograms.


Number of oil spills from tankers worldwide, 1970–2016
The bars show the number of oil spills per year. Smaller oil spills (7-700 Tonnes) in blue and large oil spills (>700 Tonnes) in organge .
Our World in Data
Number of oil spills
120
110
100
90
80
70
60
50
40
30
20
10
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Data source: International Tanker Owners Pollution Federation (ITOPF) for the number of oil spills. United Nations Conference on Trade and Development (UNCTAD) for trade data.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.
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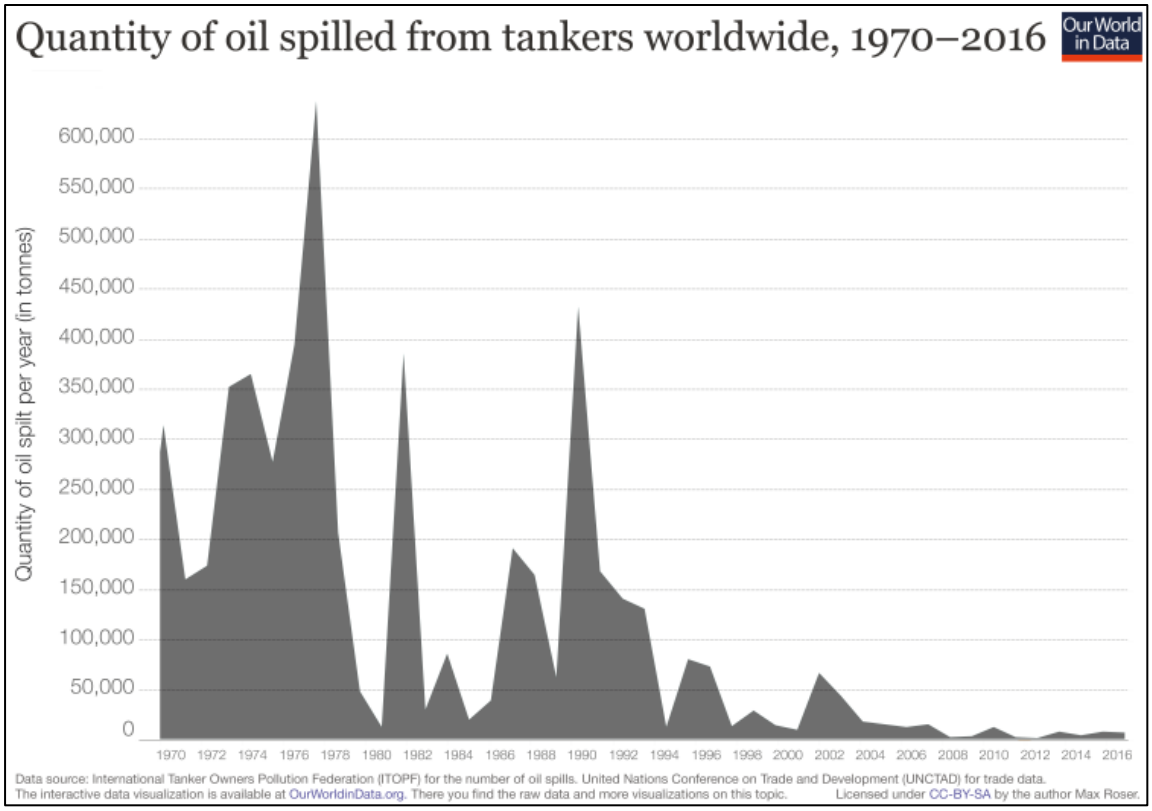
Quantity of oil spilled from tankers worldwide, 1970–2016
Our World in Data
Quantity of oil spilt per year (in tonnes)
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Data source: International Tanker Owners Pollution Federation (ITOPF) for the number of oil spills. United Nations Conference on Trade and Development (UNCTAD) for trade data.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.
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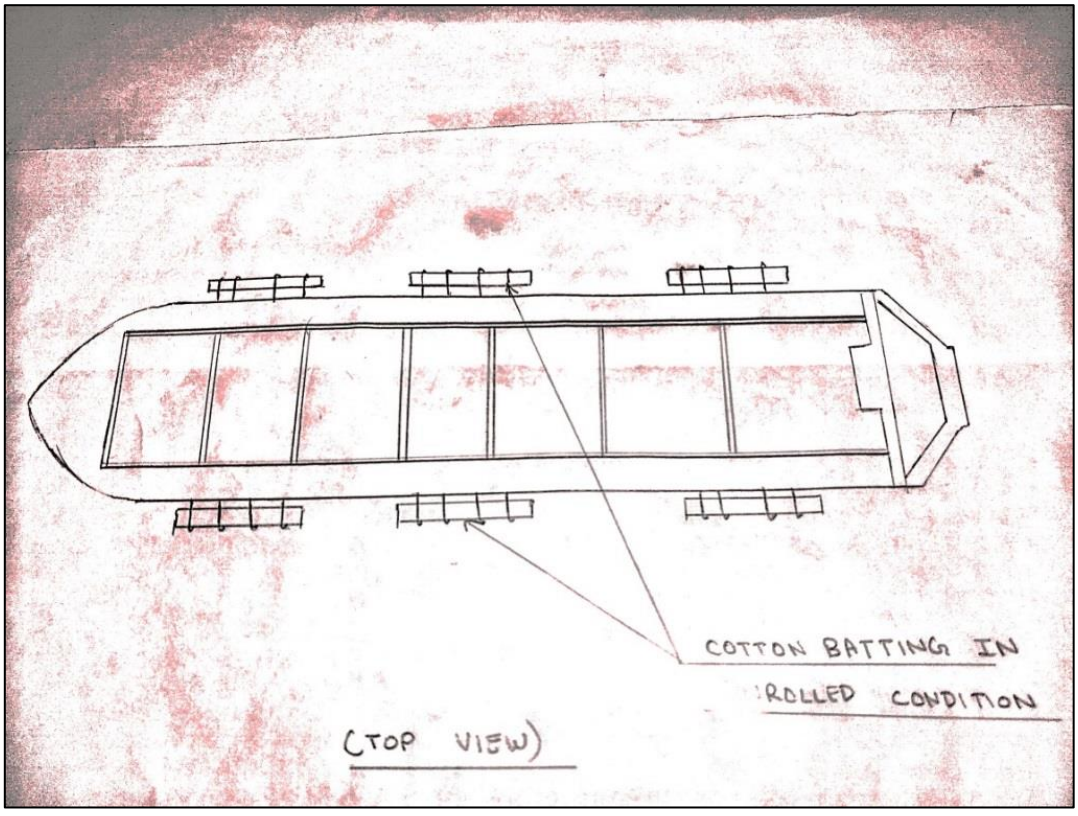
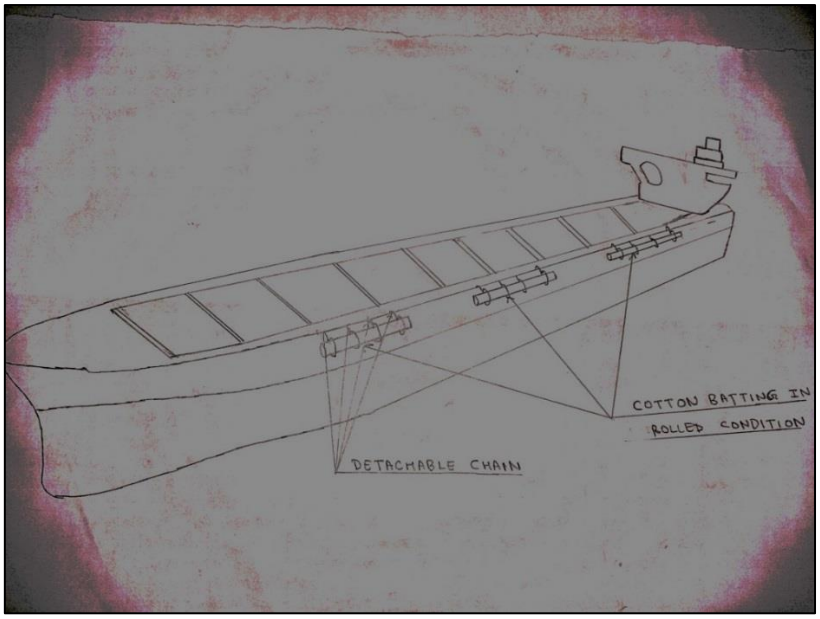
1.3. Placement of cotton batting:

