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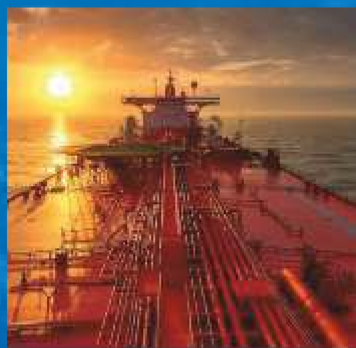
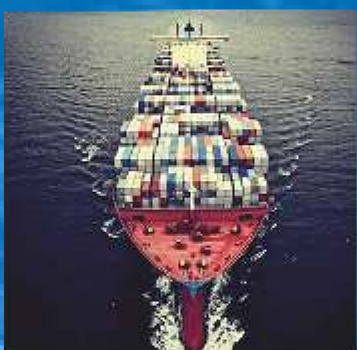


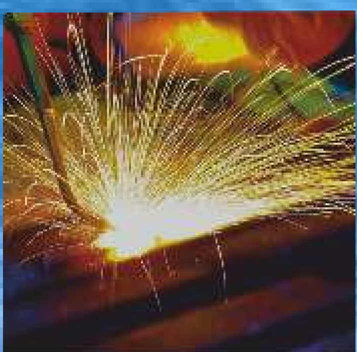


Bulletin of Marine Science & Technology, ISSN: 0974 – 8474

The journal is yearly publication of the institute. It covers technical articles/papers on science and technology, focusing marine field and its application area. It also covers patent abstract and book review.

Tolani Maritime Institute, Induri, Pune

Tolani Maritime Institute is one of the largest maritime educational centers offering Marine **Engineering and Nautical Technology** degree programs.

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The institute shall not be responsible for the statements or opinions advanced in the papers included in the current issue. Presentation or publication of a paper or any other document shall not be taken as an endorsement of any claims and technical accuracy of the contents be verified. The journal serves the purpose of knowledge building and exchange of ideas between the industry and academia.

Address for Correspondence

The Editor
Bulletin of Marine Science & Technology (BMST)
Tolani Maritime Institute
Talegaon Chakan Road
Taluka Maval, Induri
Pune -410507, Maharashtra, India
Tel: 91-2114-669600/01
Web – www.tolani.edu

Guidelines for Paper Submission

Bulletin of Marine Science & Technology (BMST – ISSN: 0974 – 8474), is the yearly technical journal of Tolani Maritime Institute (TMI).

The journal covers technical articles/papers, marine science and technology abstracts, book reviews, patent abstracts and technological developments, in general engineering or in marine related areas.

Call for Papers

Technical articles discussing various aspects of science and technology including innovations in the marine field, original research work, experimental investigations with results, industrial practices, case studies are invited for publication. The paper may be please be mailed to nitinj@tmi.tolani.edu or ajitsingha@tmi.tolani.edu or info@tmi.tolani.edu

Guidelines for paper submission

- Enter manuscript in MS word, Times New Roman, main text - font 12, subtitle - font 14 and the main title - font 16 , with main text in the single line spacing double column on A4 sheet.
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- Provide 4-6 keywords.
- Organize paper in smooth flow of title, subtitle and sub-sub title.
- Keep length of the paper to the limit of 8 pages approx.
- Provide 1 inch margin on all sides of the paper.
- Provide figures, drawings and graphs in black color on white back ground.
- Submit figures, drawings and graphs in JPEG format with 300 dpi minimum resolution.
- Number the figures and tables as per standard practice.
- Provide mathematical equations and functions in suitable equation editor.
- List the references at the end of the article with serial number.
- Submit hard copy of the full length paper on the address of correspondence mentioned in the journal.
- A declaration to the effect that – the work is original and has not copied or published earlier elsewhere – needs to be submitted along with the paper.
- On behalf of all the co-authors, the corresponding author shall bear the full responsibility for submission and shall provide his/her full address, contact number and email.
- Follow the suggested order for manuscripts: (In some cases all the points may not come in order as suggested)

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- Title, Authors, Affiliations
- Abstract
- Keywords (provide a maximum of five keywords)
- Introduction
- Main text (may include information based / knowledge based/ theory based / experimental based/ model based method)
- Data Collection / Data Analysis (if any)
- Result and Discussion (If any)
- Conclusion
- References

TECHNICAL PUBLICATION COMMITTEE CHAIR-PERSON'S MESSAGE

I am pleased to present 12th issue of Bulletin of Marine Science and Technology (BMST). Tolani Maritime Institute (TMI) has completed this year, successful 21 years in imparting Marine Education at pre-sea and post sea level. TMI has created its benchmark in the Marine Education area.

Transport infrastructure is one of the most important factors for a country's progress. Any mode of transportation is always considered as industry life line, because economy and commerce of any country depends on how fast transportation of goods and passengers can be completed in most safe and cheapest manner. Maritime sector and shipping industry have contributed substantialy in the growth of the economy of our country. It has helped in improving the image of the country on the global platform. Shipping is by far the world's most efficient form of transport, because more than 90% of the world's traded goods travel by sea. Transport systems have significant impacts on the environment, accounting for between 20 - 25% of world energy consumption and carbon dioxide emissions. The majority of the emissions, almost 97% came from direct burning of fossil fuels. Greenhouse gas emissions from transport are increasing at a faster rate than any other energy using sector. In GDP terms, shipping would be the sixth largest country in the world as per Carbon War Room, an organization that encourages businesses to reduce their carbon emissions. Shipping still has a major environmental impact. Sustainable transport systems make a positive contribution to the environmental, social and economic sustainability of the communities they serve.

The advantages of increased mobility need to be weighed against the environmental, social and economic costs that transport systems pose. The role of global mariners and technologists become crucial in addressing the challenges of the sustainable development in this sector of industries. Tolani Maritime Institute, endeavors to support the good work in whichever way it is possible. Bulletin of Marine Science and Technology provides the platform for the readers and authors to take up the activity of writing and publishing scholarly articles in varied fields of Science and Technology.

I am sure that the issue of the journal will keep interest alive of the readers and writers. Enjoy Reading and Writing!!

Dr. N. D. Junnarkar
Chairperson - Technical Publication Committee
Tolani Maritime Institute, Pune

Student's Committee Massage

It brings me immense pleasure in bringing out the 12th edition of Bulletin of Marine Science and Technology 2019 to our esteemed readers. The journey started out with a seed sown in the grounds of my imagination, only to grow and shower its sweet fruits with everyone. Taking work to its literal meaning, any sufficiently advanced technology is equivalent to magic and the age of automation is going to be age of 'do it yourself', I dedicate this magazine to everyone who seeks to make an impact and leave their marks through revolutionary techniques and technologies for betterment of the society.

BMST'19 has been a jukebox of prowess in technical ideas and thoughts by faculties and students. This edition captures every essence of advancement in technologies especially in shipping industry and their supporting media blends produced by savvy talents and gems of TMI whose sweat and steadfastness has made this edition a special one. Highlighting the eloquently penned technical thoughts on various technologies, devoted by scintillating food of thoughts by TMI cadets and for the first-time ideas of competency-based training in seafarers directly from desk of Principal Capt. Krishnamurthy Iyer. The past six months for my team have been no less than a haywire trigonometric function, with invigorating journey, accolades and acclaims. The magazine endeavours to reflect the values and facets of the institution itself. By maintaining the respect and interest of values, the magazine promises a harmonious blend of technical visions and skills. Starting from day one, we all made a commitment that we will provide a balanced coverage of innovative ideas. We had a desire to publish such a spectacular magazine that would force the readers to tickle the grey matter.

It is the readers who complete this magazine as a whole and I cannot be more grateful to them. My earnest gratitude to our faculty team consists of Dr. N. D. Junnarkar and Mr. Ajit Singh Aidhen and innominate advisors for their incessant counsel and assistance. The team hopes to build spellbinding and creative ethos just as much during the past six months. This journey would have been never possible without efforts of Cdts. Snehadri Banik, Rishabh Mishra, Pranjal Malik and Shivam Salwani, my four horsemen who put in best of their effort to do justice to readers.

I wish you all clear horizons. So, grab a seat in roller coaster of imaginative cum technical food of thoughts by authors and ride with us. Amid a gamut of emotions and changing tides, bringing together the essence of technical world in TMI has never been easy and I would like to thank my team for the efforts. Hope you all read this edition like previous ones. Suggestions and feedback are welcome as always.

Cheers!

Avishek Ankit
Students Committee Representative
Bulletin of Marine Science and Technology '19.
Email- avishekankit73@gmail.com

INDEX

COMPETENCY BASED TRAINING

Krishnamurthy Iyer
Principal, Tolani Maritime Institute, Pune.
krishnamurthyi@tmi.tolani.edu

ABSTRACT

We often hear criticism about the competency of our officers. The maritime training institutes are normally targeted for the poor performance of officers. This paper explains the lacuna in the present system and what can be done to improve the competency of our officers. The paper also tries to explain the impact of changes in technology in our competency. There are complaints from shipping companies regarding the attitude of our officers. The paper also tries to explain how we can improve the attitude of our officers. A point to be noted is, the basic concept has not changed only the context has changed.

Keywords

GPS, ECDIS, Fundamental knowledge, Reflection after learning, Integration, Self-directed learning.

Overview

In the Year 2025, Location Manning Office of a large shipping company in Singapore there are ten applications for the post of officers. Four are from India and six are from other nationalities.

The chief of manning instructs his subordinate to short list the four Indians and three from other nationalities. The subordinate asks him the reason for short listing all Indian officers. The chief of manning explains that India has a system of competency based training hence they need not waste their time in shortlisting.

In a court of enquiry, the Master of a ship is charged of negligence for the accident. The Master informs the judge "Your Honour, it took you two years to decide I was wrong on a decision which I had to take within two minutes." The definition of competency is ability to take a decision in less than two minutes and the decision should be right.

Present Method of Training With the advancement in technology a lot of syllabus is out dated and we are required to teach the latest syllabus.

But, with the advancement in technology, has the method of navigation changed? The answer is, while the context has changed, the concept has not changed. Our biggest problem is we are not paying any attention to the concept. The basic fundamental four Ls' - Lead, Log, Latitude and Lookout has not changed. The method of getting information of the four Ls' has changed.

From hand lead line, we have advanced to echo sounder. From patent log, we have advanced to Doppler log. Position fixing has changed to GPS. We have aid to lookout like Radar, ARPA and AIS. All these are part of the basic four Ls'.

There are a numerous case studies on ECDIS enabled accidents. Mostly, the accidents are not caused due to ECDIS but neglecting the basic four Ls'. The method of Navigation has not changed with ECDIS. The root cause of Cosco Busan accident was lack of knowledge on simplified symbols of ECDIS. Instead of learning the chart symbols of 5011, we will have to learn the symbols of 5012 when we use ECDIS. But, the fact remains that we will still have to learn the symbols.

It is not the advancement of technology which is a problem, but our attitude towards technology is the problem. The fundamental knowledge is like the base of a pizza and all advancement in technology is only the topping. Technology is of no use without understanding the fundamentals.

Let us look at our present system of training. Are we producing competent officers? The answer is NO.

We are puppets to system of titles and degrees. Our education system is highly exam oriented. We have never considered if we are able to apply our knowledge in practical work. We have inhibition to dirty our hands. We teach all subjects in isolation and there is no integration between the subjects.

We often see the advertisement by certain maritime training institutes stating 100% passing of their students. Is the emphasis on passing exams or becoming competent officers?

What is the way forward? (The Way Forward)

The first step is to delink degree with competency. A person can be given a degree because he/she is competent but a person need not be considered competent because he/she has a degree. Everyone needs a degree for a social status. Our system should have both degree and competency but, both should be delinked. One of the biggest problems in our system is the reduction of sea time for degree holders. Does the degree give the student a practical experience of sea service?

Sea service

A wide number of meetings are held by various experts (who do not have idea of the problems on board ship) on doing only the minimum sea time required by STCW convention to appear for competency exams. Their argument is, with lesser sea time more trainees can be trained. My view on sea time is, it should be X months. A Master should feel comfortable with an officer on the bridge who had done X months of sea time. The figure for X should be determined by sailing masters and not by shore experts.

Learning Objective

Our learning objective should not be at the end of the training period but two years after completion of training[2]. We should be able to write the objective "The student will be able to exhibit the knowledge even after two years after completion of the training programme." With this kind of objective, we not only prepare him for passing the exam, but he / she should be able to apply the knowledge even after two years of completing the training programme. The moment we have the learning objective after two years, our training programme will give emphasis on concepts. If the student has forgotten what he/she has learnt after completing the exams, he/she will not be able to apply his /her knowledge on board the ship. The learning objective will be achieved only when the officer continues to learn the subject even after completion of the course.

A study was conducted by a large company on what an officer learnt on job in shore-based training and on-board training. It was found that only 10% was learnt during shore based training, 60% was learnt on job and 30% was learnt by observing others. The 10% learnt during formal learning is extremely important as that gives a strong foundation. Without this strong foundation, he / she will not be able to learn on job or by observing others.

Integration of learning

Today after any course a student will remember some loosely related facts and concepts[2]. The correct method should be, the student should not only recall the facts but should be able to understand the conceptual structure and the logic with those facts. He / She should be able to apply that knowledge in other areas. For example, when a student performs any calculation, he/she not only understands how to perform the calculation but also conceptual understanding of the subject. In any learning, the student should have an in-depth understanding of the subject. We should be able to integrate the various subjects that we learn. We should be able to integrate the fundamental subjects with the core nautical subjects which should be integrated with the practical. If we have to teach a student on cargo lashing, we should teach the student the basics of mechanics – calculation of load, forces due to acceleration, reaction on the cargo due to the shoring. The next step is to teach on various methods of taking lashing after referring to the basic fundamentals on the forces. Once the theory is covered, practically he / she should be asked to take the lashing. If we want all theory to be integrated with practical, the training institutes will require a lot of equipment. Instead of one institute having all equipment, there could be agreement between various institutes to share their resources for practical training.

The practical application of learning should include an improvement in the skill and change in the way he / she thinks. By integration, the student should be able to connect his academic work in other areas of life[2].

For integration of various subjects, the faculties teaching fundamental subjects must have know-how knowledge of a particular concept of the topic which is applied in the core subject. We will have to 'marinize' our non-marine faculties. Our marine faculties teaching core subjects must also go through the fundamentals.

If the knowledge is not used for practical application, that knowledge has no meaning. The student must know how to use the concept. In our competency syllabus, the learning objective is restricted to knowledge and comprehension level. We have to develop the learning objective at application and analysis level. At Master's competency exam an assignment can be given on the case study of an accident. The candidate should indicate what all could have gone wrong, which rules have been contravened and what he /she would have done to prevent this accident if he/she had been the master of that vessel.

Constructivism

Knowledge cannot be simply given to students. Students should construct their own meaning[5]. It is the act of connecting new information to what they currently know in ways meaningful to them. Content covered does not always mean content learned or remembered5. Students will be able to understand the concept only when they construct on their previous knowledge.

Reflection

Learning is complete only when there is a change in the way we work or think. Learning on safe working practice is complete only when our behaviour towards safety changes. Reading a book on safety or watching a safety film does not change our behaviour. We will require to reflect what we have learnt a number of times. After watching a safety film, there must be a discussion. This must continue a number of times in different forms. A person understands a topics when it is explained in three different ways. Group discussion is a good way to reflect upon what has been learnt. The student must understand how to apply the knowledge in his/ her life. We need not only reflect on what went wrong but also on what went right. For example, after a successful voyage, the officers should reflect upon what went right during manoeuvring, during cargo operation and during the voyage and what can be done to improve the performance in future. If something has gone wrong, instead of adopting a blaming culture, the officers should reflect on how to ensure such mistakes do not occur.

Learning How to Learn

As mentioned earlier, 90% of our job we learn on our own. A student should know 'How to Learn' rather we, as teachers, should tell them 'How to Learn'. Today, students are learning how to be taught. In Dufferin during training, one of the tasks given to all cadets was to find out information. The habit of finding out information about the ship developed the culture of learning 'How to Learn'.

Two important aspects of Learning 'How to Learn' are:-

How to conduct inquiry and construct knowledge in the field. How to be a self-directed learner[2].

One of the important parts of training in pre-sea courses should be to find out information from various sources. The student should be able to search, identify the relevant information and analyse the information.

A person becomes a self-directed learner when he/she is motivated to learn, when he/she wants to achieve a goal. An actor or a singer can achieve success only when he/she becomes a self-directed learner. A student becomes a self-directed learner only when he/she realizes how the learning will assist him/her to achieve his/her goal. A student without a goal can never become a self-directed learner. A self-directed learner will care for what he/she is learning as it will affect his/her life.

An officer can become a self-directed learner only when his/her fundamentals are strong. He/She is able to understand the description given in the equipment operational manual or circuit diagram. The officer looking at the ship's plan should be able to obtain information from the plan. The officer should know where to look for information. The officer must reflect on what his seniors are doing. He/she should note what is going right and what is going wrong.

Learning through evaluation

Our evaluation process focuses on pass and fail and not on corrective measures. We must have formative tests where we give comments and not marks. We should explain the areas of weakness and where the student can improve.

Active Learning

Most of our teaching is through lectures. This is passive learning method and is not very effective. We have to emphasize on active learning. There should be a system of the student coming to the class after reading the chapter where initially there should be a discussion through interaction4. After the interaction, the expert inputs should be given by the teacher. After the inputs, the student must be asked to prepare his/her own notes which should be checked by the faculty members. A good method of active learning is, the students should be asked to give questions for the test. After the test, the paper should be distributed to other students and they should comment on the answer[4].

Dealing with weak students

There is no such thing as weak students. There are only unprepared students who are not motivated[3]. These students will require counselling and also guidance for improving their fundamentals. There should be additional tutorial classes for guiding unprepared students[3].

Attitude of officers

One of the biggest complaints from shipping companies is the wrong attitudes of officers. Most of the officers lack ethics and value system. There should be subject like professional ethics. There should be guest lectures on professionalism and value system. We must have guest lectures by various eminent personalities. A person with a goal and a positive outlook will normally believe in ethics and values. When we teach students on leadership we must emphasize on credibility, values and ethics.

Modern Teaching Methods

The context of learning has changed but the fundamental of learning has not changed. The modern learning method like e-learning can supplement the traditional learning method but cannot replace the fundamental learning. We can use e-learning for evaluation, getting information, sharing information and so on. The notes can be loaded on tablet, Google groups or any other common platforms. CBT can be used for supplementing learning.

How do people learn

As per Linda Nilson, people learn best when they are able to connect the new knowledge to what they know or believe they regard what is relevant to their life1. They are motivated by the inspiration and enthusiasm of other people in their life. They receive the material multiple times in different ways and they have success in their learning1.

For a student to succeed, he/she should face success in learning. For this reason even when a student fails, the system should ensure that he/she successfully fails

Adult Learning

When we conduct a Revalidation course, or course at Masters or Extra Master's level, we must consider the concept of adult learning.

As per Linda Nilson, adults are less forgiving about an instructor's shortage of experience, expertise, teaching savvy and suitable supplementary materials[1]. The reason is they value their own life experience and want to share and apply it in class, assignments, and group work. An adult would like to learn on his own rather than being taught[1].

The revalidation course should be split into two parts. The first part should cover various amendments and developments which have occurred during the last five years and the second part should be group discussion on case studies.

The first part can be covered using e-learning. The officer can learn in his/her own free time and complete an online test. The purpose of the online test is not to grade pass or fail but for the officer to know what he/she has learnt. He/she relearns the topics that he/she has not done well and does the test again on those topics. There can be a contact class during a week for case studies, group discussion and sharing experiences. This concept can also be applied for Master's and Extra Master's Level.

A person learns best when there is teacher to student interaction and student to student interaction. Instead of conducting a two weeks revalidation course, we can reduce it to one week and substitute one week of theory class by e-learning.

Conclusion

We have to change our focus from teaching to student centred learning. We will have to integrate all subjects rather than teaching compartment wise. A student should reflect what he/she has learnt. Learning is complete only when the student changes in the way he / she works or in the way he/she thinks. We can produce competent officers only if we rethink on the conduct of all courses.

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EXPERIMENTAL INVESTIGATION OF MICRO BUBBLE DRAG REDUCTION (MBDR) ON REDUCTION IN DRAG OF SHIP

Sudhir Sindagi
IIT, Madras
sudhirs@tmi.tolani.edu,

R Vijaya kumar
IIT, Madras

B. K. Saxena
TMI

ABSTRACT

It is reported that, merchant vessels operating at lower speeds, the fluid frictional drag accounts to almost 70%-80% of the total drag, thus there is a strong demand for the reduction in the frictional drag. The air lubrication method or Micro Bubble Drag Reduction (MBDR) is a technology to reduce frictional drag of a hull by injecting air to the bottom of the hull. Latest developments in this field suggests that, there is a potential reduction of 80% in frictional drag in case of flat plates, which encourages researchers to investigate further. In this study, experimental and numerical investigations into frictional drag reduction by microbubbles were carried out for an 8000 Tonnes Deadweight Bulk Carrier for different speeds and for different air injection rates using series of injection holes. 1:23 scaled model of the ship is modified as per the need of the investigation and is tested for the resistance of ship for both with and without injection of microbubbles in the towing tank. The experimental study was carried out for speed range of 4 knots to 12 knots in the interval of 1 knot and for each speed, effect ofdifferent injection flow rates was also investigated.

Keywords: Frictional Drag Reduction; Air Lubrication System; Micro Bubble Drag Reduction; ALS; MBDR

Introduction

It is stated that, for cargo ship, 60% of the total resistance is due to fluid friction and for tankers it is around 80%, demanding for the reduction in the frictional resistance. Numerous technologies [1], such as use of the micro-morphology-riblets, use of Polymers, use of heating wall and vibrating the flexible wall, Partial Cavity Creation, Antifouling and coatings and Super-hydrophobic surface and MBDR have been studied and applied in reducing the frictional drag. Based on the study, [2], [3] and it is concluded that, MBDR has additional advantages over other technologies, such as it is environmental friendly, operation is quite easy, low operating costs and high energy savings. It is also stated that the MBDR is able to achieve 80% reduction in frictional drag, which can result in a significant fuel savings for all types of ships. The most noteworthy contribution regarding MBDR methodology was presented by [4] using hydrogen bubbles produced through electrolysis process. From then, numerous studies have been carried out on MBDR. As shown in Figure 1, displacement ships such as tankers, Cargo Ships, Bulk Carriers, VLCC & ULCC are well suited to MBDR technique, as they are more or less in box shape with wide flat bottom causing injected bubbles at the bottom staying close to the hull bottom due to the action of buoyancy force [5]. This causes covering of the whole hull bottom with injected bubbles efficiently. Another type of ship is appropriate to MBDR technique is the Cement Carrier[6]. Cement Carrier is equipped with blowers and related piping for supplying air to load and unload cement which can be used to supply air for microbubbles, requiring only small amount of additional work.

Fig.1. Use of MBDR Technique for Ships

As the ship's speed increases, the wave making resistance component becomes larger and in turn frictional drag reduces, reducing the efficiency of MBDR technique. Therefore, MBDR is expected to be suited for slow moving vessels with Froude number varying from 0.05 to 0.15 [7]. Thin film of air was developed over an underwater surface (hull) when air is supplied from the bow by making use of use of SWR surface paint in an experiment by [8]. From the experiment it was observed that, at Froude Number of 0.20 the frictional drag on SWR surface has been reduced by 40%. [9]conducted MBDR experiments for 50m long flat plate in the 400m long towing tank. Air was injected through series of holes at two streamwise locations (one at 3.0m from the front end and the other at 31.0m from the front end) The injection plate had 1mm diameter holes. The maximum reduction of 35% was obtained. Based on the work on effect of MBDR in a rectangular channel [10], it is concluded that, the most significant parameter in deciding the MBDR effect is the effective value of the Volume fraction at the point of analysis, which is influenced by both, the injection rate and the static pressure at the point of investigation.

In this study, experimental investigations into frictional drag reduction by microbubbles were carried out for an 8000 Tonnes Deadweight Bulk Carrier for different speeds and for different air injection rates using array of injection holes of 1mm diameter. 1:23 scaled model of the ship is modified as per the need of the investigation and is tested for the resistance of ship for both with and without injection of microbubbles in the towing tank. The design exploration study was carried out for the various sizes of bubbles, flow speeds, injector flow rate and of course for different void fractions. The experimental study was carried out for speed range of 4 knots to 12 knots in the interval of 1 knot and for each speed, different injection flow rates of 0.5 CFM to 3.0 CFM was investigated.

Experimentalsetup, measurementsand procedure

The experimental work for the current study has been carried out in a Towing tank of Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai, India. The Tank is 85m in length, 3.2m in width and has 2.8m depth of water with a variable carriage speed which can run up to maximum speed of 5 m/s. As it was confirmed that, MBDR methodology has maximum effect for ships with flat bottom. Hence, for the study, a suitable hull is selected, which suits to the investigation, resulting in considerable reduction in the frictional as well total drag. Details of the selected hull are placed at Table 1 and Figure 2.

Table 1: Principal particulars of Bulk Carrier

Particulars	Ship
LBP	117.1m
Breadth	20m
Depth	7.2m
Draft	4.8m
Speed	10 knots
Displacement	10164 tonnes

The most commonly used method to generate microbubbles is by making use of Porous material [11]. However, [12] pointed out following problems in using porous plate

- Non-uniform distribution of size and number of microbubbles
- The pressure loss is very much significant.

In order to solve above problems, plate with array of holes was used by [12]. For the current study, array of holes is used for the injection purpose. As shown in the Figure 2, air compressor is used initially to compress the air, which is then fed into an air injector unit consisting of air chamber through a valve to control the flow rate of air and then through the flow meter to measure the flow rate. The air chamber has 225 holes of 1mm diameter made into its bottom plate. The Air chamber is mounted into the wooden model of ship in such way that, the bottom of air chamber is flush mounted with bottom of the model. Location of injection of Micro bubble is one of the important parameters that need to be considered in reviewing the effectiveness of skin friction reduction by micro bubbles. Based on the study carried out by [12][13] and [14], it can be concluded that, to maximise the effect of MBDR, the air injector unit for the current study is mounted at the front of the ship, so that, air bubbles cover maximum area of the bottom of the ship.

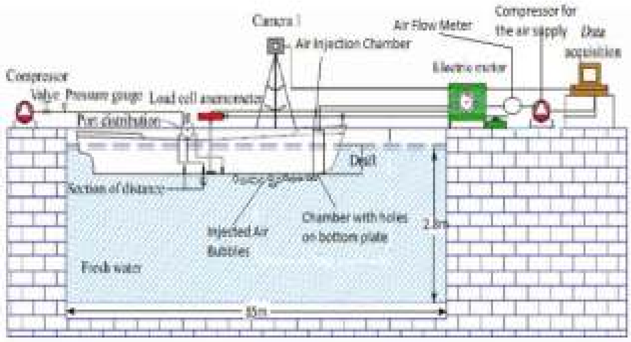

Fig.2. Details of Experimental Setup

For the visualization of flow and migration of air bubbles below the hull, bottom of the model is cut at three longitudinal locations, which is then replaced with 9mm thick acrylic sheets. As mentioned, the selected hull has been modified for the injection of bubbles and visualization of the same. Figure 3 to Figure 12 shows step by step procedure followed for the modification carried out on the existing hull.

Fig.3. Location of Injector Unit, Placed at the Front

As shown in the figure 3, initially the location of air injector is finalised so that, maximum area of the hull's bottom will be covered with injected bubbles. Based on the location of injector unit and considering the strength of hull into account, three different locations have been decided for the acrylic sheets and in turn for the flow visualization.

Fig. 4. Hull Cutting for the Injector Unit

Figure 4 shows cutting of existing hull for the location of injector unit and acrylic sheets. Figure 5 shows the complete hull, with all four cut sections. Considering the possibility of water leakage into the hull from the air injector unit, it has been decided to create separate watertight chamber for the injector unit shown in the Figure 6. This will avoid entry of water into the hull, if any.

Fig. 5. Hull with cut sections for acrylic sheets

Fig. 6. Watertight chamber for the Injector unit

To increase the strength of joint between acrylic sheets and the hull, GRP along with adhesives are used as shown in the figure 7.

Fig. 7. Water tightening of cut section and Acrylic Sheet

Considering the designed immersion of the hull at the design draft, 695 kg of ballast weight was supposed to be put inside the hull. In order to further increase the strength of joint between hull and acrylic sheets, transverse and longitudinal frames were added as shown in the figure 8, which are further joined/strengthened with the hull using GRP and adhesives shown in the figure 9.

Fig. 8. Strengthening of acrylic sheet with transverse and longitudinal frames

Fig. 9. Strengthening of acrylic frames with hull using GRP, putti and special adhesives

Figure 10 shows, the complete hull with all joints made ready from inside part of the hull. Figure 11 and Figure 12 shows preparation required from the bottom the hull to strengthen joints and smoothen it to reduce the friction with water flowing.

Fig. 10. Acrylic sheets placed for the visualization of flow

Fig. 11. Strengthening of acrylic sheet at bottom using putti and adhesives

Fig. 12.Smoothening of putti using grinder

After fitting Acrylic sheets and air injector unit, the bottom of the hull is then smoothened and then painted again to get original surface finish. The model is then attached to the towing carriage by adding sufficient ballast weights shown in the Figure 13. Figure 14 shows the complete experimental setup used for the investigation along with compressor to supply the air below the hull.

Fig. 13. Model with Ballast weights attached to towing tank

Fig. 14. Experimental Setup used for the investigation

Figure 15 shows flow bubbles below the hull for the speed of 10 knots and air injection flow rate of 1.5 CFM. As seen from the figure 15, one can conclude that, the injected bubbles covered the entire area below the hull replacing the water and reducing the frictional drag considerably.

Fig. 15. Flow of Air Bubbles Below The Hull

Results and Discussion

As mentioned earlier, the experimental investigation was initially carried out for the bare hull without the injection of air bubbles below it. The model test was carried out for speed range of 2 knots to 12 knots. ITTC – Recommended Procedures [15] for conducting model test have been strictly followed. The details of experimental parameters are placed at Table 2.

Table 2: Range of Ship and model speeds for the model testing

Ship's Speed (Knots)	Froude Number
5	0.08
6	0.09
7	0.11
8	0.12
9	0.14
10	0.15
11	0.17
12	0.18

The mechanism of drag reduction has not yet been fully investigated. An exhaustive review on past research work carried out on the experimental and numerical investigation of MBDR methodology by [2]&[10] revealed that following mechanisms could be attributed to the reduction in the frictional drag

Formation of Bubbles or Transitional Air Layer or Continuous Air Layer or Air cavity formation causing reduction in wetted surface area

Reduction in Density

Reduction in Reynolds's Stress

Reduction of Turbulence intensity in the Stream wise direction

Frictional drag of any body is given by the equation

$R_F = C_F \ 1/2 \, \rho S V^2$

From the above equation, it can be concluded that, to reduce the frictional resistance, one can reduce the value of C_F and/or density of liquid flowing and/or the wetted surface area. As seen from previous experiments based on MBDR, it is clearly mentioned that, combined effect of reduction in density and wetted surface area along with reduction in C_F due to alteration of flow properties and modification of turbulent momentum transport due the causes considerable reduction in frictional drag. When air or gas is injected below the plate into the boundary layer, mixture of air or gas bubbles and water is formed [16]. If the air injection flow rate is increased, air bubbles start coalescing with other, forming patches that cover the surface. In Micro Bubble Drag Reduction (MBDR) air or gas is injected, using a slot, porous medium or a perforated plate. In this case, size of Bubbles generated will be very small as compared to boundary layer thickness. This causes reduction in the density of liquid flowing along with alteration of the turbulent momentum transport. If the injection rate of air is injected further, transition from a bubbly flow to a Transitional Air Layer occurs, where in a Transitional air layer is formed covering more area below the body [17]. As the injection rate is increased further, a continuous air or gas layer is formed covering entire surface, known is Fully developed air layer reducing the wetted surface area. This in turn causes considerable reduction in frictional drag which reaches to almost 80%.

As mentioned earlier, the study is carried out to analyse the effect of different air injection flow rate and ship's speed on the reduction in frictional drag and total drag of ship. Figure 17 and Figure 18 shows results obtained from the experimental investigation. For the injection flow rate of 2.5 CFM as shown in the Figure 17, maximum reduction of 35.4% is obtained at a speed of 6 knots and at cruising speed of 10 knots, the reduction of 22.4% is obtained. Moreover, at a speed of 11 knots, the reduction is found to be 25.4%. For all other speeds, reduction in the drag of the ship was found to be dipping. It is a well-known fact that, at higher speeds, the percentage of wave making resistance is higher as compared to the frictional drag and as MBDR reduces only frictional drag and probably it might increase the wave making resistance also, causing increment in the total drag. Moreover, as seen from the Figure 17, reduction in the total drag is found to be more at slower speeds as compared to at higher speeds.

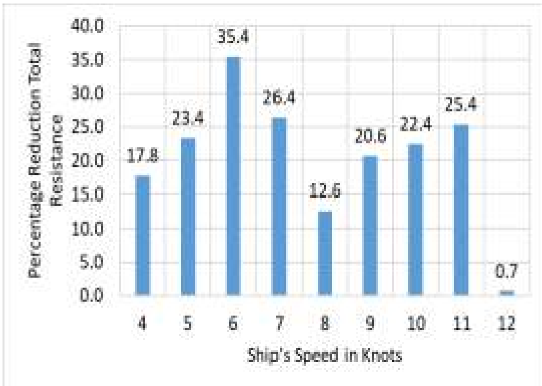

Fig. 17. Percentage Reduction in Total resistance of ship for Injection rate of 2.5 CFM

For the maximum injection flow rate of 3.0 CFM as shown in the Figure 18, maximum reduction in the total drag of 43.8% is obtained at a speed of 6 knots and at cruising speed of 10 knots, the reduction of 21% is obtained.

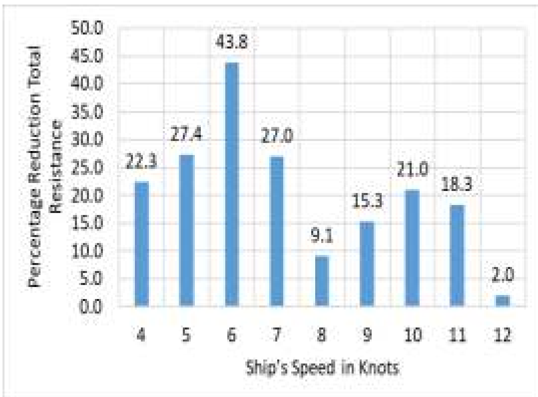

Fig. 18. Percentage Reduction in Total resistance of ship for Injection rate of 3.0 CFM

From the above study, it can be concluded that, maximum reduction in the total drag and frictional drag of 43.8% is obtained at a speed of 6 knots at the injection flow rate of 3.0 CFM. If one considers the cruising speed, the maximum reduction of 22.4% was obtained at the injection flow rate of 2.5CFM. Experimental results obtained are in line to the results obtained by [11], [18], [19][20], [21][22], [12],[9], [23] and [6].

Conclusions

In this study, experimental investigations into frictional drag reduction by micro bubbles were carried out for an 8000 Tonnes Deadweight Bulk Carrier for different speeds and for different air injection rates using series of injection holes of 1mm diameter. Following inferences can be made from the experimental investigation carried out:

Maximum reduction in the total drag of 43.8% is obtained at a speed of 6 knots at the injection flow rate of 3.0 CFM.

For the cruising speed of 10 knots, for which the ship is designed, the maximum reduction in the total drag of 22.4% was obtained at the injection flow rate of 2.5CFM.

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ROLE OF EDUCATIONAL INSTITUTIONS IN CLIMATE CHANGE

Deepchand Dhankher
Tolani Maritime Institute
dcdhankher@gmail.com

ABSTRACT

Climate Change Education is learning geared toward helping people address and develop effective responses to climate change. It helps learners understand the causes and consequences of climate change, prepares them to live with the impacts of climate change and empowers learners to take appropriate actions to adopt more sustainable lifestyles. It helps policy-makers understand the urgency and importance of putting mechanisms into place to combat climate change on a national and global scale. Communities learn about how climate change will affect them, what they can do to protect themselves from negative consequences, and how they can reduce their own climate footprint. In particular, it also helps increase the resilience of already vulnerable communities who are the most likely to be adversely affected by climate change.

The world faces not only a climate change crisis, but also threats to sustainability on all fronts. Thus, it is essential that colleges and universities formally acknowledge these transcendent problems and reorient academic programs to be relevant to the challenges all future graduates will face.

Keywords :

Climate Change, Greenhouse gases (GHG)

What is Climate Change?

When we refer to 'climate', we mean average patterns in weather. Thus, roughly speaking, climate change is a deviation from the weather patterns that have prevailed over a given period.

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere which is in addition to natural climate variability observed over comparable time periods".

Climate change is primarily influenced by the total stock of Greenhouse Gases (GHGs) in the atmosphere and not by annual GHG emissions. Naturally occurring greenhouse gases include water vapour, carbon dioxide, ozone, methane and nitrous oxide, and together create a natural greenhouse effect.

However, human activities are causing greenhouse gas levels in the atmosphere to increase. The naturally occurring greenhouse gases allow incoming ultraviolet solar radiation to pass through relatively unimpeded, but partially absorb and re-emit outgoing infrared terrestrial radiation. This naturally process raises the earth's average temperature from -18 °C to +15 °C, and is hence vital for life on earth.

At the time of industrial revolution, anthropogenic activities such as energy generation from fossil fuels and deforestation activities have been increasing the atmospheric concentrations of greenhouse gases beyond their natural levels, resulting in an enhanced greenhouse effect. This, in turn has cause a phenomenon called global warming.

According to the UN Environment Programme,

"The most profound global threat facing humanity today is the prospect that our economic activities will result in global warming with serious consequences for the earth's entire ecosystem and for the way of life in rich and poor alike. The expected consequences-rising sea levels, depleted agriculture, reduced water flows, increased health hazards, turbulent weather, social strains-suggest that both developed and developing countries have good reason to worry about climate change"[1]

Effects of Climate Change on India

The region faces formidable environmental land socio-economic challenges in its effort to protect valuable natural resources. Land and ecosystems are being degraded, threatening to undermine food security. In addition, water and air quality are deteriorating while continued increases in consumption and associated waste have contributed to the exponential growth in the region's existing environmental problems. Furthermore, the region is highly subject to natural hazards, such as 2004 Indian Ocean Tsunami.

There are various effects of climate change such as the ones listed below:

Extreme Heat

India is already experiencing a warming climate. Unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger areas.Under 4°C warming, the west coast and southern India are projected to shift to new, high-temperature climatic regimes with significant impacts on agriculture.

Every year, a no. of deaths is recorded in India due to heat strokes. This extreme heat also leads to another threat, which is drought. Crops go dry and cause huge loses to farmers.

Changing Rainfall Patterns

A decline in monsoon rainfall since the 1950s has already been observed. The frequency of heavy rainfall events has also increased. A 2°C rise in the world's average temperatures will make India's summer monsoon highly unpredictable. At 4°C warming, an extremely wet monsoon that currently has a chance of occurring only once in 100 years is projected to occur every 10 years by the end of the century.An abrupt change in the monsoon could precipitate a major crisis, triggering more frequent droughts as well as greater flooding in large parts of India.India's northwest coast to the south eastern coastal region could see higher than average rainfall.Dry years are expected to be drier and wet years wetter.

The most recent case of abrupt rainfall pattern was seen in Kerala where a phenomenon called 'flash flooding' has occurred. Heavy flooding has caused the deaths of at least 360 people in Kerala since June, the worst natural disaster to strike the southern Indian state in decades. More than 1m people have been displaced and are recovering in relief camps after 80 dams were overrun by torrential rains. The phenomenon occurs when a sudden downpour proves so heavy that the underlying ground cannot cope with the sheer amount of water it is exposed to and becomes saturated before it has a chance to drain away. Common in low-lying areas, flash floods can also be caused by an intense concentration of rain from thunderstorms on dry soil, unaccustomed to ready absorption.[2]

Droughts

Evidence indicates that parts of South Asia have become drier since the 1970s with an increase in the number of droughts. Droughts have major consequences. In 1987 and 2002-2003, droughts affected more than half of India's crop area and led to a huge fall in crop production. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh. Crop yields are expected to fall significantly because of extreme heat by the 2040s.

States affected by drought in India are Maharashtra, Karnataka, Andhra Pradesh, Orissa, Gujarat and Rajasthan, Major population of these region depended on the rice crop of the winter season.

The Marathwada region of Maharashtra states is facing severe water scarcity. Drought affected region in Marathwada includes Eight districts Aurangabad, Nanded, Latur, Jalna, Beed, Parbhani, Osmanabad, and Hingoli. Jalna is the most affected district among others in the region.Due to the failure of the monsoon, some parts of Bihar and Jharkhand along with Punjab and Haryana are also affected by drought.[2]

Groundwater

More than 60% of India's agriculture is rain-fed, making the country highly dependent on groundwater. Even without climate change, 15% of India's groundwater resources are over exploited Although it is difficult to predict future ground water levels, falling water tables can be expected to reduce further on account of increasing demand for water from a growing population, more affluent life styles, as well as from the services sector and industry.

Glacier Melt

Glaciers in the north-western Himalayas and in the Karakoram range - where westerly winter winds are the major source of moisture - have remained stable or even advanced.On the other hand, most Himalayan glaciers - where a substantial part of the moisture is supplied by the summer monsoon - have been retreating over the past century.At 2.5°C warming, melting glaciers and the loss of snow cover over the Himalayas are expected to threaten the stability and reliability of northern India's primarily glacier-fed rivers, particularly the Indus and the Brahmaputra. The Ganges will be less dependent on melt water due to high annual rainfall downstream during the monsoon season.The Indus and Brahmaputra are expected to see increased flows in spring when the snows melt, with flows reducing subsequently in late spring and summer.Alterations in the flows of the Indus, Ganges, and Brahmaputra rivers could significantly impact irrigation, affecting the amount of food that can be produced in their basins as well as the livelihoods of millions of people (209 million in the Indus basin, 478 million in the Ganges basin, and 62 million in the Brahmaputra basin in the year 2005).

Sea Level Rise

Mumbai has the world's largest population exposed to coastal flooding, with large parts of the city built on reclaimed land, below the high-tide mark. Rapid and unplanned urbanization further increases the risks of sea water intrusion.With India close to the equator, the sub-continent would see much higher rises in sea levels than higher latitudes.Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality, contaminating drinking water, and possibly causing a rise in diarrhoea cases and cholera outbreaks, as the cholera bacterium survives longer in saline water.Kolkata and Mumbai, both densely populated cities, are particularly vulnerable to the impacts of sea-level rise, tropical cyclones, and riverine flooding.

Agriculture and Food Security

Even without climate change, world food prices are expected to increase due to growing populations and rising incomes, as well as a greater demand for biofuels. Rice: While overall rice yields have increased, rising temperatures with lower rainfall at the end of the growing season have caused a significant loss in India's rice production. Without climate change, average rice yields could have been almost 6% higher (75 million tons in absolute terms). Wheat: Recent studies shows that wheat yields peaked in India and Bangladesh around 2001 and have not increased since despite increasing fertilizer applications. Observations show that extremely high temperatures in northern India - above 34°C - have had a substantial negative effect on wheat yields, and rising temperatures can only aggravate the situation.Seasonal water scarcity, rising temperatures, and intrusion of sea water would threaten crop yields, jeopardizing the country's food security.Should current trends persist, substantial yield reductions in both rice and wheat can be expected in the near and medium term.Under 2°C warming by the 2050s, the country may need to import more than twice the amount of food-grain than would be required without climate change.

The problem of farmers' suicides, also known as the Agrarian crisis is the rampant phenomenon of suicides among Indian farmers from 1990 to the present.Climate change may have contributed to the suicides of nearly 60,000 Indian farmers and farm workers over the past three decades, according to new research. One drought-hit state, Maharashtra, reported 852 farmer suicides in the first four months of this year, while in 2015, one of the worst years on record, about 12,602 farmers killed themselves across India. Overall, more than 300,000 farmers and farm workers have killed themselves in the country since 1995.[3]

Energy Security

Climate-related impacts on water resources can undermine the two dominant forms of power generation in India - hydropower and thermal power generation - both of which depend on adequate water supplies to function effectively.To function at full efficiency, thermal power plants need a constant supply of fresh cool water to maintain their cooling systems.The increasing variability and long-term decreases in river flows can pose a major challenge to hydropower plants and increase the risk of physical damage from landslides, flash floods, glacial lake outbursts, and other climate-related natural disasters. Decreases in the availability of water and increases in temperature will pose major risk factors to thermal power generation.

Water Security

Many parts of India are already experiencing water stress. Even without climate change, satisfying future demand for water will be a major challenge. Urbanization, population growth, economic development, and increasing demand for water from agriculture and industry are likely to aggravate the situation further.An increase in variability of monsoon rainfall is expected to increase water shortages in some areas.Studies have found that the threat to water security is very high over central India, along the mountain ranges of the Western Ghats, and in India's north-eastern states.

Health

Climate change is expected to have major health impacts in India- increasing malnutrition and related health disorders such as child stunting - with the poor likely to be affected most severely. Child stunting is projected to increase by 35% by 2050 compared to a scenario without climate change.Malaria and other vector-borne diseases, along with and diarrheal infections which are a major cause of child mortality, are likely to spread into areas where colder temperatures had previously limited transmission.Heat waves are likely to result in a very substantial rise in mortality and death, and injuries from extreme weather events are likely to increase. Health systems will need to be strengthened in identified hotspots.

Migration

South Asia is a hotspot for the migration of people from disaster-affected or degraded areas to other national and international regions. The Indus and the Ganges-Brahmaputra-Meghna Basins are major Trans Boundary Rivers, and increasing demand for water is already leading to tensions among countries over water sharing. Climate change impacts on agriculture and livelihoods can increase the number of climate refugees.

How can educational institutions help in tackling climate change?

It is clear that education – formal and non-formal, from primary through

to tertiary and adult education – has an important role to play in addressing this change. Education is recognized as an important first step in increasing resilience.

The United Nations Framework Convention on Climate Change (UNFCCC) Article 6: Education, Training and Public Awareness (also known as the New Delhi work program) recognizes that education mustplay a key role in a holistic response to climate change at local, national and global levels.

The American College & University Presidents' Climate Commitment (ACUPCC) — finds that higher education institutions:

Have a critical role to play in preparing society to adapt to the impacts of climate disruption by providing research and education around adaptation strategies and science.

Need to increase their curricular offerings on climate adaptation, both through mainstreaming the

information in core courses and offering electives that specialize in the topic.

Face direct risks to their operations and infrastructure from the impacts of climate disruption.

Have the unique opportunity to role-model solutions in their own operations.

Can serve as 'hubs' in their local communities for creating, testing, and disseminating knowledge about regional climate projections and adaptation strategies, and should work directly with their local communitiesto explain the science and implement solutions.

Should acknowledge the inequitable distribution of climate impacts across populations, with low income being in most need.

Should aim to identify adaptation strategies that also contribute to mitigation efforts.

Generic approaches to promote sustainable development in education include:

Curriculum: Climate change education integrated into the curricula at all levels which is tailored to local contexts – this could include:

Information on key climate change related subjects.

Practical measures of mitigation and adaptation that students can utilize in their home lives and future careers, and resilience skills to prepare them for the challenges of climate change, such as migration (including the role of ICT).

Opportunities for students to apply their knowledge to real life situations through climate change projects and problem-solving activities.

Extra-curricular activities: Opportunities to attend field trips and visit environmental sites

Teacher training: Include climate change in teacher education (e.g. disaster risk reduction education, and aspects of policy, planning and implementation) to ensure educators can effectively communicate its significance to students, with professional development opportunities to ensure up to date knowledge.

Green school policies: Promote environmentally friendly behaviour through schools which embody the values they teach through ensuring they are environmentally sustainable and carbon neutral.

Adaptation plans for schools: To protect students from heat waves, dust storms, floods, mudslides, hurricanes and storms.

Mitigation plans for schools: Use of green renewable energy, waste management, insulation and efficient energy use, healthy low energy food and drink, physical activity and green transport.

Recent Developments in Climate Change Education

Education for Sustainable Development (ESD)

Education for Sustainable Development (ESD) has been a widely promoted philosophy in the last two decades.

The concept of ESD emerged in the late 1980s alongside international discussions of environmental protection and sustainable development. It was given much of its shape at the United Nations Conferenceon Environment and Development in Rio de Janeiro in 1992, and in the resulting Agenda 21:

Education, including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their fullest potential. Education is criticalfor promoting sustainable development and improving the capacity of the people to addressenvironment and development issues. While basic education provides the underpinning for anyenvironmental and development education, the latter needs to be incorporated as an essential partof learning. (UNCED, 1992)

Key features of ESD include:

A concern for high quality education, which is interdisciplinary and holistic, fosters critical thinking andproblem solving, and is participatory and locally relevant.

An attention to values, including respect for others, for difference and diversity, and for the environment.

An acknowledgement that ESD will be shaped by diverse perspectives and will take place across arrange of learning spaces, from formal and informal, and early childhood through adult life (UNESCO,2006).

Both Agenda 21 and DESD, international policy frameworks, suggest ESD does not simply represent a single, new curriculum area for schools (e.g. environmental studies), but rather a more integrated approach to providing appropriate education and training in a diverse and rapidly changing world.

Furthermore, both frameworks strongly connect ESD efforts to international interest in both increasing access to education and providing high quality through Education for All (EFA) and MDG efforts. These assertions are supported by a significant body of academic research and policy (Bangay and Blum, 2010).[3,4]

Conclusion

Climate Change, because of its negative impacts has become a threat to our society and needs utmost attention. Educating about climate change is our best option towards tackling this menace. Educating the population about climate change is grass-root level application of policies and reforms. The basic role of educational institutions in supporting climate change education have already been discussed above.

What we really need in our society today is education through change. As it is rightly said that we lead by example, educational institutions can also lead by example by implementing environment friendly reforms to its own infrastructure.

There can be many ways by which this can be achieved, such as:

Solar Schools: This means that the schools can adopt a range of energy and water efficiency measures including: installation of a minimum 2-kilowattsolar panel; energy efficient lighting; sky lights; shade awnings; and water collection systems (solar hot watersystems and rainwater tanks).

The objectives of the scheme are to allow schools to:

- generate their own electricity from renewable sources;
- improve their energy efficiency and reduce their energy consumption;
- adapt to climate change by making use of rain water collected from school roofs;
- provide educational benefits for schools' students and their communities; and
- support the growth of the renewable energy industry.

Inclusion of Environmental Studies as a compulsory subject: As of now, there are only a few schools and colleges in India which have included environmental studies as a compulsory subject in their syllabus.

The aim behind this is to make the students aware about how the environment around them is changing and how it might them and the generations to come. They must be aware about how they can contribute towards a better country by tackling climate change and also spreading awareness around them.

If even a single student teaches 10 people around him about climate change, half of our population would already be aware of the situation. And together, all of us could work towards a better India.

Findings and Discussion

The Carbon Commitment seeks to create connections with higher educational institutions in order to carry out two goals: The first is to make an agreement with these colleges and universities that they will commit to eliminate their net greenhouse gas emissions from specified campus operations. The second focuses on education and the institutions' ability to promote research of sustainability programs and empower the "higher education sector to educate students, create solutions, and provide leadership-by-example for the rest of society."

Calling climate change a defining issue of our time, United Nations Secretary-General Ban Ki-moon said that the opportunity exists "to define our own destiny." Institutions of higher education have the advantage to shape this destiny by educating the young generation on the impacts of climate change, the actions that they can take in personal and professional life to mitigate the impact, and ways to create a sustainable society where systems thinking is a way of life. Everything is part of the puzzle.

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REVIEW ON APPLICATIONS OF THE THERMAL ELECTRIC DEVICES

Sagar B. Mane Deshmukh
Tolani Maritime Institute, Pune.
sagarm@tmi.tolani.edu

ABSTRACT

Power generation through the thermal electric systems is very much effective because of the non-moving parts in the assembly. These systems are mainly effective at small scale of the device. Thermoelectric power generation is a key way success of the small-scale systems and hence applications which uses thermal electric power generation should be reviewed. Present paper is focused mainly on review ofapplications of the thermoelectric device. Findings from all the points mentioned above are sorted after every point and collective conclusions are drawn at last. Future modifications/recommendations are suggested in the existing power generating systems.

Keywords :

Thermal electric material, applications, future modifications

Introduction

Looking at the present needs of the small capacity power generation for stationary and portable applications, review of the applications in which thermal electric devices are used and important suggestions to modify the existing systems is required. Thermoelectric power generation systems have no moving parts and hence its use in the small scale power generation is very important (because of its tendency to have zero frictional losses) [1] e.g. internal combustion can't be manufactured at small scale, because of its high frictional and heat losses [1].

Fundamental principles by which electricity is produced using thermoelectric devices are Seebeck effect and Peltier effect which are explained below.

Seebeck Effect

Thermoelectric devices work on the basic principle developed by Seebeck.Power is produced in the devices because of required temperature gradient which is created b[...]lectric material a[...]

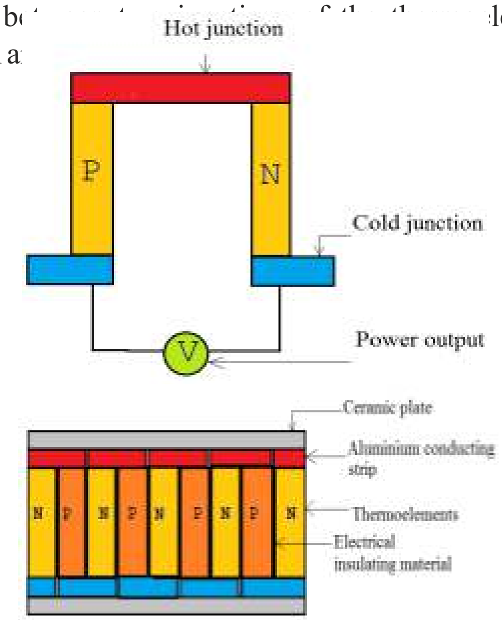

Fig.1. Seebeck effect [3]

Fig. 1 explains the working principle of Seebeck effect used in thermoelectric power generation. Seebeck effect mainly works on creation of the temperature gradient between two junctions of the thermoelectric power generator. Temperature gradient is created between two junctions (i.e. one end is hot and other one is the cold end of the generator) across the thermoelectric power generator. Due to the temperature gradient and p-n junction structure in the thermoelectric generator, it generates DC voltage. Generated DC voltage is proportional to the temperature gradient. Generated voltage can be used for running various applications like cellular phones, small capacity fans, battery charging, micro aerial vehicles, unmanned aerial vehicles, remote sensors, divert and attitude control systems etc. Power factor of thermoelectric device is formulated as [1-5]:

Powerfactor=σS^2 **(1)**

Equation (1) shows the relation between power factor, Seebeck coefficient (S) and electrical conductivity (σ) [5], Materials which have higher electrical conductivity helps in generation of higher power factor which in turn helps to produce high power output [3]. Thermoelectric power generator is a power generating device whose efficiency is limited by Carnot efficiency, this is mentioned in eq. (2) [3]

$$\eta_{max} = \left((TH - TC)\sqrt{1+ZT}\right) - \frac{1}{((TH)(\sqrt{1+ZT})+(TH/TC)} \quad (2)$$

Where, TH is hot side temperature and TC is cold side temperature. ZT here is figure of merit which is shown in eq. (3) [3],

$$ZT = \frac{\left[(S_p - S_n)^2 (T)\right]}{\left[(\rho_n K_n)^{\frac{1}{2}} + (\rho_p K_p)^{\frac{1}{2}}\right]^2} \quad (3)$$

Where, ρ is electrical resistivity, T is average temperature between hot and cold sides. Equation 3 is useful when parameters related to p and n type materials are known. Subscripts n and p indicates properties related to p and n type of semiconducting materials [1].

Thermoelectric power generating device efficiency can be given as [3],

$$\eta = \frac{energyprovidedtoload}{heatabsorbedathotjunction}$$

Ability of a given material to efficiently produce thermoelectric power is related to its dimensionless figure of merit i.e. ZT, [3]

$$ZT = \frac{(\sigma S^2 T)}{(K)} \quad (4)$$

Where, σ is electrical conductivity, K is thermal conductivity, S is Seebeck coefficient and T is average temperature.

Peltier Effect

Peltier effect describes a principle in which heat is given out or absorbed by thermoelectric device, when an electric current pass across a junction between two materials [2-9].

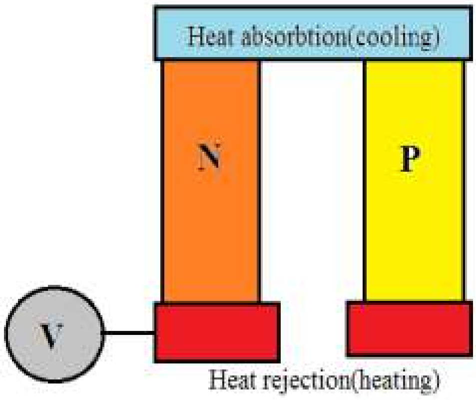

Fig.2. Peltier effect [3]

Figure 2 shows basic principle of Peltier effect for the cooling applications (e.g. Refrigeration) by using thermoelectric device. Constant voltage is supplied to the thermoelectric device as shown in fig. 2, which helps to generate a cooling effect by absorption of heat from the surface which is to be cooled.

Applications of The Thermoelectric Power Generator

There are many researches on applications of thermoelectric module, few of them are explained below:

1. A Russian scientist developed generator to operate radio receiver by using thermoelectric module, in which he used standard oil lamp as a heat source [6]. He used 3000 thermocouples in this design, but this was not optimized design because of low power output [6] and so he produced another generator by

using kerosene burner [6].

2. Figure 3 shows miniature thermoelectric generator that was discovered in 1988 by [7] and was used to run small scale applications like charging or running a watch battery,

domestic water heating component, etc.

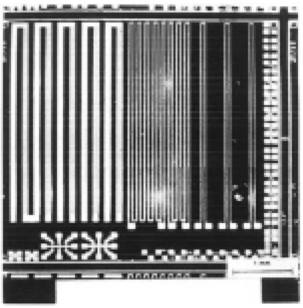

Fig.3. Miniature thermoelectric power generator photograph [2]

3. Figure 4 shows another micro scale thermoelectric generator which is used to drive an electronic chip. This device is made up of heat conducting materials like diamond or another high thermal conductivity material [7]. In this device the Be_2Te_3 alloy is placed in thermal contact with the heat conducting substrate. The low temperature region is located at the other side. Thus, a temperature gradient across the device generates electrical power [7].