The batting can be held through a system of metal chains attached to the hull of the ship, where it will be rolled up and covered with heat and water resistant plastic so as to protect it from the effects of the sun and wind. The design of the batting, covering and chains will be such that when released during an oil spill, the entire arrangement will unfurl from its position on the hull as a composite structure made of three sections. The topmost part will have the metal chains connected firmly to the protective plastic covering (making up the second section) which will in turn, be attached to the upper part of the cotton batting. These metal chains will be fastened to a ring on the hull but will also be *detachable* in nature. The chains and the plastic cover, when unrolled will almost equal the entire height of the hull so that all of the batting can be dropped onto the free surface of water, thus optimizing its utilisation. The plastic cover will have slightly extended, firm and curved edges so that when the cotton batting is rolled up the two ends of the cylindrical rolled-up structure do not remain exposed.

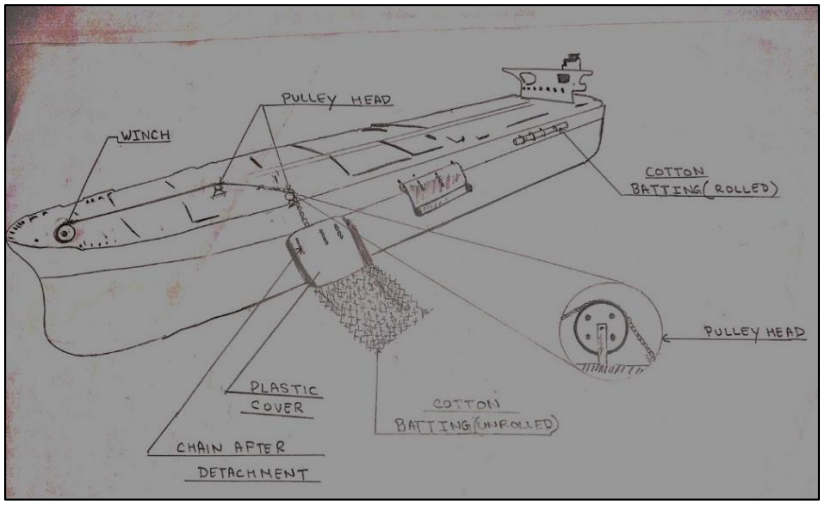
To secure the batting when it is rolled up, an additional set of chains fixed to the hull of the ship (at a position below the rolled-up batting) will lock in with the chains that are a part of the composite structure.

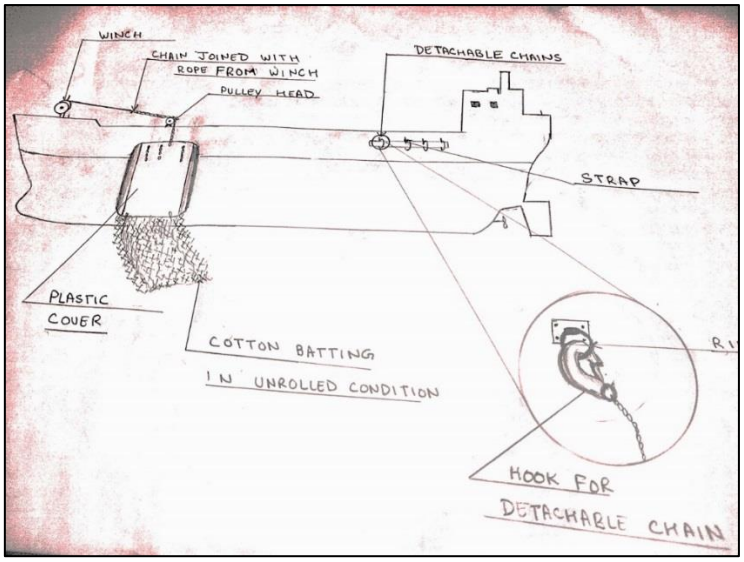




1.4. Release and lifting of the batting:

To release the cotton batting into the water, the locking mechanism of the chains needs to be opened, after which the unfurling will take place. However, before releasing the lock between the chains, it is important to free the upper metal chains (that are a part of the composite body) from the ring on the hull and then tightly fasten the loose ends of those chains, to the rope(s) from one or more mooring winches. The ropes from the mooring winches can be guided by pulleys to lead to the edge of the deck, where the chains are. The point at which the chains start must be within comfortable human reach, from the deck. Once the oil has been soaked up, the whole body can be lifted with the help of the winch, brought on deck and stored on board.





1.5. Advantages over other methods of cleaning spills:

By opting for this method to clean up an oil spill, one guarantees immediate containment of the situation, foregoing any time delay. Very minimal training is required for the members of the crew to learn the procedure to execute this operation. While booms can stop oil from spreading, a strong wave can easily cause oil to be dispersed. On the other hand, in this method, the oil will be trapped in the batting which will decrease leakage. Dispersants have been known to be harmful to the environment. Cotton does not produce any such effects.