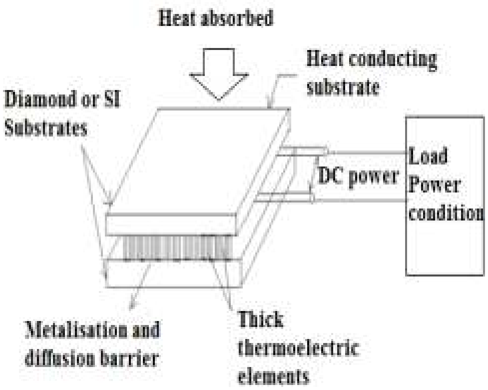

Fig.4. Use of waste heat in the thermoelectric power generator to run electronic chip [2]

4. Exhaust gases released from cars to environment can be used to generate electricity by using thermoelectric generator. Approximately 30% of fuel energy is dissipated in waste heat through passenger cars running on road [2-13]. In reference [2] thermoelectric module was established by using PbTe technology which was most suitable for converting waste heat energy into electrical energy in automobiles. Electrical energy generated was used to run battery and inverter [2]. A schematic diagram in fig.5 shows waste heat energy recovery from silencers/exhaust pipes from the automobile which is converted into electrical energy through thermoelectric generator. Final power output obtained during normal working conditions of the car was 20 – 30 KW [2].

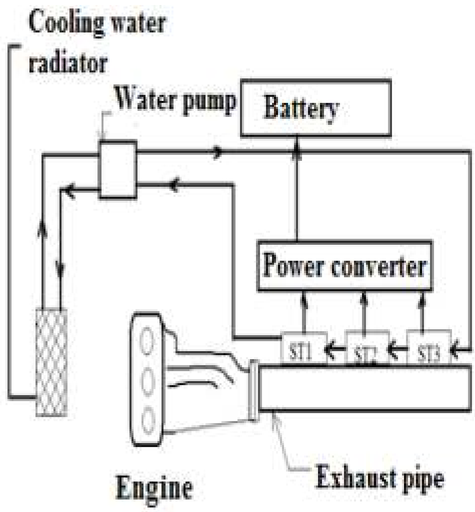

Fig. 5. Schematic diagram of converting waste heat directly into electrical power using thermoelectric power generator in IC-engine [2].

Thermoelectric generator can also be used in automobile during hot seasons to cool the seats by placing the device inside the seats [2-12]. It is most simple and efficient way to add comfort inside the car, by avoiding air conditioning of car and it also saves cost.

4. Effect of combination of thermoelectric refrigerator (TER) and direct evaporative air cooling (DEAC) system is investigated theoretically and experimentally by [8]. Thermoelectric refrigeration system was installed mainly to improve the air-cooling performance of a system. The DEAC has cooling pad in which sensible heat of inlet hot air is converted into latent heat of vaporization. Thermoelectric refrigeration was used for additional cooling by supplying cold water, which improves air-

cooling performance of DEAC [8]. Performance can further be increased by increasing number of stages. Fig. 6 shows schematic diagram of direct evaporative air cooler.

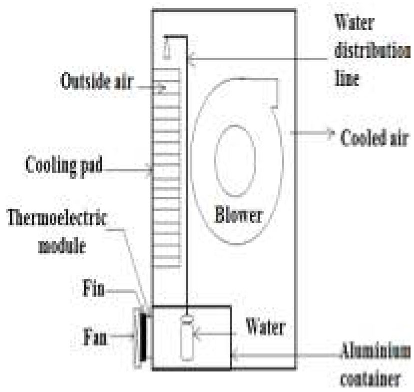

Fig.6. Schematic diagram of direct evaporative air cooler [8].

5. Thermoelectric refrigerator was developed by [7-15], which was powered by number of solar cell combined in solar panel. Solar panel gives the constant voltage and current required for thermoelectric cooler when electricity is not available (e.g. Rural areas or Deserts). Solar cells were placed as source of power supply. They generate electric current was passed through Peltier module and used to store electricity for later use [9-14]. Electricity can also be stored in batteries for further use in dark regions when there is no sun [9] or in nights. Fig. 5 shows the block diagram of thermoelectric refrigerator with solar cells. This will increase COP of the system.

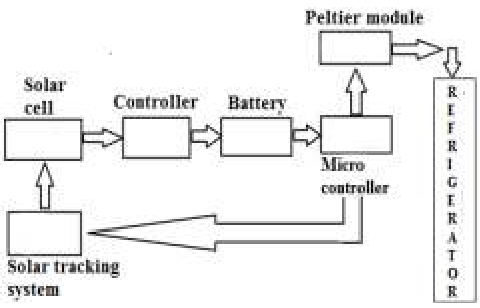

Fig.7. Block diagram of thermoelectric refrigerator with solar cell [9].

6. Medical applications describe use of temperature difference effect on treatment of various diseases in the human body. Many difficulties are faced by human bode because of thermal effects which are reduced by using thermoelectric cooling system [10]. Practical applications in the areas of medicine are neurosurgery, genecology, cryotherapy, plastic surgery, dermatology, urology, oncology etc. [10]. In the dermatology, thermoelectric devices were used for stimulation of metabolism and reducing of wrinkles for the treatment of pyoinflammatory processes, freezing out of the warts, hardening of the individual parts of human body and other medical events [10].

7. Research conducted discussed that marine vessels consumes only 7% of the total energy required in the transportation [11-16]. Thermoelectric generators were used to recover waste heat energy during transportation in ships. Because of introduction of the above thermoelectric generator system into propulsion systems reduced load on generator. This hybrid vessel called hybrid “Green Ship”. Thermoelectric generator was found to be dependent on the temperature difference generated between the exhaust steam and a coolant in ship industry [11]. Many waste heat sources in ships like scavenge air cooling, exhaust gases, engine cooling jacket, lubricating oil cooling and cargo cooling were suitable for generation of electricity [11]. Mostly TEG were used for engine waste heat recovery.

Conclusion

The present paper includes discussion on the basic principles used for power generation by using the thermal electric material. The review of important applications is covered. Use of thermoelectric generator in generating electricity by using waste heat from various systems is also discussed. Thermoelectric generators use was found to be significant in following applications: automobile, aerospace, marine industry, medical applications, in refrigeration and air conditioning applications and domestic applications. Following advantages are linked with thermoelectric power generating systems: simplicity, low cost, lower weights, practically no need of device maintenance, can be used at small scale, can be used in portable systems and can be used with high energy density fuels.

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DANGERS OF ENCLOSED SPACES

K.G. Apte
Tolani Maritime Institute, Pune
keshavkirana@tmi.tolani.edu

ABSTRACT

Any enclosed space deprived of regular and constant ventilation may become a 'dangerous space. Enclosed space is potentially life threatening and every precaution should be taken both prior to entry and while inside. Based on the findings of the risk assessment, appropriate control measures should be put in place to protect anyone who may enter an enclosed space. Procedures (such as systems of work, permits to work and emergency procedures) should be part of a ship's safety management system.

Keywords

Enclosed, Life Threatening, Precaution, Risk Assessment

Introduction

In the middle of August 2018, a vesseldischarging a cargo of coal at Paradip Port, suffered a fatal accident, when an entry was made into a partially filled hold. One person died and another person, who went for rescue also fell unconscious. The emergency alarm was raised. The crew mustered and the two casualties were brought out of the ladder trunking. One was already dead, the other person recovered after being brought into fresh air. Why did this happen? Proper procedures for entering enclosed spaces were not followed.

An enclosed space is one that:

- has limited openings for entry and exit;
- has inadequate ventilation; and
- is not designed for continuous worker occupation.

The regulations define a dangerous space as: 'Any enclosed or confined space in which it is foreseeable that the atmosphere may at some stage contain toxic or flammable gases or vapours, or be deficient in oxygen, to the extent that it may endanger the life or health of any person entering that space.' The dangers may not be readily apparent and, despite testing, isolated areas with very low oxygen content or small concentrations of toxic gases may exist. N.B.: A single inhalation with a 5% oxygen content may result in instantaneous loss of consciousness and subsequent death. Similarly, smallconcentrations of a toxic substance may result in loss of consciousness and subsequent death. Therefore, it is essential that all necessary precautions are taken including a risk assessment and the completion of a permit to work.[1]

A dangerous space may not necessarily be enclosed on all sides, e.g. ships' holds may have open tops but the nature of the cargo makes the atmosphere in the lower hold dangerous.Such places are not usually considered to be dangerous spaces but the atmosphere may become dangerous because of a change in the condition inside or in the degree of enclosure or confinement, which may occur intermittently, e.g. in diving bells or saturation chambers. Personnel need to exercise caution before entering any space on board a ship that has not been opened for some time. Examples of such spaces are:

- cargo spaces;
- double bottoms;
- fuel tanks;
- ballast tanks;
- cargo pump rooms;
- cargo compressor rooms;
- cofferdams;
- chain lockers;
- void spaces;
- duct keels;

- inter-barrier spaces;
- boilers;
- engine crankcases;
- engine scavenge air receivers;
- CO_2 rooms;
- battery lockers;
- sewage tanks; and
- adjacent connected spaces, e.g. cargo space access ways.

Risk Assessment

Any dangerous (enclosed) spaces on board ship should be identified using risk assessment and kept under review. It is recommended that an inventory is made of any enclosed spaces that seafarers may enter where there is any likelihood that they might become dangerous. The inventory should record the characteristics of the space, the likely hazard and measures to prevent entry unless safety procedures are followed. Any difficulties inherent in rescue from the space should also be considered, and solutions identified, so that in the event of an emergency, the crew is in the best position to respond quickly. This inventory should be reviewed regularly.

In addition:

- if there is any unexpected reduction in or loss of the means of ventilating spaces that are usually continuously or adequately ventilated, such spaces should also be dealt with as dangerous spaces; and
- when it is suspected that there could be a deficiency of oxygen in any space, or that toxic gases, vapours or fumes could be present, then such a space should be considered to be dangerous.

Entrances to all unattended dangerous spaces on a ship should be kept locked or secured against entry. Any hatches to readily accessible enclosed spaces should be marked as the entrance to a dangerous space. When the space is open for work to be carried out, an attendant should be posted or a barrier and warning sign put in place. As far as possible, work should be arranged in such a way that no one has to enter the space.

All crew should be given on-board training and familiarization with the risks of entry into dangerous spaces on board. Training should include as a minimum:

- identification of the hazards likely to be faced during entry into enclosed spaces;
- knowledge of the procedures for assessment of the space;
- knowledge of the procedures for safe entry; and
- recognition of the signs of adverse health effects caused by exposure to hazards during entry.

On the basis of their risk assessment, the authorized officer should decide the procedures to be followed for entry into a potentially dangerous space. These will depend on whether the assessment shows that:

- there is minimal risk to the life or health of a person entering the space then or at any future time;
- there is no immediate risk to health and life but a risk could arise during the course of work in the space; or
- the risk to life or health is immediate.

Where the assessment shows that there is no immediate risk to health or life but that a risk could arise during the course of the work in the space, the precautions should be taken as appropriate

Precautions before entering a dangerous space

The following precautions should be taken as appropriate before a potentially dangerous space is entered, so as to make the space safe for entry without breathing apparatus and to ensure it remains safe whilst persons are within the space.

- A competent person should make an assessment of the space and an authorised officer to take charge of the operation should be appointed.
- The potential hazards should be identified.
- The space should be prepared, vented and secured for entry.
- The atmosphere of the space should be tested.
- A permit to work system should be used.

- Procedures for preparation and entry should be agreed.
- Emergency procedures should be in place.

When the procedures have been followed and it has been established that the atmosphere in the space is or could be unsafe, then the additional requirements (including the use of breathing apparatus appropriate to the type and size of the space should also be followed.

In addition to pre-entry testing of the atmosphere, it is recommended that any person entering a potentially dangerous space should wear a personal atmosphere-monitoring device ('multimeter') capable of detecting oxygen deficiency, carbon monoxide, toxic gases and explosive atmospheres. It is important to recognise that carrying a personal atmosphere monitor is no substitute for pre-entry testing.

Identifying potential hazards

In carrying out their assessment, the competent person must take into account any cargo previously carried in the space, ventilation, the coating of the space, the degree of corrosion and any other relevant factors. The factors affecting adjacent spaces may be different from those affecting the space to be entered, but may affect the atmosphere in the space to be entered.

Oxygen deficiency, oxygen-enriched atmosphere, toxicity of oil, toxicity of other substances, flammability, other hazards.

Preparing and securing the space for entry

When opening the entrance to a potentially dangerous space, precautions should be taken in case pressurised or unpressurised vapour or gases are released from it. The space should be thoroughly ventilated, either by natural or mechanical means, and then tested to ensure that all harmful gases have been removed and no pockets of oxygen-deficient atmosphere remain. Any vented gases should be discharged away from the area, thereby not contaminating the immediate area of the entry point to the space or other spaces. The space should be isolated and secured against the ingress of dangerous substances by blanking off pipelines or other openings and by closing valves, in accordance with the risk assessment and on-board procedures. Valves should then be secured in the closed position, or some other means used to indicate that they are not to be opened. Remote-operated valves should, where practicable, have their remote actuators inhibited with notices placed locally and on the relevant controls. The officer on watch should be informed.

Where necessary, any sludge or other deposit liable to give off fumes should be cleaned out. This may in itself lead to the release of gases, and precautions should be taken. Compressed oxygen should not be used to ventilate any space.When appropriate, pumping operations or cargo movements should be suspended when entry is being made into a dangerous space.

Testing the atmosphere of the space

Testing should be carried out by remote means before entry and at regular intervals thereafter. Testing of a space should be carried out using properly calibrated and maintained equipment, and only by competent persons trained in the use of the equipment.

If testing by remote means is not possible, e.g. where remote double-bottom tanks have to be entered), it should be assumed that the atmosphere is hazardous until proven otherwise. The person selected to enter the space to test the atmosphere should only do so in accordance with additional precautions which include the wearing of breathing apparatus. Testing of the space should be carried out at different levels.

Personal monitoring equipment should not be used as a means of determining whether a dangerous space is safe prior to entry. This equipment is designed for personal use only, to provide a warning against oxygen deficiency, toxic gases and explosive atmospheres whilst the wearer is in the space.

Oxygen content should be at least 20.8%. However 20% is acceptable provided other tests are carried out for other toxic gasses.

Testing for flammable and hydrocarbon vapours must be carried out.

Toxic gasses should be tested by various means provided on board. Tests should be carried out for Carbon Monoxide, Hydrogen Sulfide, Carbon Dioxide etc.

Use of control systems

Use of Permits, checklists, no person should enter a dangerous space unless authorized to do so by an authorized officer

Safety precautions before entry

The space and its access areas should be adequately illuminated.No source of ignition should be taken or put into the space unless the authorized officer is satisfied that it is safe to do so. A rescue plan should be in place. In all cases, rescue and resuscitation equipment should be positioned ready for use at the entrance to the space. A risk assessment should identify what rescue equipment may be required for the particular circumstances but, as a minimum, this should include:

- appropriate breathing apparatus, with fully charged spare cylinders of air;
- lifelines and rescue harnesses;
- torches or a lamp (approved for use in a flammable atmosphere, if appropriate); and
- a means of hoisting an incapacitated person from the confined space, if appropriate.
- Means of communications should be available.
- At least one competent person, with appropriate equipment, should be posted to remain as an attendant at the entrance to the space whilst it is occupied.
- Ventilation should continue during the period that the space is occupied and during temporary breaks. In the event of a failure of the ventilation system, any personnel in the space should leave immediately.
- The atmosphere should be tested periodically whilst the space is occupied and personnel should be instructed to leave the space should there be any deterioration of the conditions.
- Should a personal gas detector give an alarm, everybody should leave the space immediately.
- If unforeseen difficulties or hazards develop, the work in the space should be stopped and everybody should leave the space so that the situation can be re-assessed. Permits should be withdrawn and only re-issued, with any appropriate revisions, after the situation has been re-assessed.
- If any personnel in a space feel in any way adversely affected, they should give the pre-arranged signal to the attendant standing by the entrance and immediately leave the space.
- Should an emergency occur, the general (or crew) alarm should be sounded so that back-up is immediately available to the rescue team. Under no circumstances should the attendant enter the space.

Procedures on completion

On expiry of the permit to work, everyone should leave the space and the entrance to the space should be closed or otherwise secured against entry or, alternatively, where the space is no longer a dangerous space, declared safe for normal entry.

Conclusion

Proper procedures must be followed at all times when entering enclosed spaces. Risk assessments must be made and proper control measures must be put into place to minimize the risks to acceptable levels.

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EMISSION IMPOSSIBLE:- HOW ARE SHIPPING COMPANIES WORKING TOWARDS MEETING THE 2020 SULPHUR EMISSION CODE

Avishek Ankit
Tolani Maritime Institute, Pune
avishekankit73@gmail.com

ABSTRACT

Sustainable shipping is recognized as one of the biggest challenges of the 21st century. It is accepted that whilst shipping is relatively safer and cleaner in comparison with other transport methods, the industry does have a significant impact on the environment. Marine Pollution has been the leading issue with the shipping industry since a decade. The International Maritime Organization (IMO) estimates that carbon dioxide emissions from shipping were equal to 2.2% of the global human-made emissions in 2012 and expects them to rise 50 to 250 percent by 2050 if no action is taken. To curb the sulphur, while till date no mandatory GHG instrument for International Shipping has been adopted, IMO has given significant consideration of the matter and has been working in accordance with an ambitious work plan with a view of adopting a package of technical provisions. To curb the sulphur emission by their vessels and abide by the new rules of IMO shipping companies can retrofit ships with sulphur scrubbers which allows for burning of lower cost high-sulphur fuel. Ships can also use alternative fuels such as Liquefied natural gas (LNG). Using EGR (Exhaust gas recirculation) method, Air lubrication system can lead to substantial reductions in sulphur emissions along with significant savings in fuel will contribute to a reduction of GHG emissions.

Keywords

Green houses gas emissions, Scupper, LNG Fuel, Smart energy savings, Fuel efficiency.

Introduction

The International Maritime Organization (IMO) as a regulator has first taken action as the global watchdog of the maritime sector recognizing its role for prevention of climate change. The regulations for the prevention of air pollution from ships (Annex VI) seek to control airborne emissions from ships (sulphur oxides (SOx), nitrogen oxides (NOx), Ozone depleting substances (ODS), volatile organic compounds (VOC) and shipboard incineration) and their contribution to local and global air pollution, human health issues and environmental problems. Annex VI entered into force on 19 May 2005 and a revised annex VI with significantly strengthened requirements was adopted in October 2008. These regulations entered into force on 1 July 2010.

Until 31st December 2019, for ships operating outside emission control areas, the limit for sulphur content of ships' fuel oil is 3.50% mass by mass. The 0.50% mass by mass limit will apply on and after 1 January 2020. Even after achieving milestones in technological advancements in improving efficiency in terms of time and money, the maritime industry is the reason behind one of the major causes of air pollution which destroys the planet's environment and the health of the people by increasing the amount of Greenhouse gases (GHG) emissions like Carbon dioxide (Co_2), Nitrogen oxide (NOx), Sulphur oxide (SOx) and other particulate matter.[5].

Kyoto Protocol

Article 2.2 of the Kyoto protocol states: -

"The parties included in Annex 1 shall pursue limitation or reduction of emissions of greenhouse gas emissions not controlled by the Montreal Protocol from aviation and Marine Bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization respectively."[1].

Emission Control areas (ECAS)

Since 1st January 2015, the sulphur limit for fuel oil used by ships in SOx Emission control areas (ECAS) established by IMO has been 0.10% Mass by Mass.

The ECAs established under MARPOL Annex VI for Sox are: Baltic sea area, the North area; the North American area (covering designated coastal areas off the united states and Canada); and the united states Caribbean Sea area (around Puerto Rico and United State Virgin Islands).

What will be the new global limit mean for ships?

Under the new global cap, ships will have to use fuel onboard with a sulphur content of no more than 0.50% m/m, against the current limit of 3.50%, which has been affect since January 2012. The interpretation of "Fuel oil used onboard" includes use in main and auxiliary engine and boilers. Exemptions are provided for situations involving the safety of the ship or saving life at sea, or if a ship or its equipment is damaged. Another exemption allows for ship to conduct trials for the development of ship emission reduction and control technologies and engine design programmes. This would require a special permit from administration (flag states).[1].

SEEMP and EEOI

SEEMP is an operational measure that establishes a mechanism to improve the energy efficiency of a ship in a cost-effective manner. The SEEMP also provides an approach for shipping companies to manage ship and fleet efficiency performance over time using. For example, the Energy Efficiency Operational Indicator (EEOI) as a measuring tool. The SEEMP urges the ship owner and operator at each stage of the plan to consider new technologies and practices when seeking to optimize the performance of ship.[2].

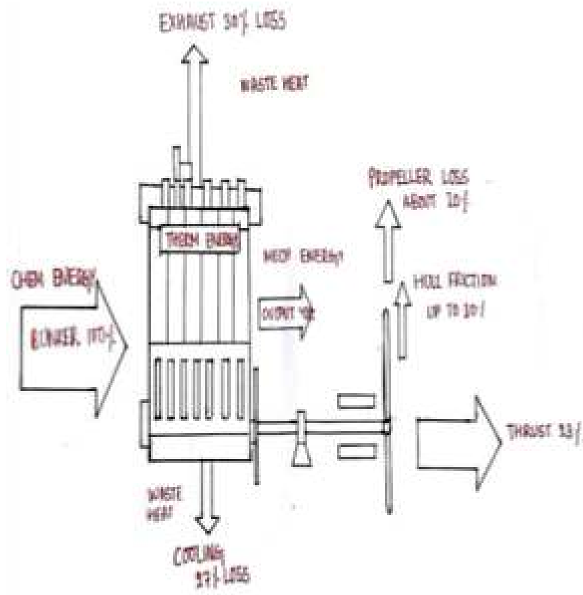


Fig. 1. General systemic energy loss

Key Features of SEEMP: -

- Broader corporate energy management policy
- Enhancement of ship efficiency
- Reduce fuel consumption
- Decrease greenhouse gas (GHG) emission from the ship.

How ships can meet low sulphur emission standards?

On general overview, ships can meet the requirement by using low-sulphur compliant fuel oil. An increasing number of ships are also using gas as fuel as when ignited it leads to negligible sulphur code emissions. This has been recognized in the development by IMO of the International Code for ships using gases and other low flash point fuels (the IGF Code), which was adopted in 2015.

Apart from this there are few innovative ideas to minimize the sulphur contents of fuel used in ships: -

1. Scrubbers (Exhaust gas cleaning systems)

2. Exhaust Gas Recirculation (EGR)
3. Alternative fuel as LNG (Liquified Natural Gas)
4. Air Lubrication system

1. Scrubbers (Exhaust gas cleaning systems)

Ships may also meet the SOx emission requirements by using approved equivalent methods such as exhaust gas cleaning systems or 'scrubbers' which clean the emissions before they are released into atmosphere. Before scrubbers or even before Sox was considered an issue for the shipping industry it was being regulated around the globe in connection with the use of large diesel engines in power production and other shore-based industries. As a consequence, exhaust gas cleaning or scrubbing technology is a long-established reality in shore-based situations cleaning up emissions from oil and coal-based power plants.

Working Mechanism

Scrubbers - Wet scrubbing technology

In a scrubber, the sulphur oxides in the exhaust are passed through a water stream reacting with it to form sulphuric acid and are removed from the exhaust gas which then passes out of the system.

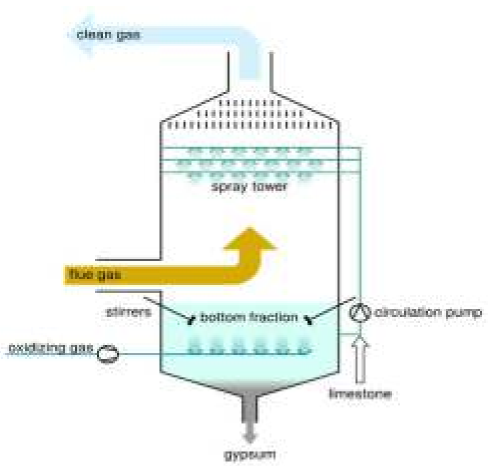


Fig. 2. Wet Scrubbing Mechanism

Sulphuric acid is highly corrosive but when diluted with sufficient alkaline seawater it is neutralised and the wash water can be discharged into the open sea after being treated in a separator to remove any sludge. The alkalinity of seawater varies due to a number of reasons. In estuaries and close to land it may be brackish and closer to neutral and in some areas where underwater volcanic activity takes place the water may naturally be slightly acidic. In the shipping sector, wet scrubbers are divided into two types; open loop and closed loop which were developed separately but which are now usually combined into a hybrid system that can employ the most appropriate technology depending upon prevailing circumstances[3].

There is one type of wet scrubber that has been developed which combines wet scrubbing with membrane technology. In an open loop scrubber seawater is used as the scrubbing and neutralising medium and no additional chemicals are required. The exhaust gas from the engine or boiler passes into the scrubber and is treated with seawater. The volume of seawater will depend upon engine size and power output but equates approximately to around 40m3 per MWh meaning a quite high pumping capability is required. The system is around 98% effective and even allowing for fuel oil with 3.5% sulphur should have no problem reaching the maximum 0.1% 2015
ECA level. An open loop system can work perfectly satisfactorily only when the seawater used for scrubbing has sufficient alkalinity. Fresh water and brackish water are not effective and neither is seawater at high ambient temperature.

For this reason, an open loop scrubber is not considered as suitable technology for areas such as the Baltic where salinity levels are not high. MARPOL regulations require the wash water to be monitored before discharge to ensure that the PH value is not too low. A closed loop scrubber works on similar principals to an open loop system but instead of seawater it uses fresh water treated with a chemical (usually sodium hydroxide but some systems others) as the scrubbing media. This converts the SOx from the exhaust gas stream into harmless sodium sulphate. Unlike the flow through method of open loop scrubbers, the wash water from a closed loop scrubber passes into a process tank where it is cleaned before being recirculated. The fresh water can either be carried in tanks or else produced on board if a fresh water generator is installed on the ship.

In order to prevent build-up of sodium sulphate in the system, a small amount of wash water is moved at regular intervals either over side or to a holding tank and new freshwater added. The volume of wash water required in a closed loop system is around half that of the open loop version however, more tanks are required. These are a process or buffer tank in the circulation system, a holding tank where discharge to sea is prohibited and a storage tank able to have a controlled temperature between 20º and 50ºC for the sodium hydroxide which is usually used as a 50% aqueous solution. There must also be storage space for the dry sodium hydroxide.The hybrid system is a combination of both wet types that will operate as an open loop system where water conditions and discharge regulations allow and as a closed loop system at other times. Hybrid systems are proving to be the most popular because they can cope with every situation[3]. The wet systems are not the most compact pieces of equipment and would take up considerable space if it were necessary to install them in under deck machinery spaces. Fortunately, they can be installed in the funnel casing and can in some cases replace part of the conventional exhaust system.

Membrane option

The new membrane scrubber recently introduced is a wet scrubber but instead of the exhaust coming into direct contact with the scrubbing water in a spray or cascade system, Nano porous ceramic membrane separation tubes are used to extract SOx from the engine exhaust. The Membrane Scrubber consists of an array of ceramic tube membranes, suspended in the exhaust stream. A manifold system circulates the absorbent solution through the membrane tubes. Exhaust gases pass over the membranes where the SOx is dissolved into the absorbent solution. The ceramic tubes have temperature limits exceeding 800°C and the use of stainless steel ensures the acidic nature of the sulphur oxides does not corrode the membrane modules. Lonada, the maker of system says one of the benefits of membrane scrubbing is the amount of effluent resulting from the system is significantly lower than typical closed loop scrubbers [4].

The absorbent solution discharge rate is much lower than existing closed loop scrubbers and allows the Membrane Scrubber to store the absorbed effluent onboard for discharge ashore. If sodium hydroxide is used as the absorbent fluid, the effluent can be regenerated for reuse with a sulphuric acid by-product.

Other absorbents such as potassium carbonate are converted into potassium sulphate which has a commercial value equal to the base absorbent making the system cost neutral in terms of consumables. It is claimed that due to the smaller volume of discharge water and the reduced amount of exhaust gas contaminants that are absorbed, the discharge water cleaning is much simpler. Removing the exhaust contaminants generates a small amount of sludge that must be stored onboard as part of the vessel's oily water. The amount of sludge generated is less than 0.05tonnes/MW hr. In the system seawater pumps provide cooling water to the heat exchanger to cool the circulating absorbent solution but no seawater is used for scrubbing of the exhaust gases.The membranes require periodic cleaning to remove soot fouling on the membrane outer surfaces.The frequency of cleaning is dependent on operating conditions of the engines. The membranes arecleaned by circulating the absorbent solution under pressure to 'back wash' the membranes. The cleaning solution sludge is collected, and sent to the general sludge tanks. The amount of sludge produced is said to be typical of an economiser cleaning.