2. REDUCTION OF ATMOSPHERIC CO_2:

2.1. Introduction:

Ocean being the natural reservoir of carbon, stores about 20 times more carbon than terrestrial biosphere and soil and 55 times the carbon in atmosphere. However, this difference had dropped heavily due to the increase of CO_2 in atmosphere resulting in Green House Effect. Thus there is a clear need for the reduction in greenhouse gas emissions in parallel with internationally agreed targets to reduce the rate of climate change, necessitating the implementation of clean energy technologies. According to the Intergovernmental Panel on Climate Change (IPCC), iron fertilization of the oceans may be potential way for maintaining the CO_2 level in the atmosphere by stimulating

the growth of phytoplankton and thereby **sequestering** CO_2 in the form of particulate organic carbon.

As per agreed by the Parties to the London Convention and London Protocol for the purpose of Resolution LC-LP.1 (2008) on the Regulation of Ocean Fertilization, ocean fertilization is defined as*, "Any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans, not including conventional aquaculture, or mariculture, or the creation of artificial reefs and does not involve the activities which cause the fertilization as a side effect"* [2].

2.2. Concept of Ocean Fertilization:

"Give me a half tanker of iron, and I will give you an ice age." John Martin[3]

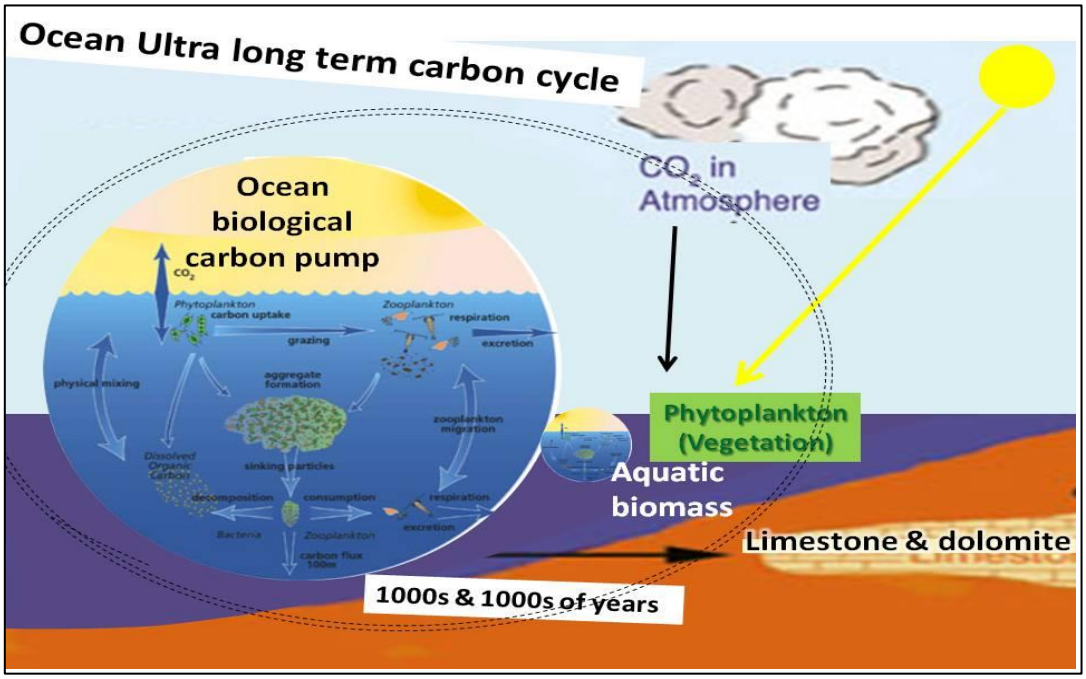
Gases are readily exchanged across the air-sea interface due to differences in the partial pressure of CO_2 between the ocean and the atmosphere. Temperature, salinity and biological activity can all influence the partial pressure of CO_2. For example, the uptake of CO_2 by marine algae during photosynthesis creates a shortage of CO_2 in surface ocean waters, driving the dissolution of CO_2 from the atmosphere into the surface ocean to restore the equilibrium. As a result of this and other processes, the ocean absorbed approximately one-third of the CO_2 released from all human activities between 1800 and 1994, leading to an increase in the total inorganic carbon content of the oceans in the range of 112 to 118 Gross Tonnage during this period.

In order for ocean fertilization to lead to climate change mitigation, three criteria must be met: (a) ocean fertilization must lead to increased growth of phytoplankton, packaging carbon and nutrients together into organic material; (b) this organic material must be transferred into the deep ocean so that it does not simply get recycled near the surface releasing its carbon back to the atmosphere; and (c) this transfer of carbon from the surface ocean to the deep ocean must result in a compensating transfer of carbon from the atmosphere into the surface ocean.

[2] "Regulation of Ocean Fertilization" (2008)
http://www.un.org/Depts/los/biodiversityworkinggroup/workshop2_currie.pdf (last accessed 21 February, 2019)
3 John Martin, (1988) https://earthobservatory.nasa.gov/features/Martin (last accessed 22 February 2019)

2.2.1. Understanding the Carbon Cycle:

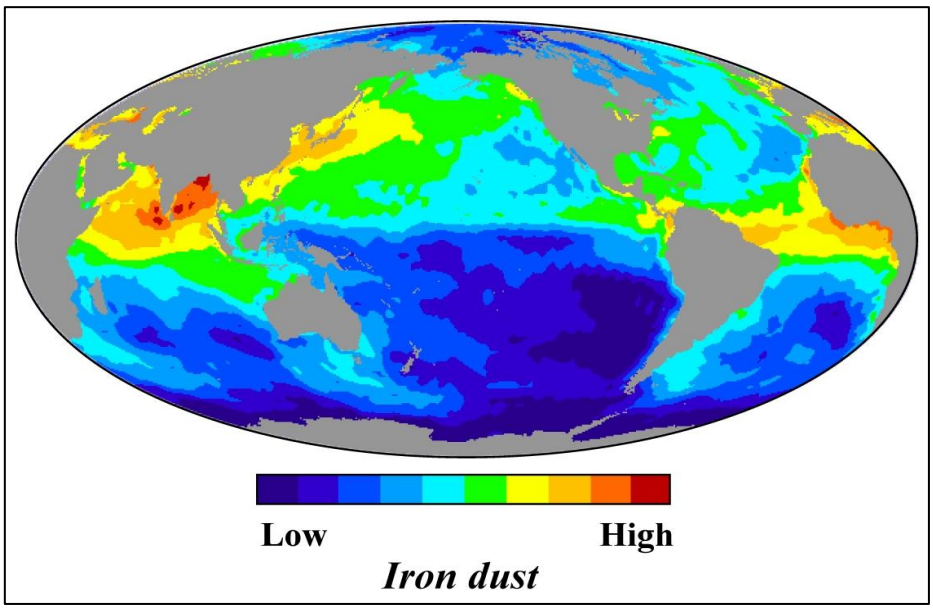
A part of the ocean, i.e. from surface to 200 metres deep sufficiently receives enough sunlight to support photosynthesis by marine plants, termed the "euphotic zone." Macro algae and rooted plants are restricted to shallow coastal waters, while phytoplankton is the dominant form of plant in the open ocean. Using sunlight and dissolved inorganic nutrients as source of energy, phytoplankton convert dissolved inorganic carbon (DIC) (bicarbonate ions, dissolved CO_2 and carbonate ions*)* in seawater into organic matter through photosynthesis, driving global marine food webs and inducing the "drawdown" of additional carbon dioxide from the atmosphere.



2.2.2. Iron in the ocean:

Major sources Fe in water bodies are river run-off; the resuspension of bottom sediments in coastal ocean environments; melting sea ice; atmospheric deposition of dissolved iron; and iron-rich deep water by vertical mixing and upwelling processes. Windblown terrestrially derived dust, mainly from the great deserts of the world, is a major source of external Fe input for the open oceans. Dust particles are transported over thousands of kilometres, creating strong deposition gradients across the oceans. Even volcanic ash is a major source of iron for ocean.

Contemporary ocean observations support the theory that natural iron fertilization elevates biomass. Separate multidisciplinary studies around the Crozet Islands and the Kerguelen plateau in the Southern Ocean observed elevated biomass, and also elevated export of carbon to the deep sea, in response to natural iron inputs.



2.2.3. Iron Fertilization:

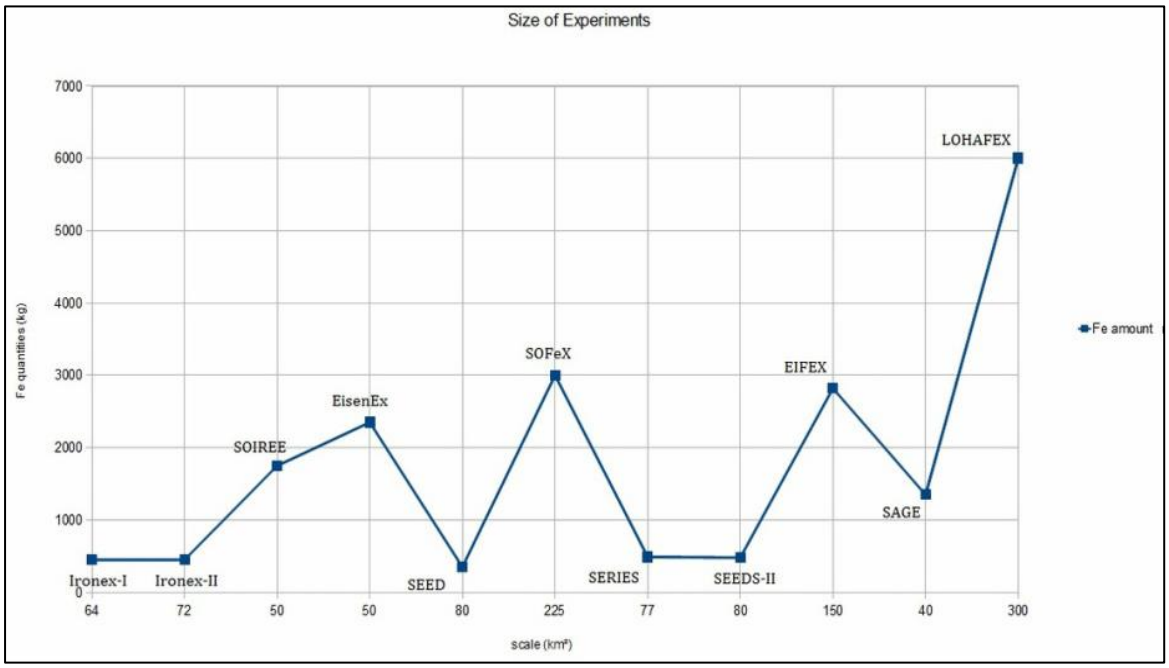
Iron fertilization is the intentional release of Fe in low iron content areas in ocean to increase the growth of phytoplankton in order to draw carbon out of the atmosphere and into the ocean. The method sequesters or store atmospheric carbon, which is currently contributing to the greenhouse effect and global warming.

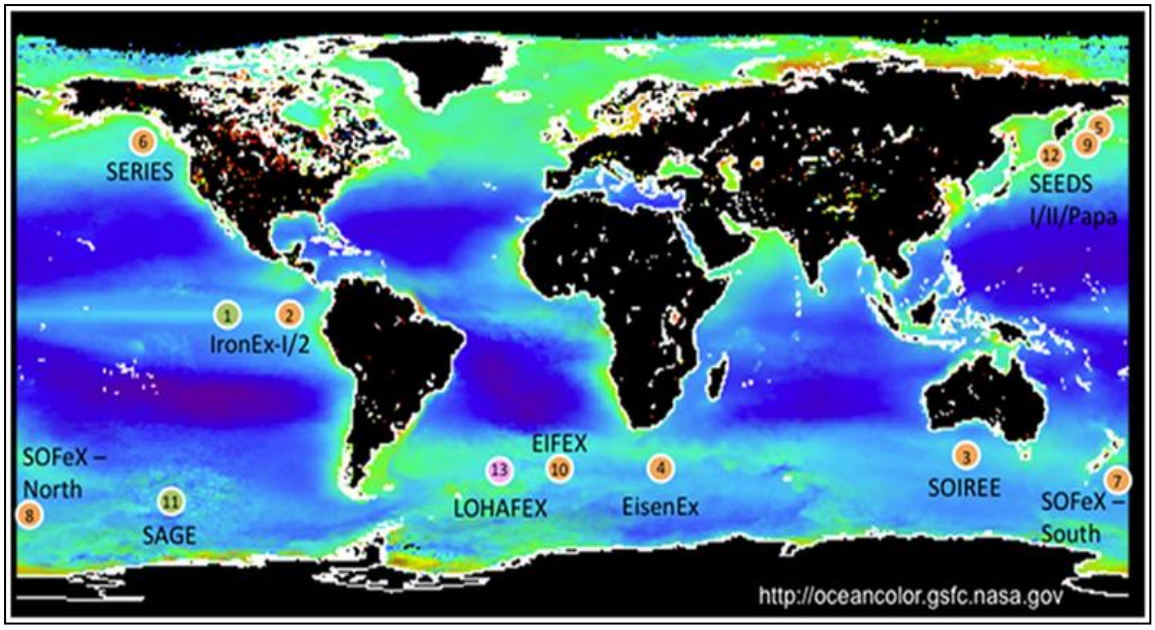
However, the method must be used in the specific regions called High Nutrient, Low Chlorophyll (HNLC) in large water bodies. HNLC regions cover 20% of the world's oceans in three major areas: PACIFIC OCEAN, SUB-ARCTIC PACIFIC OCEAN, and SOUTHERN OCEAN.