Scrubbers - Dry cleaning technology

No water or fluid of any sort is needed for the final scrubbing technology. A dry system employs pellets of hydrated lime to remove sulphur. An additional benefit is that the high temperature in the scrubber burns off any soot and oily residues. The lime pellets absorb sulphur and transform to gypsum. Although spent pellets need to remain on board for discharge at ports, they are not considered as waste because they can be used for fertiliser and to produce plasterboard among other things. The dry system has a lower power consumption than wet systems as no pumps are required. However, the weight of the unit is much higher than wet systems. Only one dry system is currently marketed for marine use. All scrubber systems require a treatment bypass for when the ship is operating without the need to use the scrubber.

This prevents damage to the scrubber and reduces maintenance. Care needs to be taken to ensure that the scrubber is not causing backpressure to the engine as this could be damaging and will affect NOx reduction systems.

Proving scrubber performance

Flag States that decide to permit scrubbers on board ships will need to ensure that operators can prove compliance. Under ANNEX VI regulation 4 there are two schemes allowed for a system to be permitted that mirror the requirements for NOx compliance. One demands that the performance of any scrubber is certified before use and, as with the NOx systems, providing it is always operated within approved parameters there is no need for continuous exhaust emission measurements on the ship. Parameters that must be continuously recorded include scrubbing water pressure and flow rate at the scrubber inlet, exhaust pressure before the scrubber and the pressure drop, fuel oil combustion equipment load, and exhaust gas temperature either side of the scrubber. A record of chemical consumption must also be maintained. Under the second scheme, the exhaust gas must be continuously monitored when the equipment is in use and there is no need for the system's performance to be certified. Under both schemes the condition of any wash water discharged to sea must be continuously monitored for acidity,turbidity and PAH (a measure of the harmful components of oil) and data logged against time and ship's position. A test for nitrate content is also required at each renewal survey.

In May 2015 at MEPC 68 the meeting adopted amendments to the guidelines for exhaust gas cleaning systems which permits a calculation-based methodology for verification of washwater discharge criteria. The revision allows for calculation or modelling to verify the discharge of wash water pH at a point of 4 m from the point of discharge. This will be reviewed after two-year's time, if necessary changes are made to the wash water discharge controls however any changes will apply only to new installations. Wet scrubbers are good at removing particulate matter and soot which although not currently regulated for specifically are likely to be so in future. Typically, a scrubber will remove at least 500kg of particulate matter for every 100 tonnes of fuel oil burned and possibly more depending on how much wash water is used. These solids must be removed before the wash water is discharged overboard and to conserve space the system should have a separation phase included that removes as much of the water as possible before sending the sludge to be stored for later disposal ashore.

What are the costs of scrubbers?

Scrubbers are increasingly being fitted to new buildings but the majority now in operation have been retrofits. The time for a retrofit is currently more than a typical scheduled drydocking meaning that extra lost earning days add to the capital outlay. The capital cost of scrubbers is currently high at between $500,000 to $5M depending upon maker and vessel size but that would conceivably reduce if volume sales materialise. Payback time for a scrubber depends upon three variables; the capital and installation cost of the system, annual fuel consumption in ECAs and the price differential between distillate fuel and the normal fuel used on the vessel. Take up rates for scrubbers may be improved if flag states and others offer state aid or attractive financial deals. So far aid has been limited to a small number of projects in Europe and some finance houses have begun offering schemes that assist with capital expenditure and which link repayments to savings made.

The number of ships fitted with scrubbers is growing and with it the number of scrubber manufacturers.

At the time when the first commercial system was fitted in 2006, there were just a few organisations interested in the potential. Today the number of makers active in the field exceeds 20 and newcomers are appearing regularly.

Comparative study on cost of scrubbers on implementation at different capacity vessels: -

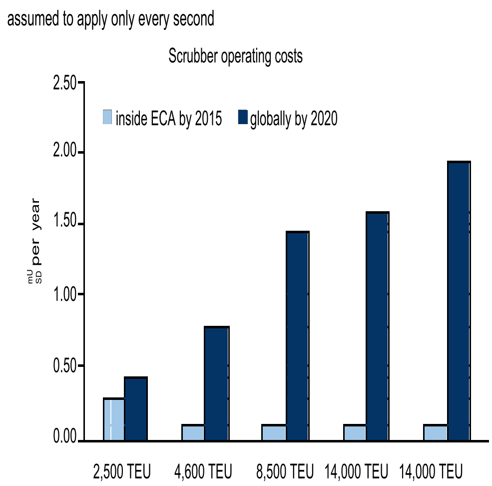


Fig. 3. Scrubber operating cost

Exhaust Gas Recirculation (EGR)

Exhaust gas recirculation (EGR) is an effective strategy to control SOx, NOx emissions from diesel engines. The EGR reduces SOx and NOx through lowering the oxygen concentration in the combustion chamber, as well as through heat absorption. Several configurations have been proposed, including high- and low-pressure loop EGR, as well as hybrid systems. EGR is also used in gasoline engines, primarily in order to reduce pumping work and increase engine efficiency. Commercial EGR systems utilize open or closed loop electronic EGR control to provide precise EGR rates and proper A/F ratios in order to achieve their Sox and NOx reduction targets while minimizing the PM and fuel economy penalties. Even more precise A/F ratio control is possible with variable geometry turbochargers.

Exhaust gas recirculation (EGR) is an emission control technology allowing significant Sox and NOx emission reductions from most types of diesel engines: from light-duty engines through medium- and heavy-duty engine applications right up to low-speed, two-stroke marine engines. While the application of EGR for NOx reduction is the most common reason for applying EGR to modern commercial diesel engines, its potential application extents to other purposes as well. Some of these include: imparting knock resistance and reducing the need for high load fuel enrichment in SI engines, aiding vaporization of liquid fuels in SI engines, as an enabler for closed cycle diesel engines, for improving the ignition quality of difficult-to-ignite fuels in diesel engines or for improving the performance of SCR catalysts.

Marine Engines

Low-speed marine engine applications of EGR are perhaps the most challenging technically. These engines are designed to burn heavy-fuel oil (HFO) that produces exhaust gas heavily laden with metals, sulphur and other components that must be removed before the exhaust gas is re-introduced into the engine. While EGR had been considered by some to be unsuitable for engines burning HFO because of the cleaning challenges, by about 2010, all major manufacturers of low-speed marine engines (MAN Diesel & Turbo, Wartsila and Mitsubishi) were considering EGR for HFO IMO Tier III applications. MAN Diesel & Turbo announced commercial orders as early as 2011.

Control of HPL EGR Systems

In this paper, we focus on control strategies typical for high pressure loop EGR systems. Figure inscribed below shows the basic components for a modern diesel engine's air management system, including sensors, with an HPL EGR system [Ford 2003]. This hardware arrangement would be typical for many modern light-and medium-duty diesel engine applications. The inlet air passes through an air filter and mass airflow sensor before it enters the turbocharger compressor. The compressed air is then cooled by the air-to-air intercooler, and mixed with the cooled EGR gases. The

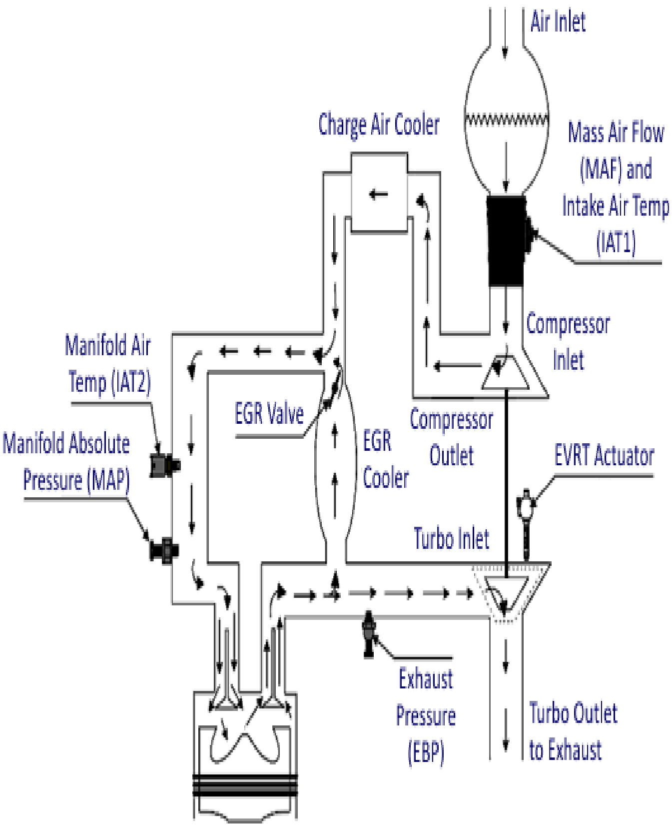
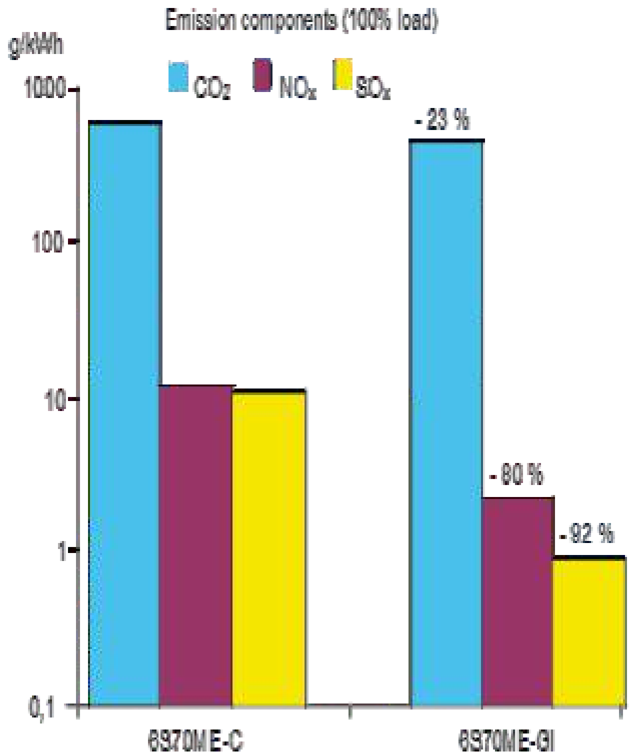


Fig. 4. HPL EGR system for medium-duty diesel engine

state of this compressed and heated air/EGR mixture is sensed by the MAT (manifold air temperature) and MAP (manifold absolute pressure) sensors just before it enters the cylinders. The exhaust gas pressure is measured by the exhaust backpressure (EBP) sensor before it exits through the turbocharger. In this example, the variable geometry turbocharger is called an Electronic Variable Response Turbocharger (EVRT) and uses an electronic control valve to control oil pressure to position the vanes and determine the effective size of the turbine housing to meet backpressure requirements [5].

Comparative study of reduction in emission components on adopting EGR: -



Non-EGR with EGR

Fig. 5. Emission components and reduction

There is dip in emission components like Co_2, NOx and Sox with installation of EGR in 6S70ME-C and 6S70ME-GI engines.Liquified Natural Gas (LNG) as Fuel for The Shipping Industry

It was a century ago when shipping had transformed from "coal fuelled "to "oil fuelled". Another hundred years later, transformation to a newer fuel source is making waves, only this time, it is to "gas".

Driven by tougher international and environmental standards, (Liquified Natural Gas) LNG is being termed as the fuel of the future. According to experts, large scale shipping is believed to be sourced by LNG in the near future. According to DNV, being "LNG Ready" could be the best option for many ships.

Reasons for Transformation

Higher marine fuel oil prices have made way to development of newer technologies based on cost and environment efficient fuels such as natural gas. Natural gas is a potential winner in terms of being environment friendly, safe, reliable and cost effective. When compared to oil, natural gas has become an important commodity with a key global energy impact. Due to the influential properties possessed by natural gas, it is the only alternative fuel which is believed to drive the future. Studies have shown that usage of natural gas or (Liquified Natural Gas) LNG as fuel has cut down the poisonous sulphur emissions or Sox significantly with a substantial reduction in carbon dioxide (CO_2) and nitrox or NOx gases.

LNG or Liquefied Natural Gas is super chilled and in liquid state when transported. Since it is already seen as a supplement fuel for a variety of segments, it can create an even bigger impact when used as ship fuel. Climate changes, current and future international shipping regulations, etc. are anticipated as costly laws which need to be complied at various stages and (Liquified Natural Gas) LNG fuel is expected to support in the process.

LNG fuelled ships are able to emit almost zero sulphur oxide emissions, which is appropriate when the regulatory 2015 ECA's or Emission Control Areas come in action. Due to lesser carbon content in LNG, release of the harmful carbon dioxide gas is reduced by nearly 25 percent. With the present market value of LNG in commercially viable regions such as the US and Europe, LNG could be offered at a competitive price when compared to heavy fuel oil or HFO and even more attractive when compared to the low-sulphur gas oil, as fuel on ships.

How is the transformation taking place?

Major container liner companies such as CMA-CGM are working towards developing future ships which are (Liquified Natural Gas) LNG fuelled along with implementing other technologies to reduce harmful ship emissions. This technology can only be developed when a solution to LNG refuelling has been concretely developed. Wartsila, a major ship engine maker has developed and completed conversion from oil-run engines to LNG powered. Such duel fuel engines have now been implemented in several cargo ships.

[M/V Bit Viking is considered the largest of the vessels afloat and in service with approx. 25, 000 dwt powered by LNG. Similarly, M/S Viking Grace is the largest passenger vessel to use LNG fuel. After almost a decade in development of LNG technology, presently, approximately 30 floating vessels are (Liquified Natural Gas) LNG fuelled and servicing the European waters. Tugboats and high-speed ferries are next in line for the conversion to LNG[7].

Some companies are building hybrid ships that are able to run on both oil and gas as fuel. The technology will see ships to be powered by natural gas for up to half way through the voyage and still be capable to switch over to bunker fuel for the remainder of the journey. Idea will be to use natural gas as the primary source of power and bunker fuel as a secondary / emergency one.

Comparative Study of LNG Fuel prices and other fuel prices: -

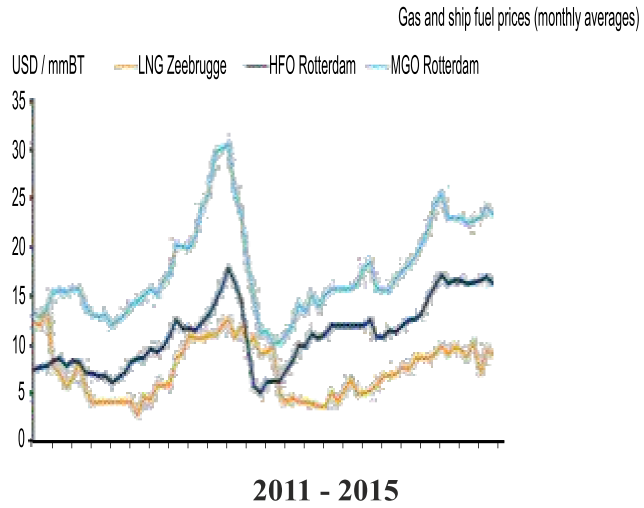


Fig. 6. Gas and ship fuel prices the last 6 years

LNG is expected to be less costlythan marine gas oil (MGO) which will be required to be used within the ECAs if no other technical measures are implemented to reduce the Sox emissions. Current low LNG prices in Europe and the USA suggest that a price – based on energy content – comparable to heavy fuel oil (HFO) seems possible, even when considering the small-scale distribution of the LNG.

Disadvantages of Using LNG as Fuel

A potential disadvantage to using LNG is space. Since gas weighs more, volume-wise it requires more space as compared to bunker oil. The farther the journey, the equally larger amount of storage space is required. So far, tanks are designed to be built in the cargo spaces of the ships for using gas as fuel. This is a major setback for the ship operators in terms of freight earned by the cargo. Engineers and architects are working towards developing systems that would make room for storing (Liquified Natural Gas) LNG. This could be anywhere on the vessel, above-deck, in the superstructures, beneath the cargo containers, astern of the vessel, etc. and this would also call for extra insulation, piping and steelwork as far as construction of the vessels is concerned. Moreover, Hyundai has now developed dedicated LNG storage tank.

Strict pollution regulations mean ship operators will be also installing more expensive units to cut emissions such as scrubbers. Another drawback before introduction of (Liquified Natural Gas) LNG is the availability of the fuelling stations, as these may have to be set up at major ports or at regular bunkering points, feasibility studies and reports may have to be attained.

Research has been progressive regarding extraction of natural gas trapped in rock formations around the globe. Future for low sulphur fuel oil looks bright and at the same time demanding with refineries falling short of delivering up to standard requirements. Ship operators are definitely going to spend from their nose with the implementation of stricter global laws and safety standards. Due to this, use of low-Sulphur fuel oil or marine diesel oils will raise the shipping companies' operating costs by four folds. This is slowly making the owners realise the value of natural gas as a prime fuel for ships engaged in long voyages. The dynamics of the ever-increasing global trade and transportation industry are working in favour of investing in natural gas for fuel on ships.

Before taking a call for the change-over decision, ship operators need to identify the scope of transition with introduction to dual fuel system, price comparison of the commodities and the areas where their ships would ply. This means ships that frequently pass through the ECA and SECA's or the emission control areas would be depending on the rise in (Liquified Natural Gas) LNG fuelling technology. LNG fuel surely holds a promising future in the shipping industry. However, only time can tell as to how well it becomes an integral part of the shipping industry in the days to come.

Air Lubrication System

When Mitsubishi came out with their Air Lubrication System, it was just one of the several energy saving techniques for ships. The Mitsubishi Air Lubrication System (MALS) was the first system of its kind which promised energy saving and emission reduction from ships using the innovative technology of Air Lubrication.

However, the shipping industry soon realized the potential of the technology, and soon, big players such as NYK Group of Companies and Damen Shipyards Group introduced their own research and experiments on the same. According to DNV, one of the world's leading classification societies, Air Bubble Lubrication System is one of the promising technologies which will help ships to improve their efficiency and reduce energy losses [4].

What is Air Lubrication System for Ships?

Air Lubrication System is a method to reduce the resistance between the ship's hull and seawater using air bubbles. The air bubble distribution across the hull surface reduces the resistance working on the ship's hull, creating energy-saving effects. With the right ship hull design, the air lubrication system is expected to achieve up to 10-15% reduction of CO2 and Sox emissions, along with significant savings of fuel.

How does Air Lubrication System work?

The Air Lubrication System works on the simple principle of trapping a layer of air bubbles beneath the ship's hull. An air blower or a dedicated system is used to generate air bubbles to pass them continuously beneath the ship's surface. Air bubble outlets are created at different locations along the bottom of the hull, symmetrically on both the sides of the ship's centre line.

The air is blown at a constant rate to form a layer of bubbles, which reduces the drag and resistance between the ship and the seawater. The system to continuously replenish the lost air bubbles ensures that a uniform layer of air bubbles is maintained beneath the ship and the desired effect is produced [4].

Concerns about Air Lubrication System

Though a promising technology, the Air Lubrication System has a few concerns regarding its implementation and performance on ships. Some of the main ones are:

- The Air Lubrication System (ALS) until now can only be used for certain types of ships having flat bottoms. Ships having V-shaped hulls, such as certain warships or recreational vessels might not be able to reap the benefits of the air lubrication system.
- To trap the layer of bubbles beneath the ship's hull is a challenging task. Though solution such as protruding ridges at the edges of the hull can help in trapping the blanket of bubbles, the sucking effect of propeller on the bubbles is difficult to defy. Another solution is to design the ship's stern or hull in such a way that it traps the air bubbles beneath the hull. However, this would substantially increase the building cost of the ship.
- It is also feared that the air cavities made for trapping the air bubbles would affect the handling and stability of the ship at the sea. If true this can cause difficulty to the ship and the crew especially in rough seas.
- The air bubbles leaving the hull surface flow into the ship's propeller. This can influence the efficiency, noise, and vibration of the propeller. Though according to the experiments conducted by Mitsubishi there were negligible effects of air bubbles on the propeller, rough seas and changes in fluid density can produce unfavourable results.
- In order to obtain the desired effect, it is important that air bubbles are of uniform size and are evenly distributed beneath the hull surface. Moreover, a change in air bubble diameter would drastically affect the air bubble distribution beneath the hull. An arrangement is therefore necessary to ensure that the bubbles are of the same diameter (if possible) and are well distributed beneath the ship's hull.

Merits of Air Lubrication System: -

As far as the MALS is concerned, the company claims that along with a high-efficiency ship hull, a container ship fitted with their air lubrication system can offer reduction in CO_2 and SOx emission of up to 35% as compared with conventional container ships. Recent findings has also supported the claim that substantial fuel savings and reduction in carbon emissions is possible through Air lubrication system when combined with other promising green ship technologies.

Air Lubrication System is now a technology which is well proved to provide benefits such as reduced carbon emissions and substantial fuel savings. With rising fuel prices and increasing pressure to make ships greener, shipping companies are now implementing promising technologies that would help them reduce carbon emissions and improve ship inefficiency. According to reports, companies such as AIDA Cruise ships along with few other shipping companies have already confirmed of plans to implement Air Lubrication Systems on their ships.

What would happen to Marine Diesel Engines when fuel has zero sulphur content in it?

American Petroleum Institute (API) published Technical Considerations of Fuel Switching Practices in 2009. According to this study, possible causes of the difficulties may be recognised by the following events- Temperature of fuel during fuel switching causes sticking of the components of high pressure fuel pumps and injectors due to thermal shock, increase in fuel viscosity and reduced lubrication of high pressure fuel pumps, - Non-compliance of the fuel in use and changes caused by sticking of high pressure pumps and fuel injectors, - Use of inadequate oil for the lubrication of bearings and cylinder liners resulting in excessive wear of the liner and piston rings, - Liner lacquering as a result of insufficient lubricating oil film.

Problems related to the high-pressure fuel pumps, since sulphur has lubricating ability, the use of LSFO leads to concern that lubrication of fuel pumps may be inadequate. The viscosity during fuel injection may change from that of HFO 10-20 [mm2 /s] to that of marine gas oil (MGO) 1-3 [mm2 /s], and become an issue. When the engine is changed over from heated heavy fuel oil (HFO) to unheated marine gas oil (MGO) or marine diesel oil (MDO), malfunctions in the high-pressure fuel pump may occur due to vaporisation of the fuel oil because of heat. Also, there is concern that the fuel oil may leak easily in the fuel pump with HFO specifications during MGO operation. The fuel leakage into the oil sump tank as the engine operates in MGO mode, may have the following effects: - Decreased viscosity of lubricating oil which, in severe cases, may adversely affect the lubrication of bearings, - Drop in flash point, which may trigger an explosion in the crankcase, - Since this fuel has low aromatic properties, it is not compatible with some kinds of rubber, and is likely to cause such as inadequate sealing [3].

Combustion problems when using low sulphur fuel oil Although abnormal wear of piston rings and cylinder liners (scuffing) as well as combustion problems such as high temperature corrosion and the use of low sulphur heavy fuel oil (LSHFO) have been pointed out for a long time, comprehensive solutions related to the effects of sulphur content in fuel on the combustion process have not yet been found. Combustion problems may occur because of each of the below factors independently, but in most cases, they occur because of a combination of several of these factors: - Low sulphur level, - Matching of low-sulphur content of fuel oil and the cylinder oil base number (BN), - FCC catalytic fines, - Defective combustibility of fuel oil, - Contamination of used lubricating oil (ULO), - Design of engine, - Maintenance and operation of engine. The assumption that low-sulphur content of fuel oil is by itself the cause of combustion problems is neither sound nor certain. The main causes of combustion problems may be the fact that a large amount of FCC catalytic fines is sometimes included in LSHFO, or that the fuel causing defective combustibility is sometimes used. Regarding the low sulphur itself, there is a concept that moderate corrosion of cylinder corrosion improves the run-in of cylinder oil and suppresses abnormal wear due to low-sulphur content. This is likely to occur owing to the fact that sulphur in the fuel burns and converts to a moderate amount of sulphuric acid which, when meeting the contact surface, minutely corrodes the piston rings and the liner (micro-corrosion), so that the contact surface becomes smooth. Consequently, the lubricating oil film can be easily retained, and the contact during a long period of operation is enhanced When using fuel oil with the sulphur content that generates moderate corrosiveness, the edges of sharp grooves of the scratches on the cylinder liner made by FCC catalyst particles become rounded due to micro-corrosion and the oil film does not get broken. On the contrary, if LSHFO is used in a cylinder liner containing a number of tiny longitudinal scratches that have occurred because of FCC particles, the edges of grooves remain sharp when there is no corrosion, and this may eventually result in the destruction of the oil film, Today, the prevailing view is that the main causes of combustion problems are primarily related to the defective combustibility or to the methods of manufacturing marine fuel oil wherein FCC catalyst residue is mixed. It is generally considered that the low level of sulphur itself is not the main cause of problems. Calcium compounds, which are the main components of the base number BN of cylinder oil, react with sulphur compounds such as SO_2 in combustion gases, and form calcium sulphate $CaSO_4$ [6].

This reaction suppresses the corrosion of the cylinder liner initiated by sulphur compound. However, if LSHFO is used and the use of cylinder oil of the normal high BN 70 to 80 continues, calcium oxide CaO is formed due to excessive BN. Abnormal deposits stick to the piston rings, shrink and harden. As CaO is harder than $CaSO_4$, excessive deposits of CaO may result in abnormal wear of the piston and cylinder liner. In order to prevent excessive deposits when using LSFO, it is necessary to carefully observe the condition of the cylinder liner and piston rings.

Problems in the crankcase oil and cylinder oil systems in two-stroke engines Crankcase system oil in two-stroke engines does not directly affect the fuel combustion, so that the sulphur content has no direct effects in the process. The impact of LSFO includes the effects arising due to contaminants from the scavenging space, such as leakage from the stuffing box and recovery and re-use of the leaked oil from the stuffing box. The contaminants from the scavenging space include cylinder oil drain and combustion products. Their features affect the sulphur content of the fuel oil in use. When normal cylinder oil having BN 70-80 is used, compared to LSFO of the sulphur content of 1-1.5%, the residual BN in the cylinder oil drain becomes higher than that used in high-sulphur fuels. As a result, the BN of the crankcase system oil increases, depending on the LSFO usage time, Low sulphur fuel oil (LSFO) is considered most suitable for use in the lubrication of cylinders and pistons in slow-speed two-stroke diesel engines. When the normal sulphur content in fuel is 1-1.5% m/m, the use of BN 70-80 can be resumed and operating conditions should be carefully monitored. When the normal sulphur content in fuel is lower than 1.0 % m/m and resulting in certain difficulties in engine operation, changing over to the cylinder oil with lower BN should be considered. In the engines with the cylinder liner temperature set to a high level, BN 50-cylinder oil can be used for the fuel having the sulphur content of 2-2.5%, If normal BN 70-80-cylinder oil is continuously used when using LSFO, serious problems in cylinder lubrication may occur.

Measures When Using Low- Sulphur Fuel Oil

Reducing the operating load of the engine is the most effective measure. By reducing the load, both temperature and pressure within the combustion chamber are decreased, the penetrating force of sprayed fuel also decreases, and the oil film retention ability improves significantly. Mixing with good fuel oil is another effective measure. Low grade fuel and good fuel should be mixed. The mixing ratio is determined by the values of properties that are known owing to fuel analysis or the ratio can be determined by increasing the percentage of low-grade fuel, while checking the operating conditions of the engine. In order to maintain stable operation, each engine manufacturer sets the recommended values of the concentration Al+Si, FCC catalytic fines, at the engine entry point. The recommended value of Al+Si for two-stroke engines ranges from 7 to 15 ppm and below. Even within the recommended range of Al+Si, under the influence of other factors, FCC catalytic fines may sometimes trigger abnormal wear of the cylinder liner and piston rings. Hence it is necessary to reduce FCC particles as far as possible and install fuel oil filters with mesh size below 10 microns, and thoroughly clean the fuel oil. Increasing the feed rate of cylinder oil and lowering the temperature of the cylinder liner cooling water are the measures resulting in strengthening the lubricating oil film. The temperature of the jacket cooling water (JCW) at the cylinder outlet is usually set at about 85-90°C, so that cooling is efficient at a small flow rate. In a normal engine room plan, the JCW outlet temperature can be made around 75°C. In this way, the cylinder lubricating oil temperature on the cylinder liner wall surface is slightly reduced and the viscosity increases. Consequently, the strength of the lubricating oil film increases and the film becomes difficult to tear. A decrease in engine load and an increase in lubricating oil quantity also represent the measures for reducing heat in the lubricating oil film, which leads to enhanced strength.

Findings and Outcomes

We introspected in detail about all the four sustainable methods that we thought of in our paper. All of the four ideas separately may not be able to provide a significant reduction in the SOx emissions but all of them combined and utilized in one green ship can surely make a difference. The use of sulphur scrubbers onboard will help reduce the amount of SOx emission from a merchant vessel along with the use of Low Sulphur Gas Oil (LSGO) will help the shipping industry cope up with the new regulations of International Maritime Organization (IMO) introduced at the 57th session of Maritime Environment Protection Committee (MPEC 57) which cap the sulphur in fuel oil to 0.5% mass by mass in 2020/2025. Some of the ideas mentioned in this paper area already being thought up by different shipping companies throughout the world in order to tackle the rules laid down by IMO. Methods like exhaust gas recirculation also aid in limiting the amount of SOx and NOx emissions to the marine environment. The shipping industry has realised the importance of green shipping and hence has been shifting the fuel of vessels from diesel to Liquefied Natural Gas (LNG) with the same efficiency in transportation as before. All the ideas mentioned are practical and can be implemented in helping us save the marine environment, we do agree that some of the ideas in this paper may require a high installation cost but the overall expenditure of the company will decrease in the long run.