2.3. Major Experiments:

Many scientific iron fertilization studies have been undertaken, between 1993 and 2019 in polar, sub-polar and tropical High Nutrient, Low Chlorophyll (HNLC) areas. These are:

1. IronEx I, 1994
2. IronEx II,1996
3. SOIREE (Southern Ocean Iron Release Experiment), 2000
4. EisenEx (Iron Experiment), 2000
5. SEEDS I (Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study), 2001
6. SOFeX (Southern Ocean Iron Experiments - North & South), 2002
7. SERIES (Subarctic Ecosystem Response to Iron Enrichment Study), 2002
8. EIFEX 2006
9. FeeP, 2004
10. SAGE,2004
11. SEEDS-II, 2004
12. EIFEX (European Iron Fertilization Experiment)
13. Haida Salmon Restoration Corporation (HSRC), 2012
14. LOHAFEX (Indian and German Iron Fertilization Experiment), 2009





Forms of iron used that were used in the above experiments were: -

- Ferrous Sulphate (powdered)
- Fe chelate (powdered)
- Iron Sulphide (powdered)
- Haematite dust (fine powder)

2.3.1. Observations made from the experiments:

1) Climatic

Observation	Effects
Increase in Dimethyl Sulphide (DMS), Dimethylsulfoniopropionate (DMSP) seen in IronEx II, SOIREE, and EisenEx	Potentially increase cloud cover. This may increase the albedo of the planet and cause cooling (CLAW HYPOTHESIS).
30 times increase in phytoplankton and **2500 metric tonne of CO_2 removed** during IronEx II.	

2) Biological

Observation	Key points & effects
Diatoms have responded to Fe additions with the greatest increase in biomass in 5 out of 12 experiments.	Diatoms are responsible for 20% of global carbon fixation and 40% of marine primary productivity.
Fe induced phytoplankton bloom in HNLC surface waters confirmed by high chlorophyll levels.	3 Increase in marine life 4 Carbon Sequestration .

2.4. Industrial production of compounds:

1) Ferrous Sulphate: -
   (a.) Reacting a source of iron with an aqueous solution of Sulphuric acid in at least a first reaction vessel, to obtain a process liquor comprising ferrous Sulphate and acid Solution
   (b.) Combining the process liquor with concentrated Sulphuric acid in a mixing vessel, causing the solution to self-crystallize, thus forming slurry comprising crystalline ferrous Sulphate monohydrate.
2) Iron Sulphide: -

   FeS can be obtained by the heating of iron and sulphur.

   $Fe + S \rightarrow FeS$

2.5. How ships can play a role:

If we are able to cut the cost of the experiment in line with protecting the nature, why shouldn't we opt for the method of utilising scrap iron from ships?

Iron required for the process can be obtained from the scrap parts of dismantled ships. In this way the cost of the process will be decreased. The scrap parts of ships are always a major concern of the society as it is a major source of pollution. This iron, if not treated properly within a given time, will get rusted and thus will be of no use. The product will be left to pollute the environment.

The iron compounds manufactured by the given process may be dispersed over waters by the functioning/sailing ships.

2.6. Benefits:

The weight of iron required for ocean fertilization for a given region was less than 10 tonnes for each experiment. This cost is still much lesser than the other carbon capture methods and there are serious advantages like the development of marine life in the particular region.

Researches are also done on the addition of other nutrients like Nitrogen and Phosphorous. However, since very small amounts of iron are required by phytoplankton to make organic matter (1 atom for every 50,000 to 200,000 atoms of carbon) compared to the nutrients nitrogen (1 atom for every 16 atoms of carbon) or phosphorus (1 atom for every 106 atoms of carbon), iron fertilization has been seen as the most feasible approach.

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METHANOL AS SHIP FUEL AND ONBOARD CCS

Sahil Kazi
Shitanjal Srivastava

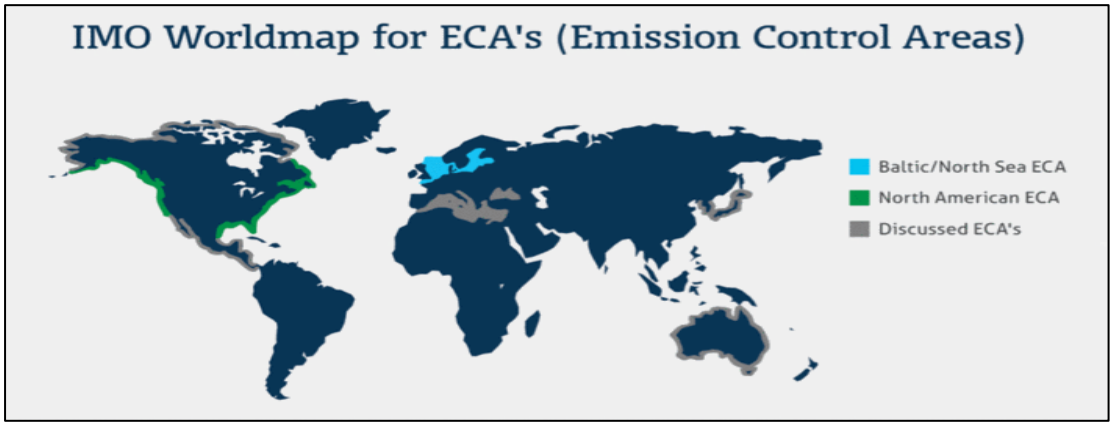
Abstract

We live in a world where we are addicted to fossil fuels. We use them to power our ships, to make electricity, to make plastic and so on & eventually contributing to the greenhouse-effect which threatens our world. This paper is regarding the usage of METHANOL as ship fuel. A detailed comparison has been done between four of the available technologies which will unfasten the ships from its restrictions. There will also be a discussion on capturing & storing of carbon dioxide onboard which will be later on converted to Methanol

1. INTRODUCTION:

IMO- The 2020 Global Sulphur limit:

IMO has set a global limit for sulphur in fuel oil used on board ships of 0.50% m/m (mass by mass) from 1 January 2020. This will significantly reduce the amount of sulphur oxide emanating from ships and should have major health and environmental benefits for the world, particularly for populations living close to ports and coasts.