In the emission control areas, the fuel switching has to be carried out not only in main engines, but in auxiliary engines and steam generators as well. When fuel oil is used after changing the type, large amount of sludge is generated if the mixing stability of LSGO and HFO is poor. Consequently, if a mixture of HFO and LSGO oils remains in fuel oil pipes, clogging of strainers, sticking of fuel oil pump and other sludge problems are likely to occur. LSGO has low kinematic viscosity so it is likely to diffuse easily when it leaks. Moreover, as its flash point is also low, there is an increased risk of fire. The flash point of fuel oil used on board ships is regulated to a value above 60°C, in compliance with the SOLAS Convention of IMO, but the flash point of a part of LSGO may be less than 60°C. Although this does not lead to problems in engine operation directly, the issue requires the design and the arrangement of the engine room to be reviewed and reconsidered.

Conclusion

This paper also stressed the link between fuel savings and GHG reduction creating an incentive for the owner to reduce GHG emission. The paper also covered the emission techniques management of the ship and the importance of role of the technical management to support GHG savings including any limitations that may be imposed on the grounds of safety, cost and regulatory conflict. Every operation should be planned and monitored and there should be an effective planned maintenance and repair regime that is included in the ships and safety management system.

Inversed public interest in exhaust gas emissions and the protection of the environment against overall adverse effects of exhaust fumes including diesel engine combustion gases, as well as the associated technological innovations, have contributed to the development of systems aimed at controlling the emissions of exhaust fumes. Changing the main engine fuel type may affect the safety of navigation due to malfunction of the engine or interruption of its operation.

Analyses of possible causes of the encountered problems have indicated that these issues have been mainly considered from the perspective of technology and engine room plant requirements when changing the fuel type on board ships. However, the causes have to include operators' errors and have to be also studied from the viewpoint of both onboard and corporate organizations.

Henceforth, we have to deploy these innovations with full proof planning to accomplish the zero-emission level by 2020.

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EFFECTIVE IMPLEMENTATION OF NANOTECHNOLOGY ON MARINE VESSELS – A SUBSTANTIAL REDUCTION IN GROSS COINAGE SPENT BY SHIPPING AUTHORITIES

Padmanabh
Tolani Maritime Institute, Pune.
info@tmi.tolani.edu

ABSTRACT

Nanotechnology has influenced the marine industry with respect to innovations in materials for improving robustness of vessel equipment, delivering more efficiency and bringing down operating costs that ultimately leads to a substantial reduction in gross coinage spent by shipping authorities and companies. Nano-enabled marine technologies promise effectual functionality in all kinds of marine vessels from yachts, cruise ships and container vessels to tanker vessels. No significant commercialization has been realized yet though there are several research initiatives in progress and the domain is considerably funded.

Therefore, we considered some recent innovations in nanotechnology for the marine industries: -

Graphene Nanoribbons and Graphene Aerogel offer potential to replace copper cables, used in filtration processes and assists in maintaining stability of ships

It is thus imperative that these technologies will have many potential applications in maritime environment. The very fact that any ship is self-sustained entity in respect of all walks of life make it prudent that no part of ship will be untouched by application of nanotechnology. Most of these applications are in the conception/infancy stage and therefore are referred to as potential applications.Therefore, we emphasize that promotion of nanotechnology offers a powerful tool to provide opportunities and incentive schemes for policy makers to put a GREEN BEACON at the horizon of 21st century shipping!

Keywords

Graphene Nanoribbons

Introduction

Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, and among many others. Nanotechnology is defined as the study and use of structures between 1 nanometer and 100 nanometers in size. To give us an idea of how small that is, it would take eight hundred 100 nanometer particles side by side to match the width of a human hair.Nanotechnology offers the potential for new and faster kinds of computers, more efficient power sources and life-saving medical treatments. Potential disadvantages include economic disruption and possible threats to security, privacy, health and the environment. Coming to marine industries, it offers innovations in materials for improving robustness of vessel equipment, delivering more efficiency and bringing down operating costs that ultimately leads to a substantial reduction in gross coinage spent by shipping authorities and companies.

Nanotechnology-Graphene aerogels offer potential to replace copper cables, used in filtration processes and assists in maintaining stability of ships. It is also used as multifunctional filters in piping system and for every liquid used on-board ships. It is preferable due to improved durability, reducing maintenance and reducing costs. It also maintains the ship stability by limiting the free surface effect in ballast tanks in the form of aerogels as it holds the liquid in space and leads to almost no free surface moment. Nanotechnology also acts as Novel fuel emulsifier. According to the theory of "hydrophilic–lipophilic balance (HLB)" and the emulsification principle, the emulsification performance and stability of ethanol–diesel blends were studied with single and mixed emulsifiers and the effects of temperature on emulsification properties were analysed.

This causes significant reduction in smoke emission and the NOx emission decreased slightly, while the THC emission increased. The CO emissions increased at light loads and decreased at heavy loads.

Therefore, by incorporating these methods we can subsequently reduce the cost of maintenance beared by companies for flawless running of marine vessels. Henceforth, it'll act as a boon for shipping arena.

Graphene Nanoribbons

Background

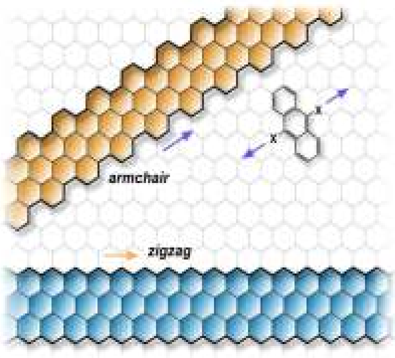


Fig. 1. Nanoribbon structures

Graphene nanoribbons (GNRs) are narrow strips of graphene. The quasi one-dimensional nature of GNRs results in additional advantages over graphene sheets, the more widely known two-dimensional counterpart to GNRs. These are basically strips of graphene with width less than 50 mm. It can be produced via graphite nanotomy, where applying a sharp diamond knife on graphite produces graphite Nano blocks, which can then be exfoliated to produce GNRs. GNRs were also produced by plasma etching of nanotubes partly embedded in a polymer film. More recently, graphene nanoribbons were grown onto silicon carbide (SIC) substrates using ion implementation followed by vacuum or laser annealing. It is currently one of the strongest materials known to man, compared to steel it is 207 time stronger by weight. It shows electrical conductivity, permeability and thermal conductivity

Properties of Graphene Nanoribbons

The electronic states of GNRs largely depend on the edge structures (armchair or zigzag). In zigzag edges, each successive edge segment is at the opposite angle to the previous. In armchair edges, each pair of segments is a 120-degree rotation of the prior pair. Zigzag edges provide the edge localized state with non-bonding molecular orbitals near the Fermi energy. They are expected to have large changes in optical and electronic properties from quantization.

Their 2D structure, high electrical and thermal conductivity and low noise also make GNRs a possible alternative to copper for integrated circuit interconnects.

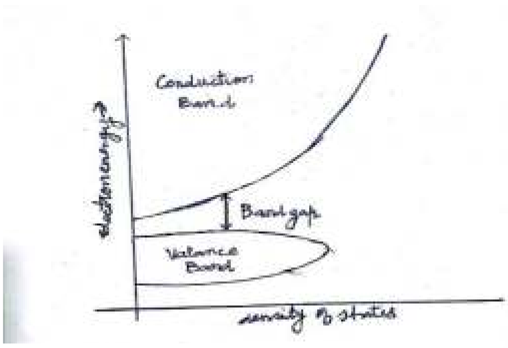
Zigzag nanoribbons are semiconducting and present spin polarized edges. Their gap opens thanks to an unusual antiferromagnetic coupling between the magnetic moments at opposite edge carbon atoms. This gap size is inversely proportional to the ribbon width and its behaviour can be traced back to the spatial distribution properties of edge-state wave functions, and the mostly local character of the exchange interaction that originates the spin polarization.

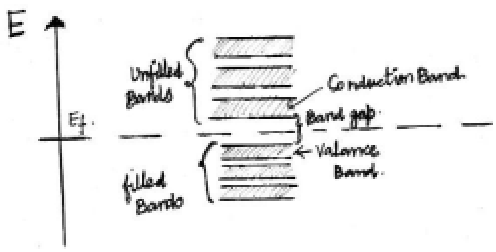
iv.)Graphene nanoribbons possess semi conductive properties and may be a technological alternative to silicon semiconductors.

Proposed applications of graphene nanoribbons on marine vessels

Electrical conductivity- substitution of copper cables

One of most useful properties of graphene is that it is a zero-overlap semimetal with a very high electrical conductivity. Zero overlap means that there is no overlap between the bottom of conduction band and top of valence band. The valence band is the highest range of electron energies in which electrons are normally present at absolute zero temperatures. The valence band is the highest range of electron energies in which electrons are normally present at absolute zero temperature, while the conduction band is the lowest range of vacant electronic states. When the valance-electrons leave the valance band which can be seen as electrons tightly bound to the nucleus, and move to the conduction band these electrons are called free electrons. These electrons are also called conduction electrons, the movement from one band to the other is called the overlap. The overlap is the external energy needed to move the free electrons to the conduction band. The smaller the Gap the less energy is required.





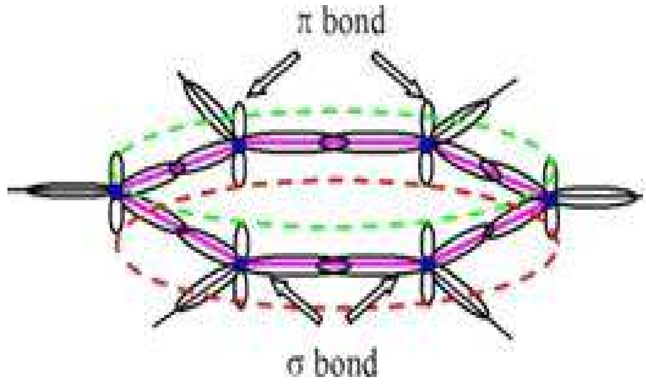


Fig. 2. Conduction Band and Valence Band

Carbon atoms have a total of 6 electrons, 2 in the inner shell and 4 in the outer shell. The 4 electrons are used for chemical bonding. But since graphene is a two-dimensional material it only needs 3 electrons for chemical bonding as can be seen in picture, one dot represents one carbon atom and as can be seen each dot only has 3 connection. This leaves the 4th electron freely in the third dimension for electronic conduction. These electrons that are highly mobile are called pi electrons. Graphene has a very high electric mobility; recent test show an electric mobility of above 15,000 *cm* and in theory it is possible to get an electric mobility of 200,000 *cm*. This is the ability of moving a charge through the material. Graphene is known to have resistivity of 1.00×10^{-8} ρ (Ω•m) at 20 °C and a conductivity of 1.00×10^{8} σ (S/m) at 20 °C where as that of copper is respectively 1.68×10^{-8} ρ (Ω•m) at 20 °C and 5.96×107 σ (S/m) at 20 °C. Therefore, graphene was better than copper.

Filters

In this chapter the use of graphene as filter material or as a filter element will be investigated. The main focus will be on creating a multifunctional filter based on graphene, this would be a filter applicable in every piping system and for every liquid. Further focus points are improving durability, reducing maintenance and reducing costs.

Filtration

On board of vessels filtration is essential. Liquids like fuel, oil and water but also air are not always pure and clean which means that they bring contamination with them into their systems. Such contaminants can cause damage to the machinery and obstruct a passage causing even more damage. Therefore, filters are placed throughout the duct to reduce this chance of damage as a result of contaminated material. Basically, everything that passes through a piece of machinery has to be filtered.

Methods

There are four main methods for filtering and each method has its advantages and disadvantages, these methods will be briefly discussed.

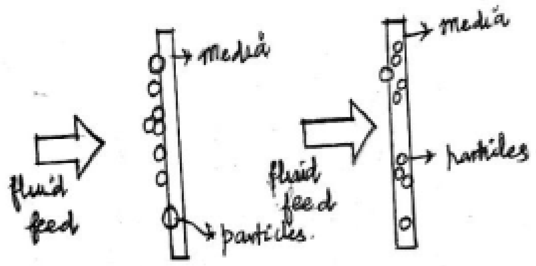


Fig. 3. Surface filtering

- Surface filtering keeps the impurities in the material attached to the surface of the filter material. In most of these filters the filter material can be cleaned if needed. Surface filtration is less expensive than depth filtration, because there is less material needed and the manufacturing technique is less complicated.
- Depth filtering, however, keeps the impurities inside the element of the filter. In these filters the whole filter element has to be replaced when the filter is full.
- Magnetic filtering contains a strong magnet which attracts iron and steel parts. All that is needed to clean the filter is to scratch the parts from the magnet.
- Centrifugal filtering is based on a centrifugal operation. The parts of dirt are brought to the widest side of a rotating drum. Filters based on the centrifugal method can always be cleaned.

Current problems with filters

At this point of time the main problems with filters are

- Multiple filters, the filters currently used on board of vessels can be improved on several characteristics. There are different kinds of filters needed for different matters. One kind of filter, usable for every fluid on board would be easier and would cost less.
- Clogged up, filters get clogged up. Depending on the type of filter it takes work to clean
- Limited durability, filters can be improved on their durability. Every filter has, depending on the type of filter, a certain durability
- Cost effectiveness, creating one filter which can be used in every piping system would be ideal because maintenance time could be shortened. If every filter on board would be the same, there would only be one manual. The crew would soon get familiar with the maintenance, which could lead to shorter maintenance time.

How has graphene be applied in filters

Several researchers have been trying to find a way to use graphene to improve filtering. There are six possible applications.

- Water treatment
- Desalination
- Removing toxic pollutants
- Filtering gasses and vapours
- Separating oil from wastewater

Water treatment is a process used to create water which is suitable for its application. There are several kinds of water treatment and several kinds of water treatment are being researched using graphene. Graphene is a hydrophobic material, which means that when graphene sheets with pores are applied to a filter, only water molecules will go through. This property makes graphene filters based on graphene sheets very suitable for, for example, wastewater treatment, boiler water treatment, cooling water treatment and desalination. The process of desalination is based on reverse osmosis. This means that two liquids are separated by a permeable membrane. Water will go through the membrane to the side with the highest concentration of a particular matter. Researchers have found that those membranes can be made from graphene which means that it can work as a filter as well. Graphene is a very thin material, so water will flow more easily through a layer of graphene than the membranes currently used for desalination. A big disadvantage is that the size of the holes has to be very small, only one μm big. The process of desalination, however, could be improved by using graphene.

Filtering with graphene is also possible in a different way. Researchers in Portugal have created certain 'tea bags' filled with heated graphene oxide and ammonia. The result is a tea bag with the ability to absorb several kinds of toxic pollutants. Graphene has proven to be able to reduce the percentage of a toxic pollutant more than the materials currently used to filter pollutants from water. In future, these tea bags might be usable to remove toxic pollutants from wastewater in practice.
Sheets of graphene oxide can be used to stop all gasses and vapours, except water. It seems that graphene can be useful in the oil and gas industry. The pores to stop most of the gasses have to be around 50 μm up to 100 μm. Compared to the required 1 μm for desalination, creating a graphene based filter for gasses should be less complicated. Research is being done to using graphene for oil separation to filter oil from wastewater. Just like with filtering gasses, a graphene oil filter could be made of graphene sheets with holes of 50 μm up to 100 μm big. A variation of graphene has already been patented, named Perforene. This Perforene is a layer of one atom thick of graphene with holes the size of 1 μm big. Another way of filtering oil is by a foam similar to the material used in the 'tea bags'. There are three types of graphene foam developed, these are omniphillic, hydrophobic and omni phobic. Only the omni phobic type is able to stop oil.

How can graphene improve filters used on board?

Graphene could indeed improve filters in future. For now, however, there has not been enough research done yet to know the exact quality of graphene filters. It will definitely take some years before the first graphene filter will be available on the market. The possibilities of graphene regarding the improvement of filters are being researched. The main invention when it comes to filters is a graphene membrane. This membrane is flexible and strong, but also very light and permeable for certain substances. How graphene membranes can be used to filter water, separate gas and desalinate materials is currently being investigated.

The use of graphene filters has not been tested in practice enough to be able to say if graphene filters could be used on board of vessels. It is for example not known yet how graphene filters would operate in systems that are exposed to high pressures and temperatures. In a few years, when researchers have had time to investigate possible applications for graphene, it might be possible to use graphene based filters on board of vessels. The main focus was on creating a multifunctional filter, one filter that is applicable in every piping system on board. If graphene can improve the durability, reduce the maintenance or reduce the costs of the filters currently used on board were the other points of focus.

Water treatment and desalination

As mentioned in the previous para, graphene filters can be used for water treatment. The biggest advantage on board would be desalination by graphene. Vessels nowadays are equipped with a system to desalinate seawater, so it can be used for drinking. This system, however, consists of a membrane so thick, it takes energy to pump the water through it. A desalination system based on graphene on the other hand, is very thin. Water just flows through it without the help of pumps. This is a great advantage and would improve the desalination system used on board. This method has unfortunately not been tested enough yet to apply graphene membranes for desalination on board. Another issue is the production of these graphene membranes. The production of graphene on a large scale itself is something scientists are still trying to figure out. Creating a sheet of graphene with pores the size with a maximum of 1 µm, also known as ‘Perforene’, is still a challenge. It is possible, but applying a desalination system based on graphene on board of vessels will take much research.

Removing toxic pollutants

Using graphene as a way of removing toxic pollutants from liquids, as researchers have applied in the so mentioned ‘tea bags’, could be a great advantage on board of vessels. The international law for the maritime industry prohibits discharge of liquids that contain toxic pollutants. Reducing the percentage of these pollutants would make it easier for vessels to discharge their polluted wastewater. An additional problem would be the used graphene ‘tea bags’, since they eventually would have to be discharged as well. Nevertheless, might these tea bags in future make it possible for vessels to remove all toxic pollutants from wastewater, but further research is required.

Function	Removing toxic pollutants
Properties	Absorbent
Requirements	Must absorb and hold pollutants
To be researched	Effectiveness

Filtering gasses and vapors

Sheets of graphene can be used for filtering gasses and vapors. These sheets are the same as the sheets that can be used for desalination, but with larger pores. Oil, gas or chemical tankers have a special vapor flange for discharging vapor from the tanks. If a graphene filter based on a graphene sheet could be made heat and high pressure resistant, this filter might be used to filter vapors. If the vapors could be filtered, it would no longer be necessary to use the vapor flange to discharge vapors to the shore. It would be an improvement for tankers, because it would make vapors one thing less to worry about. If a graphene based filter that is usable to filter vapors can be created is not sure. Further research is needed to create such a filter.

Function Filtering toxic gasses from vaporline

Properties	Permeable only for water
Requirement	Pressure resistant, effective
To be researched	Effectiveness

Filtering oil from wastewater

Another possibility is filtering oil from wastewater. Graphene sheets can be adapted to separate water from oil. This would be perfect for wastewater from, for example, wash water from oil tankers. If the oil is filtered from the waste water it could be pumped overboard instead of held in the bilge tank, which is an advantage for the load capacity of a vessel. With some more research, graphene might even be applied to create a kind of separator.

Function	Removing oil from wastewater
Properties	Must hold oil and let water go through
Requirements	Heat resistant, high pressure resistant
To be researched	Effectiveness

Stabil

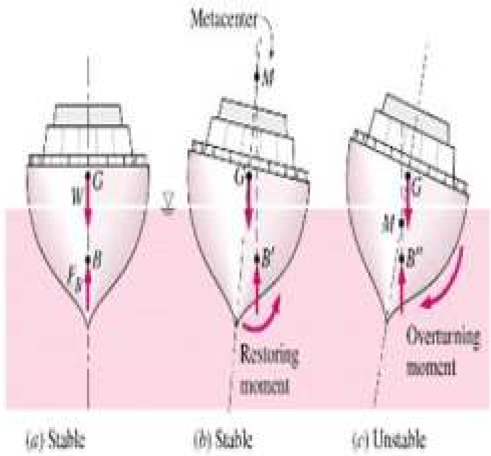


Fig. 4. Stability of ships

I. At this moment, the stability of a ship is still a major concern when designing the vessel.

As can been seen in the picture above, a ship is stable when the change of the rolling of the vessel has a restoring moment. Which means that the vessel will restore to its normal position after rolling. A ship is unstable when it has an overturning moment and continues its rolling.

However, in picture the centre of gravity is a fixed point that does not move when the ship rolls, this is never the case due to liquids that change position.

In this picture, the movement of a liquid in a tank is shown in an experiment where liquid moves from left to right. Liquid moves to the left, hits the wall, builds up energy that wants to continue moving and since there is a wall, it pushes this wall to the side and rises. Gravitational pull brings the water back down. This will lead to an effect that is called the free surface effect. The free surface effect is a mechanism which can cause a vessel to become unstable and can even capsize. It refers to the tendency of liquids — and of unbound aggregates of small solid objects, like seeds, gravel, or crushed ore, whose behaviour approximates that of liquids — to move in response to changes in the attitude of a vessel's cargo holds, decks, or liquid tanks in reaction to operator-induced motions or sea states caused by waves and wind acting upon the craft. As can been seen, the liquid is still in motion even after the tank (vessel) is on its maximum amplitude of the movement. This causes a shift of the centre of gravity which can exceed the position of the centre of buoyancy even when the ship was stable Which will lead to capsizing of

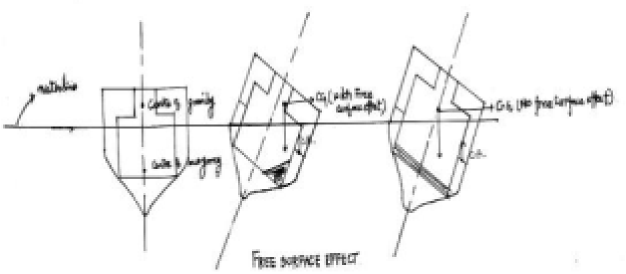


Fig. 5. Free surface effect

When the liquid can be given the properties of a solid material, there will be no free surface effect. This would greatly improve the ship's stability because the arm of the recovering moment is greater. Therefore, there is a need for something that will "hold" the liquid in its place when the vessel is in motion.

Currently used methods for limiting the free surface effect

To limit the hazards of the free surface effect, vessels use multiple smaller bulk compartments or liquid tanks, instead of fewer larger ones. The problem with this method is that there are many compartments to (un)load, that it is more expensive to make, increases the overall weight and takes up more volume that could be used for a liquid when using fewer larger ones. This liquid could be cargo like crude oil on tankers or water in the vessel's tanks

Another method is using baffles within bulk compartments or liquid tanks to minimize the free surface effects on the vessel as a whole. This also takes up volume within the tank, increases the overall weight and increases production costs.

What can graphene aerogel do to limit the free surface effect?

The properties of graphene aerogel might be able to solve the above problems that current methods for limiting the free surface effect have. Useful properties of graphene aerogel for this are: the extremely low density, the ability to be compressed and recover, its structural strength, its good absorption and it can be made hydrophilic.

Fig. 6 . A flower lifting aerogel

The plan is to use graphene aerogel as a sponge in tanks to 'hold' the liquid in place which would theoretically lead to almost no free surface moment.

Graphene aerogel

Chinese material scientists have created a graphene aerogel that is seven times lighter than air. A cubic centimetre of the graphene aerogel weighs just 0.16 milligrams. The graphene aerogel is so light that a cube inch of the stuff can be balanced on a blade of grass, the stamen of a flower, or the fluffy seed head of a dandelion. The graphene aerogel has truly superb elasticity and absorption. The graphene aerogel can recover completely after more than 90% compression, and absorb up to 900 times its own weight in oil at a rate of 68.8 grams per second. With these two features combined, the material might be used to mop up oil spills, squeezed to reclaim the oil, and then thrown back in the ocean to mop up more oil. Beyond filtration, graphene could be used inside a tank to contain the liquid because graphene can absorb 900 times its own weight. The aerogel will be put in a tank and when the aerogel is filled with the liquid, the liquid itself cannot move over great distances anymore. And therefore, the stability of ships will be improved.

When a tank is completely filled with a liquid, the liquid cannot move within the tank when the ship heels. For this reason, as far as stability is concerned, the liquid may be considered as a static weight having its centre of gravity of the liquid within the tank. When a tank is not fully loaded, the centre of gravity of the tank will move when the ship heels. This causes a virtual loss of GM. And graphene aerogel should be able to deal with this problem by making any amount of liquid static. Since aerogel acts as a sponge it is possible to easily get the liquid out of it. A way to do so has yet to be researched.

Profits

1 Cubic centimetres of graphene aerogel can contain 900 times its own weight, so this is 900*0,16=144 milligrams of water. If this would be compared to 1 cubic centimetre of water, without the graphene aerogel, this would take a total of 1000 milligrams of water. So, this means that there will be a great loss in total volume a tank can take up. Per cubic centimetre, 856 milligrams of liquid will be lost. This means that it is no use at all to fill a tank with graphene aerogel to contain the liquid. Although the vertical slack tank moment could be reduced to a minimum, the losses in weight will compensate the win in vertical slack tank moment. It could be an option to make only the top layer of a tank out of graphene aerogel. But further research needs to be done into this matter.

Possibilities

To overcome the problem of the free surface effect, it would be an option to research whether it is possible to make one thick layer of graphene aerogel. Because our research was limited, so it was not possible to test the properties of graphene aerogel. But the expectations are that these graphene 'boxes' would lay still under normal sea going movements.

Still more research is required into this matter. At this point in time researches are still trying to find the possibilities of graphene aerogel. And when applying graphene aerogel in tanks, the most promising method will be the top layer of graphene aerogel. Using graphene aerogel instead of baffles will make radical new ship designs possible, where the tanks can be shaped into practically any form and as large as is structurally possible. Also retrofitting is possible when stability is more important than the quantity of the tanks.

Conclusion

The maritime fraternity is in dire need of a green makeover considering the impact the shipping industry has on pollution.Our paper aims to implement method of Nanotechnology to maintain the life of ships. Nanotechnology has also influenced the marine industry with respect to innovations in materials for improving robustness of vessel equipment, delivering more efficiency and bringing down operating costs that ultimately leads to a substantial reduction in gross coinage spent by shipping authorities and companies. The ideas presented in this paper if implemented can have a positive impact on cutting down SOx and Carbon emissions, clean energy as well as reduce the overall coinage of the shipping companies.

This will help bring on a new era of green ships that are environment friendly as well as being equally efficient in transporting cargo which can result in preservation of marine life and hence build a greener earth. Our goal is to start a green trend in the shipping sector in this world of decreasing fossil fuel resources to make the world a greener and pollution free home to our future generations. Therefore, we emphasize that promotion of green shipping offers a powerful tool to provide opportunities and incentive schemes for policy makers to put a GREEN BEACON at the horizon of 21st century shipping! This paper outlines our current thoughts on policies, technological and operational measures to control carbon emission from ships. This paper also discusses about the Reduction in fuel consumption for marine propulsion and about their prime drivers.

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HEAT TRANSFER ENHANCEMENT OF SHELL-AND-COILED TUBE HEAT EXCHANGER UTILIZING HELICAL WIRE TURBULATOR

Rishabh Jangra,
Tolani Maritime Institute, Pune
abhiban1996@gmail.com

Abhishek Banerjee
Tolani Maritime Institute, Pune
jangrarishabh96@gmail.com

Snehadri Banik
Tolani Maritime Institute, Pune
banik.snehadritmi@gmail.com

ABSTRACT

In present study, a shell and coiled tube heat exchanger is experimentally studied in which a helical wire has been placed inside the helically coiled tube as a turbulator. The fabrication method of helically coiled tube which contains turbulator and also the effects of turbulator on thermal and frictional characteristics of heat exchanger are presented in this paper. Experiments were performed in two main modes. In first mode, the fluid of coiled tube was water and in second mode the fluid of coiled tube was air. Each mode was studied for both empty coiled tube (without turbulator) and with turbulator under different fluid flow rates. The fluid of shell side was hot water for all cases. Findings showed that this type of turbulator can be employed in coiled tubes which significantly increased the overall heat transfer coefficient and obviously pressure drop. Overall heat transfer coefficient, pressure drop, effectiveness and NTU are evaluated and discussed.

Keywords

Shell-coiled tube heat exchangerexperimental investigation; pressure drop; turbulator; heat transfer coefficient.

Introduction

In recent years, researchers have tried to reduce the size and weight of heat exchangers withoutreduction of heat transfer rate. Related to this point of view, helical tubes are considered as one of the most appropriate tubes because of their smaller size and higher performance. Nonetheless, other heat transfer enhancement techniques such as Nano-fluids, conical tubesand bubble injection etc. These are employed in order to enhance the thermal performance of coiled tubes. However, turbulators were not extensively employed as heat transfer improvement method for helical tubes (shell-coiled tube heat exchanger) in previousstudies. Thus, in this paper, helical wire was used as a turbulator for helical tube through ashell-coiled tube heat exchanger. The main studies on coiled tubes are summarized as below.

These are studied on heat transfer and pressure drop of a heat exchanger which isconstructed by placing spring-shaped wires with varying pitch within a helical pipe. Theyobserved that the helical spring elements placed inside the helical pipes improve heattransfer but cause an appreciable increase in pressure losses (the best heat transfer was achieved with the smallest pitch/wire diameter ratio). Experimentally andnumerically evaluated the performance of helical coiled tube heat exchanger with differentcurvature ratio and coil pitch. The performance of heat transferin helical coiled tube heat exchanger with wire coil inserts was evaluated. Coiled wire of different pitchesand same diameter were fabricated and used as tube inserts in copper helical coiled heatexchanger. An average increase of 120% in the coil side inside heat transfer coefficientwas observed for coil tubes with 3mm pitch spring inserts. The effect of alumina/waterNano-fluid with five different weight concentrations (from 0.78% wt. to 7.04% wt.) onconvective heat transfer characteristics was experimentally studied by Wu et al. for adouble-pipe helically coiled heat exchanger.

Principle

When Nano-particles on the critical Reynolds number is negligible. Moreover, the heat transferenhancement of the Nano-fluids compared to water was from 0.37% to 3.43% according tothe constant flow velocity basis. Numerical investigation on heat transfer characteristics in double tube helical heat exchangers have already been taken. Also there have been experiments on condensation heat transfer of R-134A in horizontal straighthelically coiled tube-in-tube heat exchangers. Evaporation heat transfer and condensationheat transfer of HFC-134a in a helically coiled concentric tube-in-tube heat exchanger. Experimental studied on thermal characteristics of a double-pipe helical heat exchanger. The effect of cold and hot fluid flow rates on overall heat transfer coefficient, inner tube Nusselt number and annulus Nusselt number were discussed. Their findings showed that, said parameters increases withthe increase of hot or cold fluids flow rates. Recently, there have been focused on exergetic behaviour of coiled tubes. They studied on the effect of differentgeometrical, thermodynamic and fluid flow characteristics on exegeticbehaviour of coiledtubes. Most recently, Mashoofi et al. investigated the effect of helical wire of thermalbehaviour of tube-in-tube helically coiled tube heat exchangers.In this paper an especial method is presented to insert a turbulator (helical wire) insidea coiled tube of shell-coiled tube heat exchanger. Heat transfer rate, pressure drop,effectiveness and NTU are studied. Memorable behaviours were observed for effectiveness.The reasons which improvethe heat transfer rate and increase the pressure drop werediscussed from new point of view.

Components

Turbulator

Helical wire is employed as a turbulator in this paper as shown in Fig. 1. There is animportant point related to inserting a helical wire into a helical tube. Helical wire should beinserted into the tube before coiling operation (when the tube is straight tube). Indeed, inthis paper, the helical wire was inserted inside a straight tube (with length of 1.8 m) andthen the straight tube was transformed into a helical tube via a special machine which can be seen in Fig. 2. Geometric specifications of turbulator are presented in Table 1.

Fig. 1.Helical wire

Table 1: Geometric specifications of Helical wire

Pitch (mm)	Helical Diameter (mm)	Wire Diameter (mm)
5	4	0.9

Fig. 2: Geometrical representation of shell

In this paper, simulations were performed in two main modes. In first mode, the fluid of coiled tube was water and in second mode the fluid of helical tube was air; (shell side fluid was always hot water). Each mode was tested for both with turbulator and withoutturbulator. Thus, totally four modes were investigated. Experiments procedure includinghot water flow rate (shell side), cold water rate or air flow rate (coil side) and inlettemperatures are presented in Table 2 for main modes. All procedures shown in Table 2 were carried out for both empty coiled tube and coiled tube with turbulator.

Table 2: Temperature specifications

First mode (fluid of coiled tube is water)			
Coil side inlet temperature (^{0}C) ± 0.7	Shell side inlet temperature (^{0}C)	Coil side water flow rate (LPM)	Shell side water flow ate (LPM)
16	40	1, 1.5, 2, 2.5, 3	1
16	40	1, 1.5, 2, 2.5, 3	2
16	40	1, 1.5, 2, 2.5, 3	3
16	40	1, 1.5, 2, 2.5, 3	4
16	40	1, 1.5, 2, 2.5, 3	5
Second mode (fluid of coiled tube is air)			
Coil side inlet temperature (^{0}C)	Shell side inlet temperature (^{0}C)	Coil side air flow rate (LPM)	Shell side water flow ate (LPM)
18	40	1, 2, 3, 4, 5	2

Coiled tube:

Table 3: Geometric Specification of coiled tube

Turns	Pitch (mm)	Coil diameter (mm)	Tube inner diameter (mm)
9.5	30	60	6

Table 4: Geometric specification of Shell

Length (mm)	Thickness (mm)	Inner diameter (mm)
400	2	110

Calculations method

Overall heat transfer coefficient, pressure drop, effectiveness and also NTU effectiveness curves are four main parameters which are evaluated and discussed in present paper for different conditions. The average heat transfer rate (qave) can be calculated with:
(qh + qc)(1)
= m h cph (Th,in – Th,out) (3)
= m c cpc (Tc,out – Tc,in) (4)
The shell side surface was isolated during the stimulation and the difference between qh
and qc was less than 2%.
Overall heat transfer coefficient (Ui) is calculated by:

$$U_i = \frac{q_{ave}}{A\,\Delta T_{LMTD}}$$

$$\Delta T_{LMTD} = \frac{(T_{h,out} - T_{c,out}) - (T_{h,in} - T_{c,in})}{Ln\left(\frac{T_{h,out} - T_{c,out}}{T_{h,in} - T_{c,in}}\right)} \quad (5)$$

$$\varepsilon = \frac{\text{actual heat transfer}}{\text{maximum possible heat transfer}} \quad (6)$$

In which maximum possible heat transfer is evaluated by:
m.c(Th, inlet – Tc, inlet) (7)
(m .c)minis evaluated using of cold fluid or hot fluid mass flow rate (minimum flow rate).
Hence, depending on (m c)min two different correlations are obtained for calculating of ε.

Results and discussions

Verification of empty tube (without turbulator)

Validation was performed for empty tube (without turbulator). However, Nusselt numbershould be calculated in order to compare with other correlations. Hence, Wilson plotsmethod was used to evaluate the amounts of Nusselt numbers as described below. Indeed,Wilson plots method is an appropriate technique for experiments in which only inlet andoutlet temperatures have been recorded (temperature distribution on tube surface is not2 required). hi is related to the overall heat transfer coefficient (Ui) by the flowing equation.

$$\frac{1}{U_i} = \frac{1}{h_i} + \frac{A_i \ln(\frac{d_o}{d_i})}{2KL\pi} + \frac{A_i}{A_o h_o} \quad (8)$$

Shell side Reynolds number is a constant value for set of coil side flow rates (see each row5 of table 2). Thus, it can be assumed that ho and thereupon the last two terms on the right-hand side of Eq. (8) are constants. The coil side heat transfer coefficient is assumedto behave in the following manner with the coil side Reynolds number:

ho = BRe m (9)

Eq. (9) is substituted into Eq. (8) and the values of constant B and the exponent m areobtained through curve fitting. The coil side heat transfer coefficients (hi) could then becalculated. Hence, the experimental Nusselt number can be evaluated by :

$$Nu_{exp} = \frac{h_i\, d}{K}$$

The range of De and Pr for present experiments (air fluid) is 71 < De < 357 and Pr=0.71.

Hence, validation was performed by Kalb and Seader equation.

Heat transfer analysis

First mode (fluid of coiled tube is water)

The amounts of overall heat transfer coefficient are presented in Fig. 3. Fig. 3 (a) isrelated to empty coiled tube (without turbulator) and Fig. 3 (b) is related to coiled tubewhich contains turbulator.

As seen in Fig. 3, employment of turbulator causes improvement of overall heat transfercoefficient. Moreover, the amount of U is increased with increment of cold or hot fluidflow rate too. The reasons of heat transfer enhancement due to using of turbulator (helicalwire) can be explained as below.

The key roles of turbulator are increment of turbulence level of fluid flow andmixing thermal boundary layer. In present study, fluid of coiled tube is strongly mixed dueto contact with helical wire (turbulator) through the helical tube which increases the heattransfer rate and subsequently overall heat transfer coefficient. For first mode, turbulatorincreased the heat transfer rate between 59 and 78 % (depending on flow rate). Maximum improvement is observed in 3 LPM of coil side and 5 LPM of shell side.

In addition to key role of turbulators, there is another significant reason which causes enhancement of U as described below. Obviously, turbulator reduces the effective inner volume of coiled tube. On the other hand, each turbulator causes reduction ofeffective diameter of tube. Hence, a hydraulic diameter is defined and the effective crosssection are of coiled tube is calculated using of hydraulic diameter. The amount ofhydraulic diameter is always less than tube diameter. Thus, the amount of cross sectionarea from which the coil side fluid passes is reduced for coiled tube which contains turbulator. Hence, for a constant water flow rate, the water mean velocity (and obviously Reynolds number) of empty tube is less that the coiled tube which contains turbulator. Higher Reynolds number means higher heat transfer rate. Fig. shows the amounts of Reynolds number for empty coiled tube and coiled tube with turbulator. Reynolds number was calculated with flowing equations. For coiled tube with turbulator, hydraulic diameterwas placed instead of tube diameter. “d” is tube diameter of coiled tube (inner diameter). It should be noted that, “rc”, “e” and “b” are related to turbulator (helical wire). “rc” is curvature ratio of helical wire (turbulator), “e” is wire diameter and “b” is the pitch of helical wire. Tube diameter of coiled tube is around 6 mm however the amount of hydraulic diameter (after inserting the turbulator) is around 3.51 mm. In most studies related to turbulators, the effect of hydraulic diameter is ignored which seems is incorrect. Indeed, for this type of turbulator (helicalwire), evaluation of hydraulic diameter (due to turbulator) is important because this type ofturbulator occupies a significant volume of inside of tube.

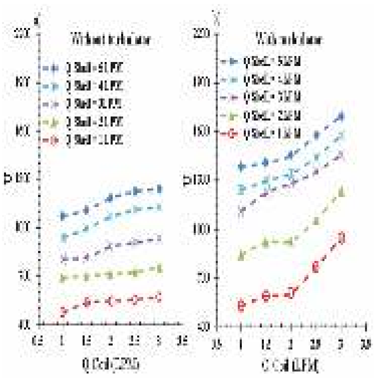

Fig. 3. Overall heat transfer coefficient for first mode (a) without turbulator b) with turbulator

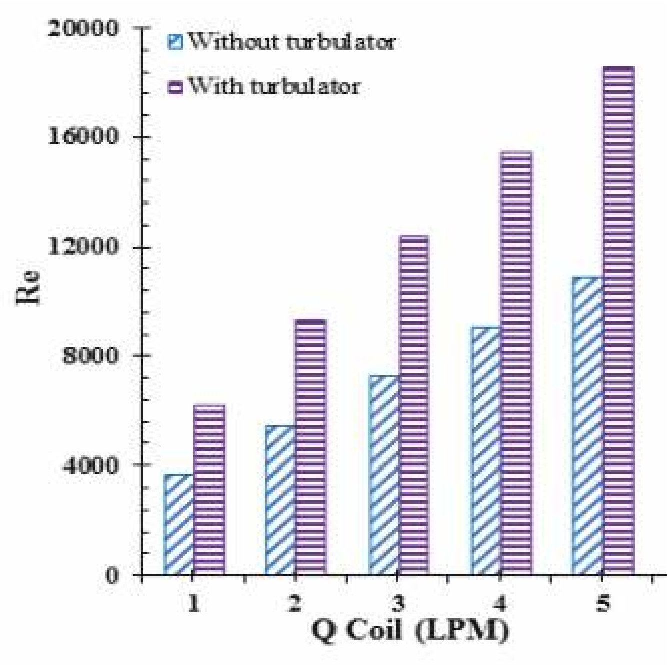

Fig. 4. Reynolds number of each flow rate for with and without turbulator

Second mode (fluid of coiled tube is air)

The amounts of overall heat transfer coefficient are presented in Fig. 5 for second mode.Fig. 5 (a) is related to empty coiled tube (without turbulator) and Fig. 5 (b) is related tocoiled tube which contains turbulator. Depending on air flow rate, turbulator increases theamount of heat transfer rate between 26 and 52%. Maximum enhancement was observed at5 LPM. In addition to two reasons of heat transfer enhancement due to turbulator which was described for first mode, there is another memorable reason for second mode (air fluid). Indeed, as described in first mode, the main reason is mixing behavior of turbulator and the next reason is related to hydraulic diameter and increment of Reynolds number. However, for air fluid another reason can be explained as below. Obviously, using of turbulator causes increment of requirement air inlet pressure (for a defined air volumetric flow rate). Increment of air inlet pressure increases the numerator ofEq. (18). Hence, subsequently air inlet density is increased. And according to increment of air inlet density increases the air inlet mass flow rate (Kg/s). It should be noted that air volumetric flow rate (Qa) which is measured by Rota-meter (LPM) does not change.And finally according to increment of mass flow rate (m) increases the amount of heat transfer rate. Indeed, although the values of volumetric air flow rate are the same (for example 2 LPM) for both empty tube and coiled tube with turbulator, their mass flow ratesare different. It should be noted that, this event is occurred only for gas fluids (because ofcompressibility) and not for liquids. Indeed, for liquids (water), inlet pressure does not have effect on inlet water density (or it is very negligible). Fig. (6) shows the amounts of2 air mass flow rates for each volumetric air flow rate (with and without turbulator).

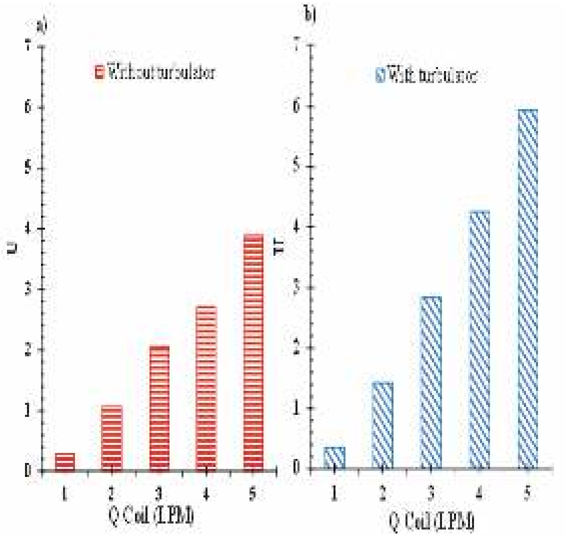

Fig. 5. Overall heat transfer coefficient a) without turmulator b) turmulator

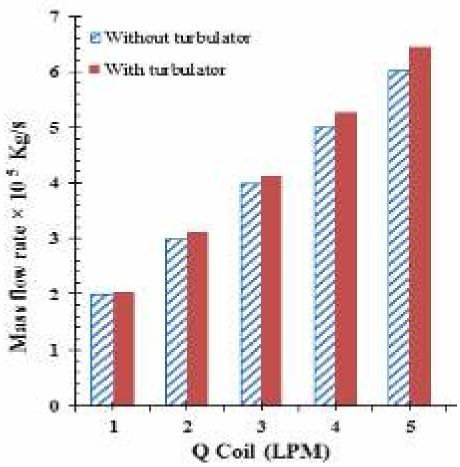

Fig. 6. Mass flow rate for each volumetric air flow rate

Effectiveness

First mode (fluid of coiled tube is water)

Effectiveness of empty coiled tube (without turbulator) and with turbulator are presented in Fig. 7(a) and Fig. 7(b) respectively. As seen in Fig. 7, the behavior of effectiveness can be descending or ascending or a combination of both of them. The reasonis directly related to the amount of _m c. Indeed, as described in section 4, effectiveness may be calculated with Eq. (9) or Eq. (10). For a constant curve, some pointsmay be evaluated via Eq. (9) and other points are evaluated via Eq. (10). A peak pint is observed for those cases. If al points are calculated with one of the equations, the curves shows a constant behavior (descending or ascending) For example, in Fig. 7(b), the behavior of Qshell = 1LPM is ascending. In this12 case,_m c is calculated with shell side flow rate (because it is less than coil side flowrate for all points of this case). Hence, denominator of is constant and the amount of nominator increases. Thus, the amount of effectiveness is increased with increment of coilside flow rate. Now consider shell side flow rate of 5 LPM. In this case, both denominator and nominator of are variants. Indeed, the amount of _m c is calculated with coil side flow rate (because coil side flow rate is less than shell side flow rate for all points ofthis case). The increment rate of denominator is more than the increment rate of nominator and the result is descending behavior of this case. For shell side flow rate of 2 LPM _m c_is evaluated from coil side flow rate for three initial points and isevaluated from shell side flow rate for two final points.As a result, effectiveness curves do not have an absolute behavior and it depends on m c. If in another paper, a constants behavior is observed for all cases, it means that24 the range of tested flow rates creates a constant value of m c for all points.

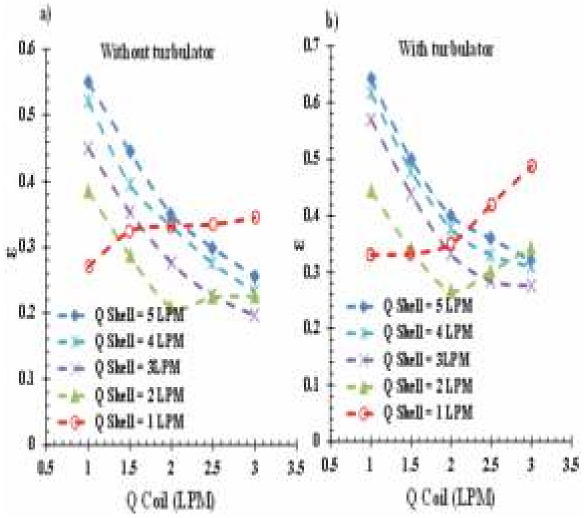

Fig. 7. Effectiveness for first mode (a) without turbulator b) with turbulator

Second mode (fluid of coiled tube is air)

The amounts of effectiveness for second mode are presented in Fig. 8. In this mode, mc of air is always less than the amount of mc for water. Hence, effectiveness increases with increment of coil side air flow rate. Although the shell side fluid is water,turbulator plays a key role on enhancement of effectiveness when the fluid of coil side is air. For higher values of coil side air flow rate, the value of effectiveness approaches to 1.

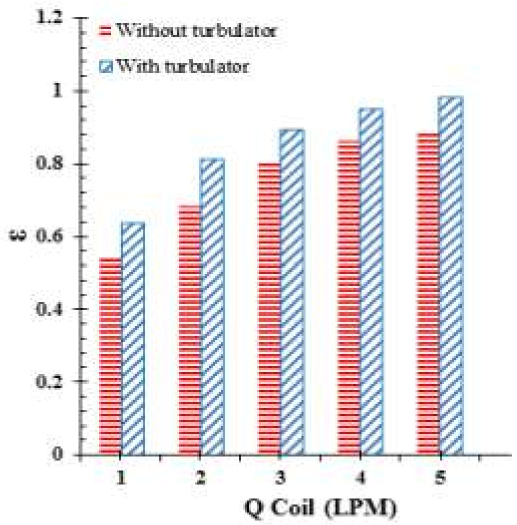

Fig. 8. Effectiveness (for second mode)

Conclusion

In this paper, helical wire was inserted inside a coiled tube (as a turbulator) via anespecial method which was described in the paper. No type of turbulator was used for coiled tubes before. Then the thermal, frictional and effectiveness characteristics of tubewas compared with empty coiled tube (without turbulator) through a shell-coiled tube heatexchanger. The fluid of shell side was hot water while the fluid of coiled tube was air or cold water. Different shell side and coil side flow rates were performed. The reasons which cause enhancement of thermal of frictional characteristics of coiled tube (due to turbulator) were clearly discussed from new points of view. Three heat transfer improvement mechanisms were explained for air fluid and two mechanisms for water fluid. Memorable and interesting behaviours were observed for effectiveness charts. Generally, this type of turbulator can be used for helical tubes and the result is higher heat transfer rate and obviously extra pressure drop.

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INNOVATIVE APPROACH IN TRANSPORTATION INTEGRATION OF INLAND WATERWAYS

Rohit Yadav,
College of Military Engineering,
aak1192@gmail.com

AzharAlam,
College of Military Engineering,
rohityadav160891@gmail.com

ABSTRACT

Transportation is the single largest component of cost for any company. Transportation is key to existence of any organisation as it delivers the product in the hands of customer. Supply Chain Managers have to do a fine balance between cost of transportation and service levels. One of the important decisions in transportation is selection of mode of transportation. Inland Waterways Transportation (IWT) is the mode of transportation within a country where cargo is moved over rivers and canals. As compared to road and rail, IWT is more fuel efficient, environment friendly, less capital intensive, safe and possess least external costs. In spite of carrying several advantages and being recurrently used in several countries, the spread of IWT in India is extremely poor. IWT does not contribute even 0.5 per cent of the total Indian freight transportation. The paper attempts to understand the Indian shipper's transportation service requirements and various factors which influence his choice of mode and how IWT in India can realign itself to meet these requirements. The paper provides some of the recommendations for IWT sector to evolve to meet the shipper's service requirements.

Keywords

Comparison, technological and physical viability, transportation corridors, other nations IWT, way ahead, IWT units of Indian Army.

Introduction

Water based transport is effective as operating costs of fuel are low and environmental pollution is lower than for corresponding volumes of movement by road, rail or air. A major advantage is that the main infrastructure i.e. the waterwayis often naturally available, which then has to be "trained", maintained and upgraded. Transport over waterways is especially effective when the source and/or destination are waterfront locations. Intermodal transport may be interpreted as a chain of actors who supply a transport service. Inland navigation can play a crucial role in increasing supply chain service performance.

History

Northeast India has many large and small rivers providing facilities for water transport, especially in plains sections. In ancient period until roads were constructed, the Brahmaputra and Barak rivers were common and only means of transport. During the British rule the Brahmaputra and Barak-Surma rivers were used extensively for transport and trade between northeast India and the port of Calcutta (now Kolkata). With the growth of the tea industry these rivers became important carriers of trade. The East India Company started the water route along the Brahmaputra from Kolkata to Dibrugarh in 1844 and steamships were introduced by the Joint Steamer Company in 1847. At the same time Silchar was linked with Kolkata along the Barak-Surma-Meghna navigation channel. However, with the partition of India in 1947, water transport received a serious blow as a foreign country was born between northeast India and the port of Kolkata. Dibrugarh was also considered to be a massive port in Asia in 1947.

Benefits

Inland water transport saves on fuel. It is a cost effective mode in case of hazardous goods and oversized cargos. It is environment friendly and saves on time. It is a safe mode of transportation as it reduces number on accidents as compared to road and rail. Moreover it is also free from congestion. It generates employment opportunities to the communities which are traditionally involved in shipping. It promotes cruise culture and tourism and is useful in domestic cargo transportation. In North East India, road and rail transport is blocked during monsoons and difficult terrain precludes building of extensive rail and road network in this area, while water transport is suitable in such regions. It creates less pollution as compared to existing transport system.The following pictures fig1, fig2& fig3 show the advantages and comparison of the inland waterways with the existing transport.

Fig. 1. Advantages of IWT

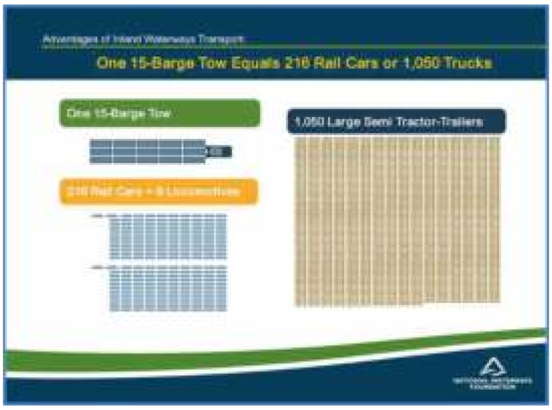
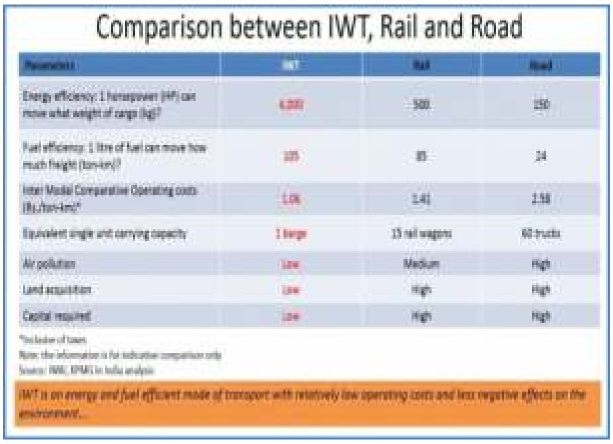


Fig. 2.Comparison with Other Modes of Transport



Comparison between IWT, Rail and Road

Parameters	IWT	Rail	Road
Energy efficiency: 1 horsepower (HP) can move what weight of cargo (kg)?	4,000	500	150
Fuel efficiency: 1 litre of fuel can move how much freight (ton-km)?	105	85	24
Inter Modal Comparative Operating costs (Rs./ton-km)*	1.06	1.41	2.58
Equivalent single unit carrying capacity	1 barge	15 rail wagons	60 trucks
Air pollution	Low	Medium	High
Land acquisition	Low	High	High
Capital required	Low	High	High

IWT is an energy and fuel efficient mode of transport with relatively low operating costs and less negative effects on the environment...

Fig. 3. Comparison with Other Modes of Transport

Government Initiative and Various Schemes:

Inland Waterways Authority of India (IWAI):

Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. Its headquarters is located in Noida, UP. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration.

National Waterways come under purview of Central Government and Inland Waterways Authority of India (IWAI), whereas other waterways are under the control of the state government.

National Waterways:

There are 111 officially notified Inland National Waterways (NWs) in India identified for the purposes of inland water transport, as per The National Waterways Act, 2016. Out of the 111 NWs, 106 were created in 2016. The NW network covers around 20,275.5 km. NW-1, 2, & 3 are already operational. Cargo as well as passenger / cruise vessels are plying on these waterways. Detailed Project Report (DPR) for development of NW-4 & 5 was completed in 2010. The DPR of NW 5 was updated in 2014. For the newly declared 106 NWs, techno-economic feasibility studies have been initiated.

Fig. 4. Waterways in India

Coastal Shipping:

Coastal shipping acts as an inter-modal transportation and plays an important role in integrated logistics chain in developed countries.

Coastal shipping, also known as Short Sea Shipping (SSS) accounts for 43% of cargo traffic in Europe.

Other economies such as US and China have adopted development and utilization plans for increased transportation through inland / coastal waterways.

Cargo Movement by IWT in India:

Cargo movement by IWT increased from 32 million tons in 2003-04 to 69 million tons in 14-15. Most of the cargo movement by IWT takes place in Goa and Maharashtra, which account for around 90% share of cargo traffic on IWT.

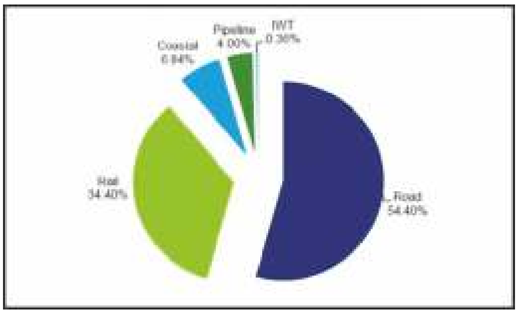


Fig. 5. Modal Share for Inland Cargo Movement

Possibility of Integration of IWT with Coastal Shipping:

The integration of inland waterways with coastal shipping depends upon:-

Infrastructural linkages: Connectivity of seaports with inland waterways in the State.

Operational Aspects: Design of inland vessels is being able to move / berth at the sea-ports and coastal vessels moving / berthing on inland waterways.

Regulatory Framework: Allowing the inter-modal flow of the vessels.

Integrating with Other Plans and Programs:

The Central Government has several different programs dealing with rivers. Water being a state subject , state governments also have many plans for rivers in their respective states. It is important that these programs and waterways integrate properly with each other. If this does not happen, there could be conflicts between various programs of the central government and also centre-state conflicts.

ILR Program: One such program is the Inter Linking of Rivers. It's a moot question how interlinking of rivers would fit with the waterways project. The former wants to divert water from "surplus" rivers, while the latter needs substantial water to continue to flow in the rivers. We have not seen either the waterway reports or their interlinking reports address this issue.

Ganga River Basin Management Plan:Ecological restoration of National River Ganga is urgently needed since river biodiversity is being rapidly lost. The main factors affecting the river habitat identified for causing this loss habitat disturbances are plying of noisy vessels, dredging etc. Hence, the measures recommended are restrictions on river bed farming, gravel and sand mining, plying of vessels, dredging, and bed and bank modifications.

An IIT Consortium report emphasized that there should be restriction on environmentally harmful activities in the national River Ganga basin, including allowance, prohibition or regulation of sand mining, dredging, stone crushing, sediment removal and mining of other materials from river beds. Plying of noisy vessels, dredging, and river bed and bank modifications by taking into consideration the actual environmental impacts assessed in specific situations as also their social and economic implications.

Technological and Physical Viability:

Water Flow: For smooth functioning of inland waterways water depth must be maintained throughout the channel. The basic prerequisite for waterways transport is the availability of water flow in the main waterways. This may have decreased over years because of increased usage arising from habitation, industrial and agricultural needs. The extent of regular flow may also have decreased because of impact of dams and river on river streams.

River Training Dredging and Navigation: The next requirement is that the river is drained and consistently provides a sufficient depth vis-a-vis the draft of vessels that are expected to play on it. This is possible for some type of river beds and may require maintenance of banks and dredging of river bed periodically.