Four technology variants are investigated:

- Scrubber
- WHR
- LNG System
- Methanol System with WHR

2. SCRUBBER:

It is a large piece of equipment fitted in the exhaust system of the ship and is mainly designed to water wash the exhaust gas. It uses sea water or fresh water mixed with caustic soda and sprays it over the exhaust gas containing Sox which gets converted into sulphuric acid. It is designed with a holding tank for zero discharge which stores the sulphuric acid. This mechanism cuts off the Sox emission.

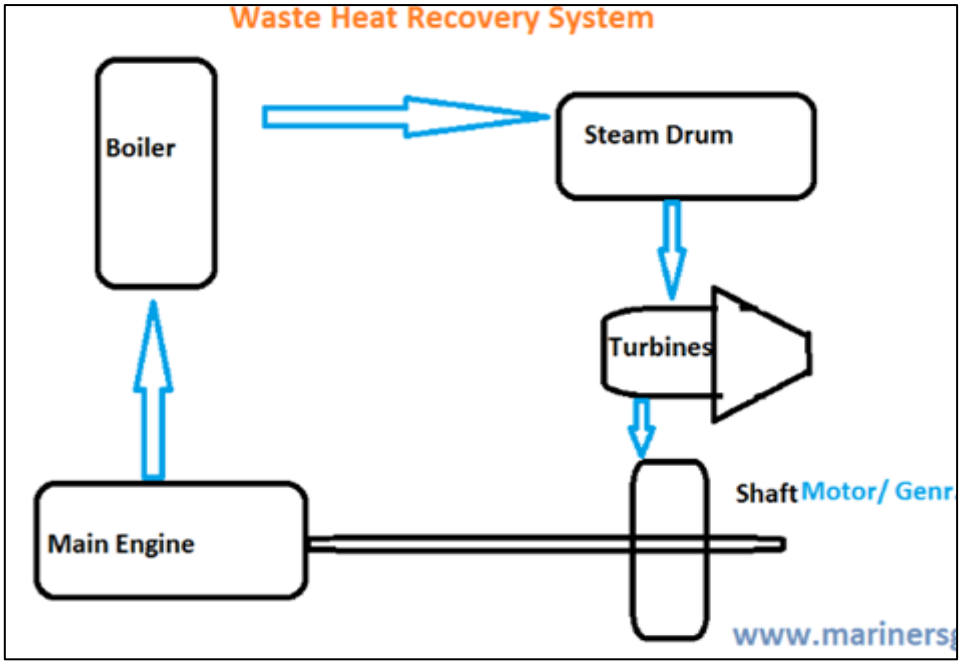
Challenges:

- It requires a huge amount of money to install onboard
- High maintenance required
- It does nothing about CO2 emission
- It cuts either Sox or NOx at one time which means that it will not be able to cope up with the long-term IMO regulations

3. WHR- WASTE HEAT RECOVERY:

Fuel is burnt in the engine and the exhaust goes out of it. Although the energy from fuel released in the engine is already used by the engine, but the heat is still there in the exhaust. Now this heat in the exhaust can be used to heat the water and generate system.

- The smoke passes through a "**WATER TUBE BOILER**". The heat is taken by the water in the tubes and steam is generated. This steam than comes to **STEAM DRUM** and from there it is used for different purposes.
- From the steam drum it is passed through a set of regulator and finally reaching to a steam turbine and with this **steam turbine**, alternator is attached which generate s electricity
- When the engine runs at a higher rpm, let's say 60+ there is so much exhaust generated that it is too much to be used for steam generators. So this excessive exhaust is passed through a gas turbine which is attached on the same shaft as steam turbine



This system also has shaft *generator and motor* combination. It acts as generator when steam turbine is not generating enough electricity as per the consumptions and acts as motor when there is excess of electricity produced by the turbine. When it acts as motor, it helps the shaft of the engine to turn, thus deducing load in engine and less fuel consumption.

So WHR is a very intelligent system which works together and the kind of efficiency this system has is really excellent.

Challenges:

To make it run, you need additional pumps, condensers, regulators and other more things.

Advantages:

- Reduced carbon footprints as only main engine is consuming fuel
- Number of auxiliary machinery can be reduced like generators

MAERSK, MSC etc. has already installed WHR on their ships.

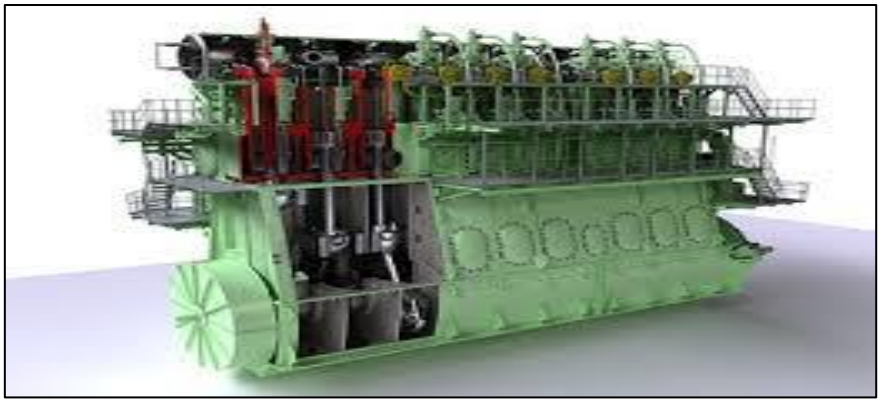
4. LNG TECHNOLOGY:

Modelling Assumptions:

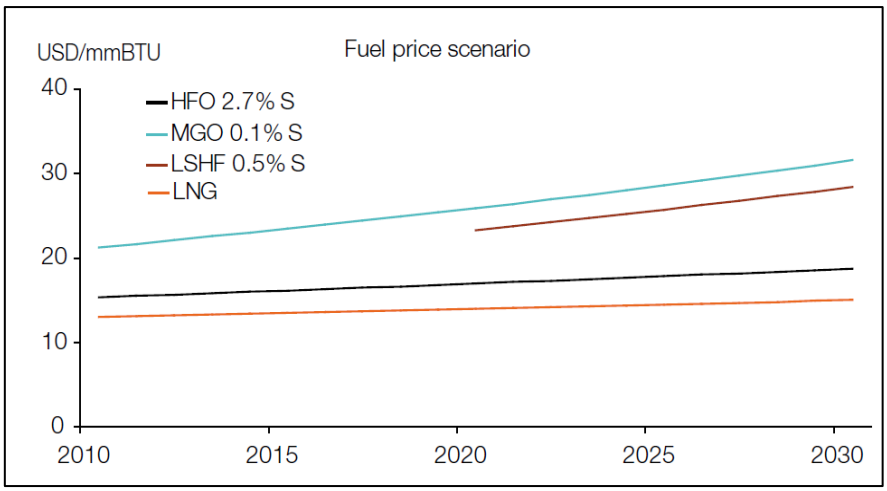
The MAN B&W ME-GI (Gas Injection) engine series is best in terms of engine performances like output, speed, thermal efficiency etc.

The control concept of the ME-GI engines comprises of 3 different fuel modes –

- Only fuel mode- when maneuvering or when no gas fuel is available, the engine is run on conventional fuel system
- Only gas mode- constant gas injection when enough and constant gas supply is available, with fuel oil quantity for injection depends upon engine load
- Fuel and gas mode- both oil and gas fuel is used in the cylinder liner with oil fuel about 6-8 % depending upon the load of the engine



FUEL PRICE SCENARIO:



MGO and LSHF are expected to increase faster than HFO and LNG with stronger increase in demand. The starting year for the fuel price scenario is 2101 and 650 USD/T (=15.3 USD/mmBTu) for HFO and 900 USD/T (=21.2 USD/mmBtu) for MGO are set. LNG is set at 13 USD/mmBTu which includes small scale distribution costs of 4USD/mmBTu. It is assumed that distribution cost doesn't increase over time.

BENEFITS:

- A low carbon content of LNG compared to traditional ship fuels enables a 20-25 % reduction of CO_2 emissions.
- LNG is expected to be less costly than MGO which will be required to use within the ECAs if no other technical measure is implemented to reduce Sox emission.

CHALLENGES:

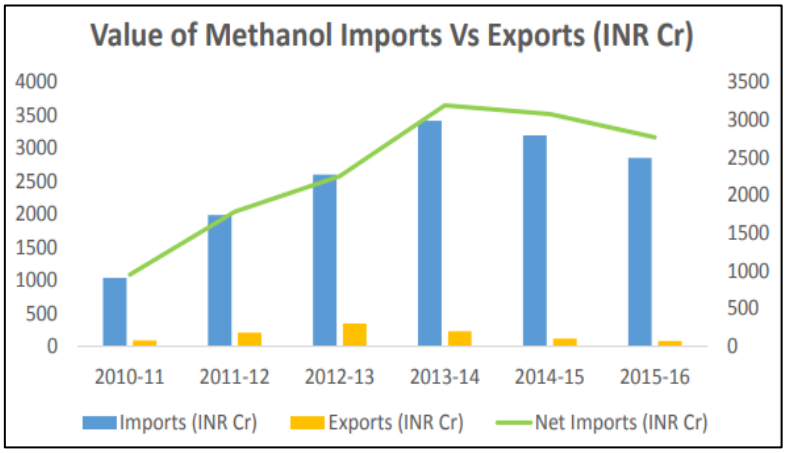
- BUNKERING of LNG
- More space needed on board for storage
- High skilled personnel's required
- High maintenance required

5. METHANOL TECHNOLOGY:

Modelling Assumptions:

The MAN ME-LGI (Liquid Gas Injection) two stroke engine is capable of dual fuel operation according to the diesel cycle. The engine is based on the proven concept of ME-GI engine series concept that has been developed since early 90s and is used on both sea and land. When operated in Gas or Methanol a burst of pilot fuel is used to initiate the combustion. The cylinder head is fitted with two fuel oil valves and two gas valves that can be exchanged for valves suited for methanol. A common rail system is used to supply gas and oil-controlled valves is used to control the injection timing. Similar to high compression diesel the risk of methanol contamination is very low as the fuel is injected to the ongoing combustion.

FUEL PRICE SCENARIO



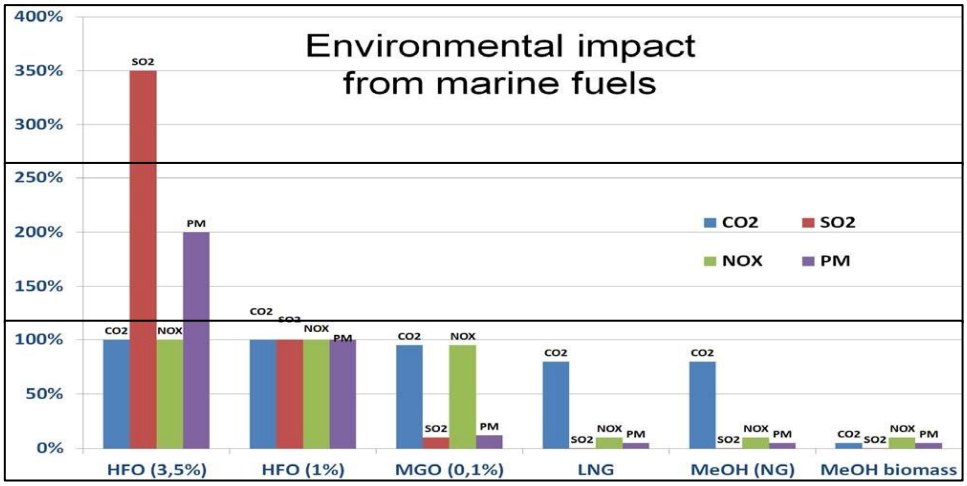
EUROPE- 419 euro / MT

UNITED STATES- 485 USD/MT

INDIA- 500 USD/ MT

Current price of methanol in India is INR 25-27 per liter which is costlier than what we buy from other countries. It is estimated that a 1600 tons per day of methanol plant will require a capital expenditure of approx INR 1200 crores which would be able to produce methanol at INR 17-19 per liter which is comparable with the cost of imported Methanol. We will talk about the mass production of Methanol in India in later part of this paper.

BENEFITS:



- Fulfils SECA regulations (Sulphur Emission Control Areas)
- It is highly available in chemical market- today in surplus.
- It can be used with high efficiency in Marine diesel engines after minor modification using a small amount of pilot fuel (dual fuel)
- Lower risk of flammability
- Higher octane number fuel

Methanol produced from natural gas, together in one process and used in ship fuel would achieve twice overall CO2 emission reduction obtainable from the use of biomass alone.

6. DETECTION OF HARMFUL GASES IN ATMOSPHERE:

A team of researchers from the Indian Institute of Science (IISc) have developed a novel sensor to detect harmful gases in the atmosphere. The sensor, which can catch a single nitrogen dioxide molecule among millions of other molecules, is one of the most sensitive in the world. Also, unlike other NO2 sensors, which perform at high temperatures, the new sensor works even at room temperature.