Industrial And Agricultural Needs: The requirements for navigation channel markings night navigational aids including the possible development of GPS and river maps and charts for navigation exists. The National Inland Navigation Institute in Patna has been set up to oversee this development by the use of appropriate technology.

Locks: The physical drop of river channels cannot be too much or else locks have to be provided to manage the height differential.

Availability of Vessels and Associated Infrastructure: India has a long history of river based water transport. Among operators, the government owned CIWTC (Central Inland Water Transport Corporation) is the largest owner of vessels and barges. Private operators have a substantial fleet, but have not been investing in new vessels in the last decade. In fact, it has been scrapping vessels of late and all operators may require some help in reviving them and investing in new vessels.

Infrastructure:

Apart from the waterways or the channels themselves, these national waterways will also need and hence involve the construction of other related infrastructure facilities like riverside jetties and ports, navigational aids and control points, material handling sites, storage godowns, barge maintenance and repairing centers, refuelling points, associated dredging equipment, parking areas for vessels and so on. Some of the port/terminals are planned as multimodal hubs which will connect rail, road and waterways, for e.g. the multi-modal hub at Varanasi. Moreover, there is a plan to link many of the national waterways to each other, to roads and railways and to major ports. This scheme is being called the Integrated National Waterways Transportation Grid. According to the National Waterway Transportation Grid Study by Inland Waterway Authority of India: “Integrated National Waterways Transportation Grid study is undertaken with an aim to link all National Waterways to National/ State Highways, Railways and Sea Ports so that all these waterways become an integral part of the total transportation grid.” Another aim is to also connect the waterways to the different economic corridors being planned like Eastern Freight Corridor, Western Freight Corridor well projects like **Sagarmala Project,** which aims to promote port-led direct and indirect development. According to the Vision for Coastal Shipping Tourism and Regional Development of the Shipping Ministry, “The Sagarmala project at hand envisages seamless connectivity of sea-borne cargo with inland waterways for hinterland movement.” The Inland Waterway Authority of India has signed a MoU with the Dedicated Freight Corridor Corporation of India Ltd to develop a multimodal hub at Ramnagar near Varanasi in Uttar Pradesh. This multimodal hub will connect the National Waterway 1 to the Eastern Freight Corridor as well as the highway. The rail line of the eastern Corridor runs parallel to National Waterway 1 between Allahabad and Varanasi. Through this linkage, commodities and cargo can be swapped / shifted from and to the National Waterway 1, the Eastern Freight Corridor and road transport.

Scoping Mission to NW-2:

According to site report prepared by IWAI, the key take away points of the report were:

Development of Multimodal/intermodalterminals /logistic Hubs: Selection of locations is primarily proposed based on preliminary assessment of cargo, accessibility to rail and road connectivity, existing / future usage.

Development of Satellite Bases: Providing permanent berthing structure for year round operation, adequate facilities on bank with slope for future expansion and proper road connectivity up to the nearest national highway for smooth access.

Other Logistic Infrastructure Interventions: Report gives out setting up following infrastructure at NW-2 i.e. from Sadiya to Dhubri on Brahmaputra river.

Road Connectivity:While it is the imperative that proper four lane road connectivity to all new proposed IWT terminals as proposed would be planned and provided.
Bank Protection: Sites have been enmarked where the bank erosion is taking place. Measures are taken to arrest the bank erosion can be more feasible if planned, designed and executed.

Fairway Development and Maintenance Infrastructure: Fairway/ navigational channel is by far the most important IWT infrastructure for success of sustained IWT operations. Vessels equipped with state of art hydro graphic facilities, Cutter Suction Dredgers (CSD) and Hydraulic Surface Dredger (HSD). Maintaining approach channels at permanent terminals and R0-Ro ferry sites.

Floating Terminals: These terminals are good for berthing, embarking/ disembarking and manual loading/ unloading of goods. But these are not good for mechanical handling of cargo.

Navigation Aids: IWAI already maintains day navigation aids, night navigation aids, DGPS stations, pilotage services etc. these should be further strengthened as per demand from time to time.

Other Nations Experience:

Surveys have been done in past reports of other countries where inland waterways have been successfully used and continue to be used. In the region, United Nations Economic and Social Commission for Asia and Pacific publications on IWT give brief comparative pictures of India, Bangladesh, China, Indonesia and Thailand. It also discusses measures such as standardization of navigation rules & modernization strategies through this forum. An initiative taken by Japan attempts to consolidate the knowledge base and facilitate exchanges of good practices on IWT. IWT experience across world is varied and offers interesting comparison.

Bangladesh: A significant fraction about 35% of the freight movement in the country is by it because of the Geography of the region. Riverine ports are quite well developed and competing modes (rail and Road) are not as developed in comparative terms.
Thailand: IWT is next to road in share of freight carriage (about 20 million tons). Passenger movement in and around Bangkok is significant, with different types of services, including Express services.

North America: Freight movement on the Great Lakes and the Mississippi continue to be the important modes. Leisure activities based on water movement are quite common.

Europe: It is estimated to carry about 7% (and growing) of freight traffic in those EU States. In the EU States with waterways, this proportion is 12% overall and it account for more than 40% of ton-kilometer in some regions.

China: The navigable inland waterways in China total more than 100000 kilometer and there are a large number of Inland port facilities with work of large vessels. IWT accounts for almost 10% of the total freight tonnage carried in the country.

Problems Envisaged:

National Waterways Act, 2016 aims to give inland waterways the place it deserves as a means of transportation. It seeks to declare certain inland waterways as national inland waterways and work for its integrated development. But government is likely to face the under mentioned challenges in achieving the desired objective

Operational:
Seasonal variations in river water levels and dependency on monsoonal rain. Drying up of rivers will require maintaining water artificially- building of barrages.

Interlinking of Rivers:Ministry of Water resources have concerns of waterways impact on interlinking. Flood/pollution in one waterway or the interlinked river can adversely affect the other.

Heavy sedimentation and curved path of rivers make it difficult to sail. Inland sailing skills haven't developed either due to lack of demand.

Inland waterways can compete with land and railways only if hinterland connectivity is provided for. This limits the scope of waterways which are heavily dependent on last mile connectivity of road and railways.

Depth:The availability of depth on inland waterways may not be amenable for construction of an optimum designed vessel suited for both. Therefore, the depth on waterways needs to be further increased to at least 3.5 meters.

Infrastructural:
Indigenous shipping industry hasn't developed so much to provide for surge in requirement of inland transportation ferries and vehicles.

Creation of port terminals.
Infrastructure at ports and waterways where goods exchange is to be done are less equipped to handle cargo.

Financial:
Paucity of finances and unwillingness of the private sector vis-a-vis investments.
Insufficient budgetary allocations.

Institutional:
Absence of robust institutional capacity in implementation. E.g.: Inland Waterways Authority of India (IWAI) lacking autonomy.

Difficulty in getting land acquisition and coordination of state governments, as water and land are state subject.

Overlapping of authorities. E.g.: Ministry of Transport, Water Resource M1inistry and Ministry of Environment.

Social:
Competing demands on the stressed water levels, particularly for agricultural and household needs.
Threat to Aquatic Wildlife: Environment clearances can be granted only once the detailed plans of projects are made. This may delay project implementation and also can undermine the efforts of project planning if clearance is not granted. Also clearance may be stretch wise.

Way Ahead
The government has decided to take up 30 of these waterways for development in the next three years. In fact, because these waterways could also find linkages

with the ports of India, the shipping ministry hopes to connect the hinterland using these waterways as well, in addition to the roads and rail that most people are familiar with.

To encourage the modal shift from road and rail, the State government may provide incentives to the shippers for moving the cargo by IWT. The operators may leverage the incentives and attract cargo shippers to IWT with cost-economical offers.

Experimenting with innovations that would allow barges to be powered with LNG (liquefied natural gas, from which a leaner fuel CNG is derived). These barges will be designed in such a manner as to operate in waters that have a depth of not more than 2.5 metres

The new vessels capable of carrying 2,500 tonnes and navigating in shallow waters are being designed in India.

National Waterways Act is a step in right direction and needs to be complemented with adequate policy and financial support. It can boost India's economy and promote green development due to its eco-friendly nature. The new road of India's development is waterway.

IWT Units of Indian Army

Indian Army has deployed IWT units at various locations to provide crossings across major rivers. The units are responsible to ferry troops as well as provide logistic support. Their inventory consists of various types of boats and equipment. These specialized units are trained and equipped for improvement works on banks, speed loading, ferrying and unloading of a large quantum of troops and material at short notice in both peace and war situation.

Conclusion

IWT and coastal shipping are complementary in nature to each other for providing hinterland-port-port connectivity. The operational and regulatory paths are already paved for integrating IWT with coastal shipping. However, infrastructural aspects need further attention. In addition, the viability of using the inland waters for movement of cargo toward the nearest port also has to be considered.

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HYDROGEN USED AS AN ALTERNATIVE FUEL

Keith Mariadas
GEIMS , Lonavala,
info@tmi.tolani.edu

R.K.Vignesh
GEIMS , Lonavala,
info@tmi.tolani.edu

Nikith Amin Raju
GEIMS , Lonavala,
info@tmi.tolani.edu

ABSTRACT

The concern for cleaner air along with stricter air pollution regulations and the desire to reduce the dependency on fossil fuels has resulted in the use of hydrogen as an alternative fuel for internal combustion engines(IC engines).

The automobiles, at present day use products of fossil fuels. These have the main carbon molecule. These after combustion is converted into carbon oxides emissions, nitrogen and sulphur compounds are emitted as SOx, NOx, smoke, unburnt carbon and particulate matter. Hydrogen gas fuel was considered as a substitute for the petrol requirement, and also safe guard against the other emissions.

Keywords:

Hydrogen, Emission, Pollution

Introduction

The difference in cost between natural gas and petroleum fuel has been increasing and that trend is expected to continue in the long term. The transportation industry is looking for ways to reduce costs. A natural gas-diesel dual-fuel engine is a proven technology that can provide substantial fuel savings. Expensive fuel is substituted with natural gas, and only a small amount of petrol is used to ignite the natural gas air mixture. A relatively simple and inexpensive retrofit kit is used to convert the engine onto a natural gas dual fuel engine. The gas fuel is stored on board the vehicle in the petrol bunk.

A variety of studies have shown that dual fuel engines provide dramatic reductions in NOx and particulate emissions. Hydrogen gas also produces substantially less CO_2 compared to petrol combustion, which could be important in meeting future global warming restrictions. One issue with natural gas dual fuel engines is that some tests have shown relatively high emissions when the engines are operating at light loads. This is because the low concentration of natural gas has approached the lean limit and some of the natural gas has remained unburned.

The most significant aspect to which I wish to draw you attention is, 'The Combustive Properties of Hydrogen'. The properties of hydrogen are detailed in Section 1. The properties that contribute to its use as a combustible fuel are its:

- Wide range of flammability
- Low ignition energy
- Small quenching distance
- High auto ignition temperature
- High flame speed at stoichiometric ratios
- High diffusivity
- Very low density

An understanding of 'The Pre-Ignition Problems and its Solutions' is essential for comprehending the rest of my presentation:

The primary problem that has been encountered in the development of operational hydrogen engines is premature ignition. Premature ignition is a much greater problem in hydrogen fueled engines than in other IC engines, because of hydrogen's lower ignition energy, wider flammability range and shorter quenching distance.

Premature ignition occurs when the fuel mixture in the combustion chamber becomes ignited before ignition by the spark plug, and results in an inefficient, rough running engine. Backfire conditions can also develop if the premature ignition occurs near the fuel intake valve and the resultant flame travels back into the induction system.

A number of studies have been aimed at determining the cause of pre-ignition in hydrogen engines. Some of the results suggest that pre-ignition are caused by hot spots in the combustion chamber, such as on a spark plug or exhaust valve, or on carbon deposits. Other research has shown that backfire can occur when there is an overlap between the openings of the intake and exhaust valves.
Fuel Delivery Systems

Adapting or re-designing the fuel delivery system can be effective in reducing or eliminating pre-ignition. Hydrogen fuel delivery system can be broken down into three main types: central injection (or "carbureted"), port injection and direct injection.

Central Injection or Carbureted Systems
The simplest method of delivering fuel to a hydrogen engine is by way of a carburetor or central injection system. This system has advantages for a hydrogen engine. Firstly, central injection does not require the hydrogen supply pressure to be as high as for other methods. Secondly, central injection or carburetors are used on gasoline engines, making it easy to convert a standard gasoline engine to hydrogen or a gasoline/hydrogen engine.
Port Injection Systems:
The port injection fuel delivery system injects fuel directly into the intake manifold at each intake port, rather than drawing fuel in at a central point. Typically, the hydrogen is injected into the manifold after the beginning of the intake stroke. At this point conditions are much less severe and the probability for premature ignition is reduced.

Direct Injection Systems:
More sophisticated hydrogen engines use direct injection into the combustion cylinder during the compression stroke. In direct injection, the intake valve is closed when the fuel is injected, completely avoiding premature ignition during the intake stroke. Consequently the engine cannot backfire into the intake manifold.

Thermal Dilution:
Pre-ignition conditions can be curbed using thermal dilution techniques such as exhaust gas recirculation (EGR) or water injection.
As the name implies, an EGR system re circulates a portion of the exhaust gases back into the intake manifold. The introduction of exhaust gases helps to reduce the temperature of hot spots, reducing the possibility of pre-ignition. Additionally, re circulating exhaust gases reduce the peak combustion temperature, which reduces NOx emissions. Typically a 25 to 30% recirculation of exhaust gas is effective in eliminating backfire.
On the other hand, the power output of the engine is reduced when using EGR. The presence of exhaust gases reduces the amount of fuel mixture that can be drawn into the combustion chamber.
Another technique for thermally diluting the fuel mixture is the injection of water. Injecting water into the hydrogen stream prior to mixing with air has produced better results than injecting it into the hydrogen-air mixture within the in-take manifold. A potential problem with this type of system is that water can get mixed with the oil, so care must be taken to ensure that seals do not leak.

Engine Design:
The most effective means of controlling pre-ignition and knock is to re-design the engine for hydrogen use, specifically the combustion chamber and the cooling system.
A disk-shaped combustion chamber (with a flat piston and chamber ceiling) can be used to reduce turbulence within the chamber. The disk shape helps produce low radial and tangential velocity components and does not

amplify inlet swirl during compression.

Since unburned hydrocarbons are not a concern in hydrogen engines, a large bore-to-stroke ratio can be used with this engine. To accommodate the wider range of flame speeds that occur over a greater range of equivalence ratios, two spark plugs are needed. The cooling system must be de-signed to provide uniform flow to all locations that need cooling.

Additional measures to decrease the probability of pre-ignition are the use of two small exhaust valves as opposed to a single large one, and the development of an effective scavenging system, that is, a means of displacing exhaust gas from the combustion chamber with fresh air.

After discussing the most effective means of controlling pre-ignition, various ignition systems shall be discussed eventually.

Due to hydrogen's low ignition energy limit, igniting hydrogen is easy and gasoline ignition systems can be used. At very lean air/fuel ratios (130:1 to 180:1) the flame velocity is reduced considerably and the use of a dual spark plug sys-tem is preferred.

Ignition systems that use a waste spark system should not be used for hydrogen engines. These systems energize the spark each time the piston is at top dead center whether or not the piston is on the compression stroke or on its exhaust stroke. For gasoline engines, waste spark systems work well and are less expensive than other systems. For hydrogen engines, the waste sparks are a source of pre-ignition.

Spark plugs for a hydrogen engine should have a cold rating and have non-platinum tips. A cold-rated plug is one that transfers heat from the plug tip to the cylinder head quicker than a hot-rated spark plug. This means the chances of the spark plug tip igniting the air/fuel charge is reduced. Hot-rated spark plugs are designed to maintain a certain amount of heat so that carbon deposits do not accumulate. Since hydrogen does not contain carbon, hot-rated spark plugs do not serve a useful function. Platinum-tip spark plugs should also be avoided since platinum is a catalyst, causing hydrogen to oxidize with air.

Crankcase Ventilation

Crankcase ventilation is even more important for hydrogen engines than for gasoline engines. As with gasoline engines, un burnt fuel can seep by the piston rings and enter the crankcase. Since hydrogen has a lower energy ignition limit than gasoline, any un burnt hydrogen entering the crankcase has a greater chance of igniting. Hydrogen should be prevented from accumulating through ventilation.

Ignition within the crankcase can be just a startling noise or result in engine fire. When hydrogen ignites within the crankcase, a sudden pressure rise occurs. To relieve this pressure, a pressure relief valve must be installed on the valve cover.

Exhaust gases can also seep by the piston rings into the crankcase. Since hydrogen exhaust is water vapour, water can condense in the crankcase when proper ventilation is not provided. The mixing of water into the crankcase oil reduces its lubrication ability, resulting in a higher degree of engine wear.

Thermal Efficiency:

The theoretical thermodynamic efficiency of an Otto cycle engine is based on the compression ratio of the engine and the specific-heat ratio of the fuel as shown in the equation:

The higher the compression ratio and/or the specific-heat ratio, the higher the indicated thermodynamic efficiency of the engine. The compression ratio limit of an engine is based on the fuel's resistance to knock. A lean hydrogen mixture is less susceptible to knock than conventional gasoline and therefore can tolerate higher compression ratios.

The specific-heat ratio is related to the fuel's molecular structure. The less complex the molecular structure, the higher the specific-heat ratio. Hydrogen ($\gamma = 1.4$) has a much simpler molecular structure than gasoline and therefore its specific-heat ratio is higher than that of conventional gasoline ($\gamma = 1.1$).

Main Work

Emissions:

The combustion of hydrogen with oxygen produces water as its only product:

$2H_2 + O_2 = 2H_2O$

The combustion of hydrogen with air however can also produce oxides of nitrogen (NOx):

$H_2 + O_2 + N_2 = H_2O + N_2 + NOx$

The oxides of nitrogen are created due to the high temperatures generated within the combustion chamber during combustion. This high temperature causes some of the nitrogen in the air to combine with the oxygen in the air. The amount of NO x formed depends on:

- The air/fuel ratio
- The engine compression ratio
- The engine speed
- The ignition timing
- Whether thermal dilution is utilized

In addition to oxides of nitrogen, traces of carbon monoxide and carbon dioxide can be present in the exhaust gas, due to seeped oil burning in the combustion chamber.

Depending on the condition of the engine (burning of oil) and the operating strategy used (a rich versus lean air/fuel ratio), a hydrogen engine can produce from almost zero emissions (as low as a few ppm) to high NO x and significant carbon monoxide emissions.

Figure 1 illustrates a typically NO x curve relative to phi for a hydrogen engine.

A similar graph including other emissions is shown in Figure for gasoline.

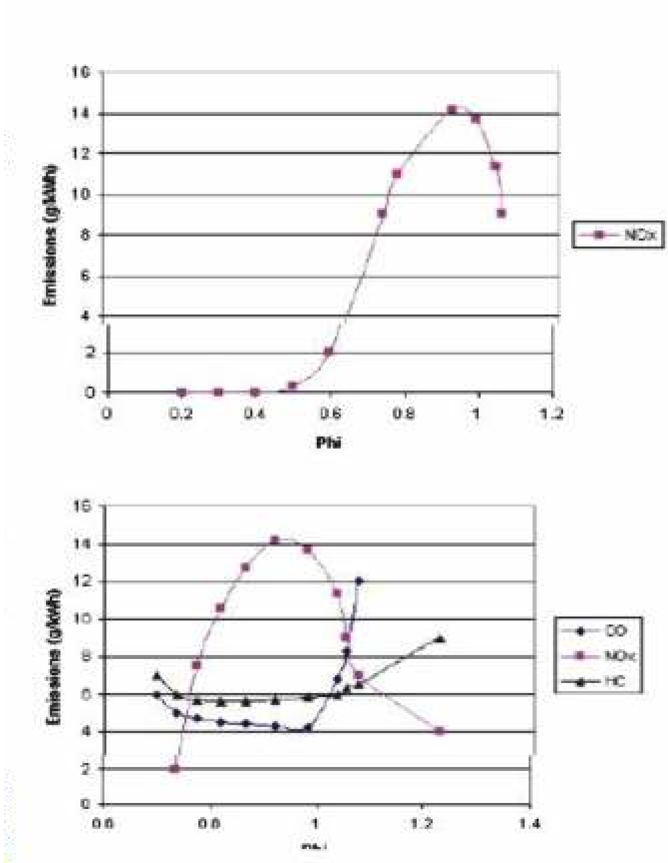

Fig. 1: NOx vs. phi for a H2 engine

Power Output:

The theoretical maximum power output from a hydrogen engine depends on the air/fuel ratio and fuel injection method used.

The stoichiometric air/fuel ratio for hydrogen is 34:1. At this air/fuel ratio, hydrogen will displace 29% of the combustion chamber leaving only 71% for the air. As a result, the energy content of this mixture will be less than it would be if the fuel were gasoline (since gasoline is a liquid, it only occupies a very small volume of the combustion chamber, and thus allows more air to enter). Since both the carbureted and port injection methods mix the fuel and air prior to it entering the combustion chamber, these systems limit the maximum theoretical power obtain-able to approximately 85% of that of gasoline engines. For direct injection systems, which mix the fuel with the air after the intake valve has closed (and thus the combustion chamber has 100% air), the maximum output of the engine can be approximately

15% higher than that for gasoline engines.

After having said about various ignition systems, I must emphasize on the advantages of hydrogen in internal combustion engines.

Hydrogen Gas Mixtures:

Hydrogen can be used advantageously in internal combustion engines as an additive to a hydrocarbon fuel.

Hydrogen is most commonly mixed with high pressure natural gas for this purpose since both gases can be stored in the same tank. If hydrogen is blended with other fuels, it usually has to be stored separately and mixed in the gaseous state immediately before ignition. In general, it is impractical to use hydrogen in conjunction with other fuels that also re-quire bulky storage systems, such as propane.

Gaseous hydrogen cannot be stored in the same vessel as a liquid fuel. Hydrogen's low density will cause it to remain on top of the liquid and not mix. Furthermore, liquid fuels are stored at relatively low pressures so that very little hydrogen could be added to the vessel.

Liquid hydrogen cannot be stored in the same vessel as other fuels. Hydrogen's low boiling point will freeze other fuels resulting in fuel "ice".

Hydrogen can be used in conjunction with compact liquid fuels such as gasoline, alcohol or diesel provided each are stored separately. In these applications, the fuel tanks can be formed to fit into unused spaces on the vehicle. Existing vehicles of this type tend to operate using one fuel or the other but not both at the same time. One advantage of this strategy is that the vehicle can continue to operate if hydrogen is unavailable.

Hydrogen cannot be used directly in a diesel (or "compression ignition") engine since hydrogen's auto ignition temperature is too high (this is also true of natural gas). Thus, diesel engines must be outfitted with spark plugs or use a small amount of diesel fuel to ignite the gas (known as pilot ignition). Although pilot ignition techniques have been developed for use with natural gas, no one is currently doing this with hydrogen.

Applications

We have been discussing the Advantages of Hydrogen in internal combustion engines so far, I believe it is time now to focus on the significant applications of Hydrogen in Marine field

Air & Marine Transport Emissions:

- Domestic Air Transport 5% = 295 million tCO_2e
- Int'l Air Transport 7% = 413 million tCO_2e
- Marine Transport 10 % = 590 million tCO_2e Compared to
- Land transport emissions = 4.720 million tCO_2e

IMO reports that:

- Total maritime trade doubled from 1985 to 2007
- Total container trade has grown 8-fold over the period
- 1120 million tCO_2e emitted in 2005, much higher than the Stern Report numbers
- Energy used per tonne delivered by sea has been declining

Marine transport related emissions to go up by 72% by the year 2020 without action Maritime transport GHG emissions -

- Technological developments on marine engine efficiency
- Better fuels
- Ship speed (4% reduction = 13% less fuel)
- Use of on-board renewable energies
- Advanced sail technology
- Photovoltaic
- Hydrogen

Applications of Hydrogen in Maritime Industry:

- No / low emissions (GHG reduction)
- No noise / vibrations
- No water pollutants
- No dependency on imported oil
- Production of H_2 possible from a variety of sources
- Electric propulsion systems on ships superior to IC 6
- Flexible placement of energy-generator and electric engines
- Higher efficiency than conventional Engine -

generator set for electricity production

- Fuel cell: ~ 50%
- Diesel Gen Set: ~ 15%
- Lower rotation speed and larger diameter propeller

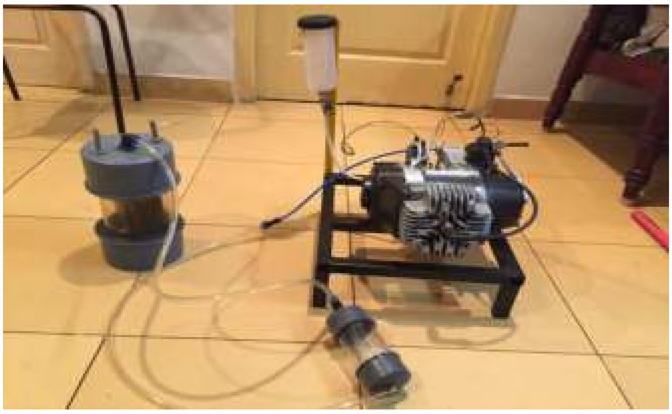

Fig.2. Experiment Setup

Construction Of Hydrogen Generator:

The major parts of the oxy-hydrogen generator are:

- Generator plates
- Generator body
- Bubbler body
- End caps
- O-rings
- Swivel elbow
- Delivery tubes
- Nozzle
- Bolts
- Nuts
- Washers

Working Principle

The basic methodology involved in this process is a simple electrolysis process. The electrolyte used here is distilled water and potassium hydroxide solution is used as catalyst, in order to initiate the reaction. Potassium hydroxide is mixed with distilled water in the ratio 1:4 and of normality 0.1N. When DC current is supplied to the electrolyte through the generator plates, displacement of ions take place. Due to this displacement of ions, electrochemical reactions take place. Hydrogen gas is liberated at the cathode while oxygen gasis liberated at the anode. Both these gases travel through the PU connecting tubes to the bubbler where the impurities are removed.

The pure gas is then fed to the nozzle. It is then passed through the PU delivery tubes and is collected in the collected jar.

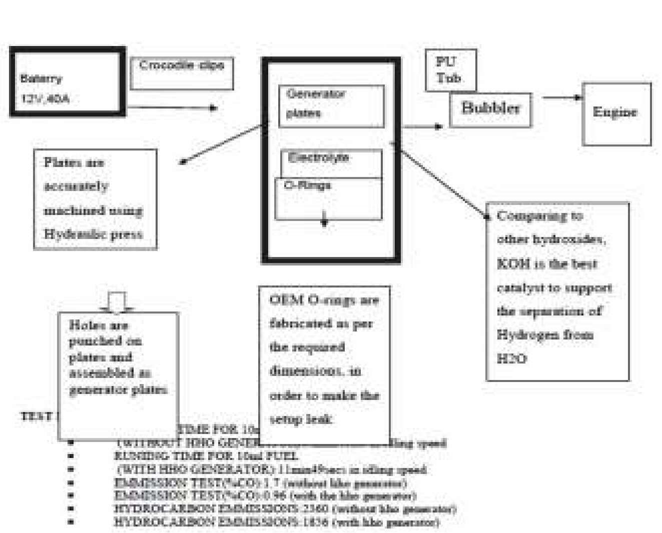

Fig. 3. Environment Effects of Hydrogen

Hydrogen in the environment:

Hydrogen forms 0.15 % of the earth's crust; it is the major constituent of water. 0.5 ppm of hydrogen H_2 and various proportions as water vapour are present in the atmosphere. Hydrogen is also a major component of biomass, constituting the 14% by weight.

Environmental stability:

Hydrogen occurs naturally in the atmosphere. The gas will be dissipated rapidly in well ventilated areas.

Effect on plants or animals:

Any effect on animals would be related to oxygen deficient environments. No adverseeffect is anticipated to occur to plant life, except for frost produced in the presence of rapidly expanding gases.

Effect on aquatic life:

No evidence is currently available on the effect of hydrogen on aquatic life.

Effects of exposure to hydrogen:

Fire:

It is extremely flammable. Many reactions may cause **fire or explosion. Explosion:**

Gas/air mixtures are explosive. Routes of exposure: The substance can be absorbed into the body by inhalation.

Inhalation:

High concentrations of this gas can cause an oxygen-deficient environment. Individuals breathing such anatmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness,unconsciousness, nausea, vomiting and depression of all the senses.

Inhalation risk:

On loss of containment, a harmful concentration of this gas in the air will be reached very quickly.

Physical dangers:

The gas mixes well with air, explosive mixtures are easily formed. The gas is lighter than air.

Chemical dangers:

Heating may cause violent combustion or explosion. Reacts violently with air, oxygen, halogensand strong oxidants causing fire and explosion hazard. Metal catalysts, such as platinum and nickel, greatly enhancethese reactions.

Conclusion

The proposed prototype of oxy-hydrogen generator was successfully made besides fulfilling the portability criterion.

The prototype worked according to our expectation and did all the operations it was intended to deliver. We suggest further improvements for the further advancement of the prototype with our experience during this project. By making very small changes to the proposed prototype this oxy-hydrogen generator can be manufactured successfully and used for commercial purpose.

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ARTIFICIAL INTELLIGENCE WITH VIRTUAL REALITY: "NEXT LEAP OF FAITH FOR MIT'S"?