An optical fibre is usually used for communication purposes, but by ingeniously modifying its clad, we are able to use it in different applications like gas and bio sensing.

7. CONVERSION OF CO_2 TO METHANOL:

Scientists have developed a new catalyst that uses a special formulation of palladium and copper. This process is carried out by ARTIFICIAL PHOTOSYNTHESIS.

Artificial Photosynthesis:

A replicating natural photosynthesis system we could convert the energy from the sun into fuel. This would be open up a whole new world of renewable energy opportunities for us. However, we soon run into a few challenges. The natural photosynthesis system is very complicated at a molecular level.

The Process of Artificial Photosynthesis:

It consists of four steps and is aimed at mimicking natural photosynthesis-

- LIGHT HARVESTING – trapping light particles or photons and concentrating their energy in the reaction centre.
- SEPARATION OF CHARGE- In the reaction centre, sunlight is used to separate the different electrical charges: positive 'holes' and electrons.
- SPLITTING WATER- the positive charges obtained from the charge separations are used to split water into hydrogen ions (protons) and oxygen.
- FUEL PRODUCTION- The easiest way hydrogen gas can be made on the surface of the noble metals such as platinum. However, scientists are busy looking for a substitute as noble metals are expensive and scarce, and therefore difficult to commercialize. As we said, at this point the production of S2 gas is main focus.

  $2H^+ 2 e^- \rightarrow H2$

  $CO_2 + 2H^+ 2e^- \rightarrow CO + H_2O$

  $CO_2 + 2H^+ + 2e^- \rightarrow HCOOH$

  $CO_2 + 4H^+ + 4e^- \rightarrow HCHO + H_20$

  $CO_2 + 6H^+ + 6e^- \rightarrow CH_3OH + H_20$

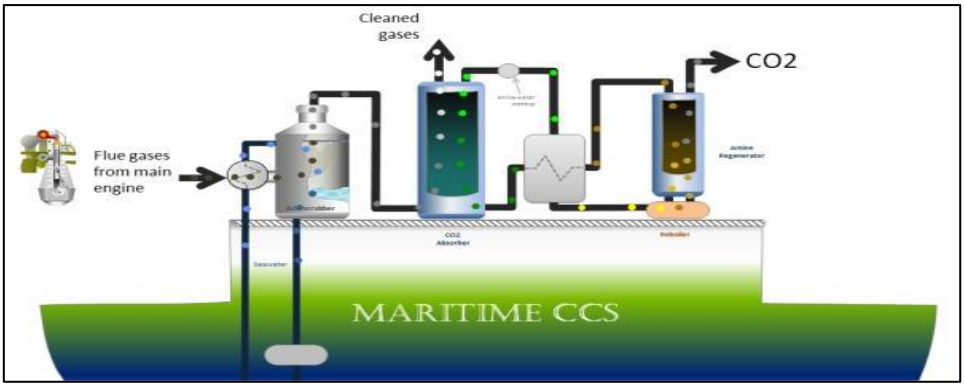
  $CO_2 + 8H^+ + 8e^- \rightarrow CH_4 + 2\ H_2O$

  This is partially an artificial production of the Calvin cycle.

But now the challenge rises that how can we capture and store carbon dioxide onboard…???

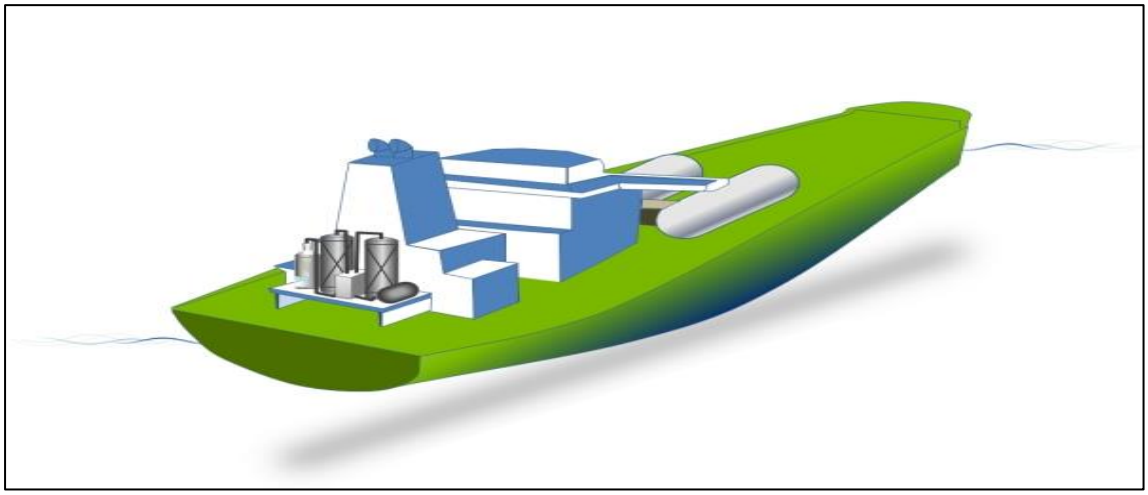
8. ONBOARD CCS – CARBON CAPTURE & STORAGE:

Carbon capture and storage is a complex, emerging process currently being put through its paces at various pilot power plants around the world. In its originally intended form, the basic CCS process involves the separation of CO2 from a fossil fuel power station's post-combustion flue gas, removing its emission from the power generation cycle and transmitting it for storage or industrial use. If we can use CCS **onboard** than we will be able to separate CO2 from the exhaust gas and can store it so that we can convert it into Methanol again.



So the basic CCS process involves the separation of CO2 from the exhaust gas and transmitting it for the storage for conversional use.

The big **challenges** are that you have a limited amount of space onboard and of course constant movement of ship. It also creates a very strong requirement for extra safety and risk management.



We can place the CCS at the **aft of the funnel**, so behind the accommodation space of the vessel on a raised deck. Eventually it will be less risky and it will not take any cargo space.

9. CONCLUSION:

- In this paper we have been able to create a never-ending cycle where we cut off the emission of Sox and NOx using METHANOL system with WHR and the reduced

amount of CO2 is captured again by the CCS and taken to on land power plants where it is converted again to METHANOL and is used for fueling ships.

- Reducing emission of these gases also help in reducing many natural calamities like we recently faced – KERALA floods, which was caused due to the disturbance in weather cycle
- Creating power plants and mass-producing METHANOL in India using CO2 will help in reducing its cost to 16-17 INR per liter
- It will also help the MAKE IN INIDA initiative as power plants will be first set up in India which will help in prolonging the chain of employment.

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