Thulasi ram
HIMT, Chennai.
gthulasi.12c@gmail.com

Shakkthivel
HIMT, Chennai.
shakkthivel2020@gmail.com

ABSTRACT

All kinds of industries are taking baby steps towards VR & AI technology. It looks like the VR& AI technology will mature in future to set a trend. Also, stay in industries quite a long period of time. Maritime industry has taken initiatives to bring up safe working practice, blue revolution, safety of seafarers and machine intelligent training for operating of the new technology in industry. The paper briefly discuss about the traditional training followed from past to e-learning at present. In this kind of conventional training the grasping power of trainees differs from student to student. So the world is developing its technology rapidly and the youth of today are very much interested in handling electronic gadgets. If this point is taken into consideration, by training the students with AI & VR equipment, comparatively the knowledge gained by the students will be more to conventional training. So, below we have discussed how the new technology growing up in other industries could impact the shipping industry as well as – Maritime training institutes (MIT's).

Keywords:

Traditional training, e-learning, artificial intelligence, virtual reality

Main Text

Conventional training:

Traditionally, the primary educational technique of traditional education was simple oral recitation, in a typical approach, students sat quietly at their places and listened to one student after another recite his or her lesson, until each had been called upon. The teacher's primary activity was assigning and listening to these recitations; students studied and memorized the assignments at home. It was also an extremely inefficient use of students and teachers time. This traditional approach also insisted that all students been taught the same materials at the same point; students those did not learn quickly enough failed. The conventional educator, on the other hand, regards truth not as something that the soul can perceive but as something relative and subjective. You have your truth; I have mine. That is synonymous for, "There is no truth." In addition, it lays the foundation for a teaching approach and a curriculum that is ordered to the emptiness that I claimed above was the ultimate goal of conventional education. Education should be a right for all, irrespective of their socio-economic standing. In addition, in some ways, the conventional mode is not able to take in everyone, as it is not prepared for the diversity of situations.

In a conventional set up, the teacher or faculty delivers a lecture, students take notes and in between there is interaction on a given topic or subject. The format is clear-cut and often faculty driven. Interaction or lack of it depends on the faculty. The amount of time invested is often critical, not just for students' but also for faculty.

Challenges with lecture-based learning

The teacher has a dominant role in most classroom activities. The student becomes a passive participant in learning as lessons are pre-planned and designed for the needs of the group. Goals are set for the group with no opportunity for individual planning. The responsibility for identifying problem behaviours and resolving problems is placed on the teacher. Poor behaviour is often tolerated until it becomes extreme. Punishment is the primary outcome and conflict resolution training is often ignored.

Subjects are often taught without the meaningful context of relating them to other subjects to engage the student's interest. Reinforcement of learning comes through the external evaluation of the teacher and comparisons with others through grade assignments. Students may become discouraged from learning as they compare themselves to others. Homework may take several hours a night. This is a result of group goal setting with limited class time for student comprehension. Concepts are quickly introduced in the class and mastered/memorized at home.

Its passive: Probably the main argument levied against lecture-based classroom styles involves how little it truly engages students. Breaking up the monotony with activities like quick papers, merely punctuating lectures with something more interactive might be all a teacher really needs to get students learning and retaining knowledge.

It does not engage every learning style: Only visual/verbal and auditory/verbal learners get anything out of lectures, so tactile/kinaesthetic and visual/nonverbal students end up falling behind. Educators who fear their courses might not completely reach all styles might want to explore different ways to infuse other activities and projects into the syllabus so everyone gets a chance to see lessons in a way that makes sense.

It facilitates rote learning above all else: Listening to lessons on repeat only works best for some subjects, not all, and its main drawback involves compromising critical thinking skills.

It is biased: The most effective education allows students to consider content from multiple angles and form opinions accordingly, not just perpetually parrot back what teachers spoon-feed into their cranial meats.

It precludes discussion: Only allowing the teacher a forum to express his or her personal views shuts out all other insights, which leaves students feeling excluded from their own educations.

It is not the right fit for every subject: The arts, math’s, and sciences especially benefit from more interactive, hands-on approaches, three subjects one would expect more talk-based approaches — might not completely rock the lecture-based structure, either.

Minimal student feedback: If a teacher just stands there talking to the class, there is no real way to fully grasp whether students understand the subject until assignment or test time rolls around, different learners absorb lessons in a more comfortable way, but it also allows them to inquire about anything particularly confusing as well.

Not every teacher excels at public speaking: Poor communicators can seriously screw over different learners, even if they typically benefit from traditional lecture structures.

Not every attention span lasts that long: The average attention span is 10 minutes in university students; say some disconcerting studies, which is not exactly conducive to most classes. Others posit the number might hover between 15 and 25. They provide all the education of a traditional lecture — if not more — without wasting money on slashing periods down.

It only nurtures a limited range of skill sets: As a passive format, creativity, critical thinking, analysis, and other more active ingredients in a valuable education receive little attention. Lectures certainly fortify memorization and note taking, but they are not the only abilities students need to succeed.

Common problems faced by students in e-learning:

- Adaptability Struggle
- Technical Issues
- Computer Literacy
- Time Management
- Self-Motivation
- Virtual Reality

Human brain:

According to Zabisco, the average person responds far better to visual information compared to just plain text. Whether you are buying a product or revising for an exam, visual stimulation over text translation allows the brain to consume the material with more consummate ease. Well first off, it could be something to do with the fact that 90% of information transmitted to the brain is visual, and visuals are processed in the brain at 60,000 times the speed of text. In other words, we look at pictures and videos regularly and we consume them more quickly than we do text.

Definition of virtual reality:

A computer technology uses virtual reality headsets, sometimes in combination with physical spaces or multi-projected environment to generate realistic images, sounds and other sensations that stimulate a user’s physical presence in a virtual world or imaginary environment. On a computer VR is primarily experienced through two of the five senses: sight and sound.

How it works?

VR tricks our brain into believing we are in a 3D world. The first way VR does this is with the stereoscopic display. This works by displaying two slightly different angles of the scene to each eye, simulating depth. This along with other ways to stimulate depth like the one parallax (slower movement of objects when seen from far), shading and techniques create an almost life like experience. An example of stereoscopic display is below.

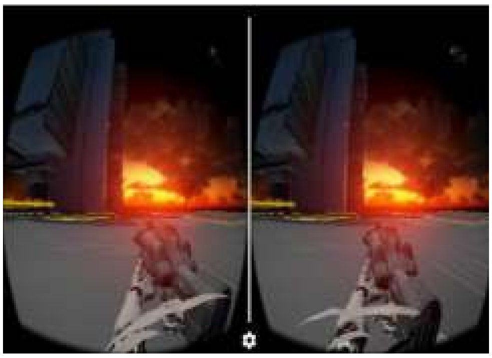

Fig. 1.Different angles of scene to each eye (target point)

Military: VR useful for training soldiers for combat situations or other dangerous settings where they have to learn how to react in an appropriate manner. Virtual reality simulation enables them to do so but without the risk of death or a serious injury. They can re-enact a particular scenario, for example engagement with an enemy in an environment in which they experience this but without the real world risks. This has proven to be safer and less costly than traditional training methods.

Health Care: Healthcare is one of the biggest adopters of VR, which encompasses surgery simulation, phobia treatment, robotic surgery, and skills training. One of the advantages of this technology is that it allows healthcare professionals to learn new skills as well as refreshing existing ones in a safe environment. In addition, it allows this without causing any danger to the patients.

Business: Virtual reality is being used in a number of ways by the business community, which include:

- Virtual tours of a business environment
- Training of new employees
- A 360 view of a product

Many businesses have embraced virtual reality as a cost effective way of developing a product or service. For example, it enables them to test a prototype without having to develop several versions of this which can be time consuming and expensive. In addition, it is a good way of detecting design

Sports: VR is used as a training aid in many sports such as golf, athletics, skiing, cycling etc. It is used as an aid to measuring athletic performance as well as analysing technique and is designed to help with both of these. It also used in clothing/equipment design and as part of the drive to improve the audience's experience.

Education: Education is another area, which has adopted VR for teaching and learning situations. The advantage of this is that it enables large groups of students to interact with each other as well as within a three dimensional environment. It is able to present complex data in an accessible way to students, which is both fun and easy to learn. In addition, these students can interact with the objects in that environment in order to discover more about them.

So it makes sense to implement virtual reality as one of several forms of technology in order to educate tomorrow's technological elite. Education has moved on from books, pencils and pens to the use of interactive technologies to help impart knowledge and understanding.

Artificial intelligence

It is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think. AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

How it works?

There is no single way in which artificial intelligence works. One definition of AI is when a computer can solve a problem that normally requires a level of intelligence. Over the past 60 or so years, many different approaches to solving a wide variety of problems have been discovered by AI researchers. For example, chess can now be played by computers such as Deep Blue at a Grand Master level. It works by examining many thousands of chessboard configurations, to see the future result of making particular moves. Another example is expert systems, which solve problems in areas such as medicine and engineering by duplicating the problem solving performed by real human experts. Other problems are more difficult. For example, making computers read and communicate in English is very challenging, and is far from solved.

Goals of Artificial Intelligence:

To Create Expert Systems − The systems which exhibit intelligent behaviour, learn, demonstrate, explain, and advice its users.

To Implement Human Intelligence in Machines − Creating systems that understand, think, learn, and behave like humans.

Applications of AI: It has been dominant in various fields such as,

Gaming − AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.

Natural Language Processing − It is possible to interact with the computer that understands natural language spoken by humans.

Expert Systems − There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.

Vision Systems − These systems understand, interpret, and comprehend visual input on the computer. For example;

- A spying aeroplane takes photographs, which are used to figure out spatial information or map of the areas.
- Doctors use clinical expert system to diagnose the patient.
- Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

Speech Recognition − Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

Handwriting Recognition − The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

Implementation of VR and AI in shipping industry

The next five to ten years will be decisive for virtual reality. While consumers today feel a bit intimidated by the price of VR technology, the interest in the industry is far from going flat. Virtual realities are steadily finding its niche in the market and begin to make an impact on the business world. Robert Bryan and Adam Bullas from Opace, a Birmingham-based digital marketing agency, have recently published detailed research on the possible intersections of VR and the business like

- One stop engineering knowledge shopping
- Addressing the needs of industry
- Experience the design functionality

Can a machine think and behave as humans do?

Artificial intelligence represents a new way of interfacing with data. With the cost of sensors, data storage, and analytics plunging, nearly every industry can now produce Exabyte's of data concerning its daily operations, from the temperature of a computer processor to the vibration in a bearing. Artificial intelligence promises to simplify the analysis of all this data by optimizing the analytic process. By shifting data optimization from humans to computer programs, useful insights into patterns, trends, and applications can be rapidly developed and executed. Some of the technologies developed by shipping companies are discussed below.

Mitsui O.S.K. Lines, Ltd. (MOL) announced that it teamed up with Fujitsu Laboratories Ltd., and Tokyo University of Marine Science and Technology to verify the accuracy of technology to estimate vessel performance at sea by applying Fujitsu's artificial intelligence (AI) technology, This project is a part of MOL's initiative to assess the effectiveness of AI technology, and aims to reduce fuel consumption and vessels' environmental impact by verifying the accuracy of the technology, using Fujitsu's AI Technology to estimate vessel performance at sea.

Eco Marine Power announced that it will begin using the Neural Network Console provided by Sony Network Communications Inc. as part of a strategy to incorporate Artificial Intelligence (AI) into various ongoing ship related technology projects including the further development of the patented Aquarius MRE (Marine Renewable Energy) and Energy Sail. The Neural Network Console is an integrated development environment using deep learning for AI creation and has been used in deep learning applied technology development within Sony since 2015.Various functions are included such as recognition technology and a full-fledged GUI (graphical user interface) and these allow deep learning programs to be developed. Deep learning refers to a form of machine learning that uses neural networks modelled after the human brain and is notable for its high versatility with applications in a wide variety of fields including signal processing, and robotics.

Mitsui O.S.K. Lines, Ltd. (MOL) announced the development of a mariner safety education tool goggle, which uses virtual reality (VR) technology created by Tsumiki Seisaku Co. Ltd. As explained, the tool uses VR technology to re-enact various training scenarios and work operations, offering a new level of realism and immersion. The new VR safety education tool works on easily portable VR goggles, allowing seafarers to train safely in any location, on board or in an office or training centre. This is expected to increase seafarers' safety awareness and contribute to the minimization of on board accidents caused by unsafe behaviour.

During the 2017 SAFETY4SEA Conference, Mr. Yuzuro Goto, Managing Director, K Line LNG Shipping (UK) Ltd, talked about a 3D simulation tool, developed by Propel that his company uses for training crew on board. In addition, Propel has developed a 3D-simulation model, entitled SAYFR, in an effort to allow people on board and ashore to interact in different scenarios.

Benefits of VR and AI:

- Teach more with less as the cost of equipment.
- Ensures safe working environment to eliminate serious risks.
- Trainee can work on an oil rig as real time experience.
- Access to perform important safety operations simulating real life scenarios in various weather conditions.
- Equipment can be updated in the field without huge new capital outlays for equipment.
- Learn by doing – engaging situations that mirror real life scenarios by trainees.
- No requirement of physical infrastructure by spending huge amount to install labs.

Advantages of using VR and AI in the maritime training:

Students as Creators:

While research centres will continue to build advanced immersive labs, the developments in standalone VR headsets and software platforms like Unity and Unreal engine are driving a democratization of immersive experiences. New VR native applications like Tilt Brush will enable our trainees to become creators in virtual worlds. They will not only have the opportunity to observe unseen phenomena but to prototype solutions to complex problems.

Provides Outstanding Visualizations that are not possible in the Traditional Classroom:

Virtual reality is great because it lets us explore different realities and alternate our experiences. By wearing a VR headset, you are encountering high-quality visualizations that can mark you in a positive way.

Creates Interest:

No matter what age they have, students will always love to sit and watch something instead of reading it. The VR technology is quite interesting, as it can create amazing experiences that could never be "lived" in the real life. Students will definitely feel more motivated to learn with the use of this technology.

Increases Students' Engagement:

Nowadays, teachers find it very hard to create a productive engagement within the class. With the virtual reality technology present in the education, this aspect will forever disappear, as most of the students will feel tempted to talk about their experiences within their virtual reality.

Doesn't Feel Like Work:

Let us face it; placing a headset on your head and watching stuff flash before your eyes, learning new information through videos and amazing visualizations, it does not look like work. If we can make education fun, trainees will love to learn more stuff and be more ambitious .This is a general rule. When we enjoy doing something, we will do it with more interest, we will do it better, and we will not feel like we are doing something painful.

Improves The Quality OfEducation In Different Fields:

The content writing and editing field. Virtual reality can often help at find mistakes in content and provide awesome editing features.

Eliminates The Language Barrier:

With virtual reality, every possible language can be implemented within the software. Therefore, language will no longer represent a barrier for student's education plans.

Digital Assistants:

Highly advanced organizations use 'avatars 'who can actually interact with the users, thus saving the need of human resources, the robots think logically and take the right program decisions. Emotions are associated with moods that can cloud judgment and affect human efficiency. This is completely ruled out for machine intelligence.

Difficult Exploration:

Artificial intelligence and the science of robotics can be put to use in mining and other fuel exploration processes. Not only that, these complex machines can be used for exploring the ocean floor and hence overcoming the human limitations. Due to the programming of the robots, they can perform more laborious and hard work with greater responsibility. They do not wear out easily.

Conclusion for advantages of VR and AI in MIT's:

The use of virtual reality and cloud based simulation engines promises to train automatons in real-world scenarios through simulated trial and error without endangering real people and real things.

Challenges of Using VR and AI In maritime training:

Deteriorates Human Connections:

While virtual reality can be a great asset for most of the existent fields of activity, it can also be a huge disadvantage. The traditional education is based on personal human communication and interpersonal connections.

Lack of Flexibility:

If in class you can be flexible, ask questions, receive answers, using a virtual reality headset is a different experience. This lack of flexibility can be a disadvantage for most of the students, and that is because education is not a fixed activity. It always fluctuates!

Functionality Issues:

Like with any programmed software, things can often go wrong. When things go wrong, you students' learning activity is over until the tool is fixed. This can be quite expensive and inconvenient.

Addiction to the Virtual World:

The possibility of students getting addicted to their virtual world is also big, if what people experience is better than their normal existence, there isquite a big chance of them becoming addicted.

Quite Expensive:

Advanced technology is often expensive, but it is one time investment. If we wish to expand this virtual reality trend and reach the masses, we have to spend billions of dollars on these features. More than that, the modern education that takes advantage of the virtual reality environment will only be accessed by the rich ones. The poor will not afford it; therefore, we will create inequality in education.

Lack of compute power:

AI – specifically the machine learning and deep learning techniques, which show the most promise, require a huge number of calculations to be made very quickly. This means they use a lot of processing power.

Conclusion for challenges of VR and AI in MIT's:

As you have probably noticed, the virtual reality environment is consistently evolving. It could bring dozens of benefits to almost any field, but it can also prove to be harmful. Per total, we believe that the

modernization of education with virtual reality can be quite a productive accomplishment.
Also the whole paper we are talking about the VR and AI. In the below tabulation-1 the importance of artificial intelligence is discussed and the effectiveness of machine intelligence can be noticed.

Conclusion:
Here we suggest for all the maritime trainings institutes (MIT's), as the AI with VR technology equipment for installation will be very expensive. So, MIT's has to calibrate with international large companies with deep profits to launch pilot consumer equipments of AI with VR for the maritime training. If this technology is adapted in short period of time which will result in the equipment cost to drop down to considerable price so that all the maritime training institutes can afford to adopt and install the AI with VR technology in all MIT's.

Programming without AI	Programming with AI
A computer program without AI can answer the specific questions it is meant to solve.	A computer program without AI can answer the specific questions it is meant to solve.
Modification in the program leads to change in its structure	AI programs can absorb new modifications by putting highly independent pieces of information together. Hence, you can modify even a minute piece of information of program without affecting its structure.
Modification is not quick and easy .it may lead to affecting the program adversely.	Quick and easy program modification

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KNOWLEDGE BASED EXPERT SYSTEMS FOR ENGINE ROOMS

Rishikesh Rout
Tolani Maritime Institute, Pune.
rishikeshrout99@gmail.com

Ranbir Bhalla
Tolani Maritime Institute, Pune.
pkpalta70@gmail.com

ABSTRACT

We've identified two factors which can result in grievous injury to a person working on heavy machinery onboard. One of the factors is Human Error, it is of common knowledge that seafarers use sign language in the engine room while working on machinery due to the fact that they have ear muffs on to prevent damage to the ear drum but use of sign language among different nationalities can be difficult and is not a viable way of an effective means of communication. The idea that we've introspected involves insertion of speakers and mics in the ear muffs which can be tuned to a specific radio frequency for communication. This is a very simple task to achieve and enhances the effectiveness of the PPE. In tropical regions the engine room temperature is known to rise to about 50 degrees Celsius, which can impede one's performance in the engine room. To tackle this problem we've formulated an idea that is derived from the basic principle of working of a nozzle.

It will be designed to be lightweight, durable. It shall use no electricity or chemical refrigerant like freons hence preventing any violations of the MARPOL annexures or contribute to GHG emissions in ECAs. These two ideas can increase the overall safety of a person working onboard and hence prevent loss of life or damage to machinery in case of any unfortunate accident.

Keywords:

MARPOL- Marine Pollution; PPE- Personal Protective Equipment; GHGs- Green House Gasses; ECAs- Emission Control Areas;

Introduction

Roughly 90% of the World Trade is by the shipping industry. As of January 2017, 52,183ships comprise the merchant fleet throughout the world from different shipping companies which employs 1,647,500 seafarers, of which 774,000 are officers and the rest are crew members. This makes safety onboard a merchant vessel of paramount importance to the crew members and officers working on dangerous machineries. Shipping has always been a very rewarding career, let alone being lucrative, dealing with machines and machinery worth crores is no joke and the safe transport of goods whose worth is sometimes even more than the ship depends primarily on how well these machines are maintained, their routinely check-ups etc. In order to make this possible, a marine engineer, on an average spends around 5-6 hours working in the engine room and this number is bound to increase in case of emergencies like overhauling of the main-engine. The International Convention of the Safety of Life at Sea (SOLAS) Chapter V that deals with the rest and work hours of the personnel onboard states that a period of 10 hours of rest bifurcated to 6 hours and 4 hours a day making a total of 70 hours a week is necessary for a seafarer to battle fatigue but these numbers tend to change in case of emergencies wherein a person has to work for long hours managing work even if he/she is fatigued. This can lead to a non-safe working environment since a slight mistake in conveying a message to the engineer at work on a heavy machinery just because he is not in his senses due to lack of sleep can lead to major accidents and even cause death. The only way to battle this is by increasing the comfort of the seafarers working in the Engine Room and the Deck Department so as to provide them an easier work experience resulting in the increase in the efficiency of the work being done by them. The paper outlines a few innovative methods to tackle such basic problems troubling the shipping industry from time immortal. The idea that we've introspected involves insertion of speakers and mics in the ear muffs which can be tuned to a specific radio frequency for communication. This is a very simple task to achieve and enhances the effectiveness of the PPE. The cost of making such headsets that provide noise cancellation along with the ability to communicate is negligible in comparison to the increase of safety that it offers. While working in such hot spaces one really needs to make sure that he isn't distracted by petty factors to ensure that he can work to the best of his abilities for long hours without getting fatigued. In tropical regions the engine room temperature is known to rise to about 50 degrees Celsius, which can impede one's performance in the engine room. To tackle this problem we've formulated an idea that is derived from the basic principle of working of a nozzle. The idea is the construction of light fabric vests to provide cool compressed air to the wearer to prevent fatigue, loss of water and hence dehydration. These jackets/vests contain a compressed air bottle that continuously supplies air to many tiny nozzles which cover the entire jacket, as air is passed through the converging/converging-diverging section of the nozzle, the temperature of air drops drastically at the expense of pressure which results in the cooling effect. It will be designed to be lightweight, durable. It shall use no electricity or chemical refrigerant like freons hence preventing any violations of the MARPOL annexures. The temperature can be varied by varying the initial pressure of the nozzle to provide the right cooling effect and the inlet for the compressed air can be taken from the air compressor already present onboard for cranking of main engine by inserting a bypass line. This vest can be worn under a regular boiler suit, or design a special boiler suit that has this arrangement in conjunction with its usual arrangement.

Marine Radio Earmuffs

Understandably, noise considerations have become one of the most important design aspects of ships as far as human health, habitability and environment are concerned. Furthermore, the performance of people on board, affected by an undesirable noise level, may lead to human error, which is considered the reason for most maritime accidents. Hazards due to noise have a great effect on occupational health and safety, and noise at work can cause hearing loss which may be temporary or permanent. The noise effects range from short-term consequences such as annoyance and discomfort, to long-term predicaments such as hearing losses. Besides its undesirable health effects, noise clearly influences the performance of crew. Due to a continuous reduction in crew sizes over the recent years, fatigue considerations become the main contributor to human error resulting in the need for further studies concerning human factors.

Engine rooms are the most noise infested areas in the ship structure which puts a lot of trouble for engineers and the engine crew to communicate with each other while working on different machinery. The only way out from the past decade to fight this problem was to use sign languages to convey messages throughout but the reliability of a sign language on a multinational ship is very less since the crew consists of people from different nationalities having different native languages. Since the engine crew has to mandatorily wear Hearing protection ear muffs to protect their ear drums from the excessive noise around them if we insert speakers and microphones as done in common headsets inside those earmuffs we can provide an internal radio channel for communication. The tactical divisions of different militaries throughout the world already uses this technology in gun ranges and during combat to prevent hearing loss as well as simultaneously communicate with other fellow soldiers on the battle ground. The same technology can be used in the shipping industry as well since value of life is same everywhere may it be on a battle ground or in a workspace with heavy machineries.

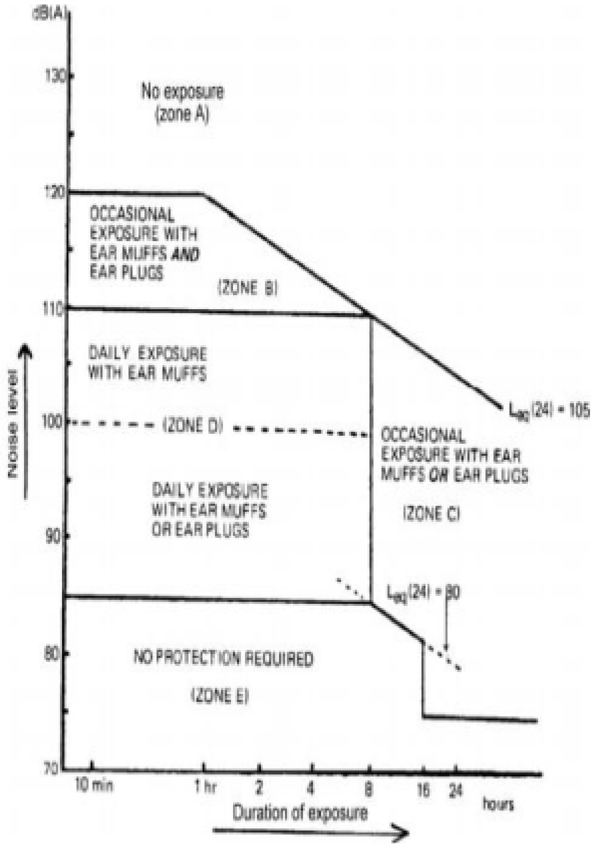

Fig.1. Allowable daily noise exposure levels

Design and working

The specially designed enhances your performance through bionic hearing technologies which heighten your ability to communicate with others and better understand your environment. The system clearly reproduces natural sound, while its ultra-fast digital processor provides active hearing protection from continuous, intermittent, and impact noise — seamless to the user.

In-ear headset

It shall capture voice through the headset's microphone inside the ear tip via air conduction. This eliminates pick up of ambient sounds commonly experienced with external microphones, enabling workers to communicate clearly. The in-ear headset is ideal for workers who operate in confined spaces or wearing head protection (e.g., respirators, welding shields, helmets).

Automatic fit check.

Upon ear tip insertion and system start up, it performs a quick calibration check to detect proper fit, validating adequate hearing protection and clear communications in each ear. It alerts the users if he/she does not achieve minimum level of protection and are required to refit.

Exclusive in ear dosimetry

It shall provide a real-time measurement of the worker's protected and unprotected noise exposure throughout the day, creating a verifiable measure of noise exposure.

Fully adaptive hearing protection

The bionic hearing expands the workers' personal situational awareness, understanding, and communication by not only adapting to changing noise noises but also amplifying sounds up to 5x normal hearing. This allows your workers to remain aware of their surroundings, assess rapidly changing environments and potential threats, and reduce further exposures to hazardous noise. The control unit includes volume control buttons, allowing the user to reduce or increase the level of the surrounding sound.

Compressed Air Nozzle Jacket.

Excessive heat can cause dehydration, heat exhaustion, and in the most serious cases, heat stroke. At worst, the working environment can hospitalize employees if not monitored closely, but heat can also cause fatigue, slow down productivity and cloud judgment. Using nozzles to have sudden temperature drops of compressed air can aid to provide a cooling effect to the bearer. A nozzle is often a pipe or tube of varying cross sectional area, and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy and as the velocity increases there is a drop of temperature of the air.

Principle

It is based on the simple principle of thermodynamics, that when air passed through a duct of varying cross section, decreasing, to be precise, its temperature decreases drastically, at the cost of pressure. It shall essentially contain a strap-on vest, with many such tiny nozzles covering the entire surface area. The compressed air shall be supplied with a light weight compressed air bottle, capable of providing cooling effect for at least 15 hours before its next re-charge. The recharge can be done via the the main air compressor, using a separate line.The vest shall also contain a button to activate the supply of compressed air when needed and also to shut it off when the desired body temperature has been reached.It shall also contain a gauge which tells us the pressure inside the compressed air bottle at any given time. It shall be worn in conjunction with a regular boiler suit, preferably under the boiler suit to prevent oil stains and dirt from blocking the openings. The vest when donned will supply the bearer a temperature of 22-23 degree Celsius during the passage of the ship through tropical waters where the temperature of the engine room reaches 40-50 degrees. The output temperature can be adjusted as the vessel moves from hotter climate to a comparatively colder climate by adjusting the pressure in the compressed air bottle in the vest.

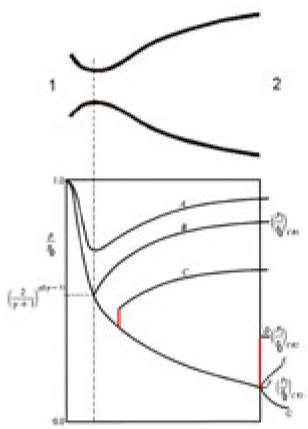

Fig. 2. Pressure Temperature relation in a nozzle

Certain parameters that affect the exit temperature of nozzles are -

Nozzle size, given by the exit area.

Pressure at entry

Discharge pressure

Pros of using air nozzle jackets

Inexpensive as compared to the some vests in market which are powered by an air conditioning cycle.

Easy to wear, compact and durable vest.

In no way violates any of the 6 MARPOL conventions.

Recharging is very easy and once recharged can be used for a long time.

The control of the extent of cooling is in the hands of the wearer.

Lightweight and comfortable to wear.

Problems faced while using an air nozzle jacket

Since we're dealing with pressurized compressed air, it can be a little dangerous.

Expensive

Has to be stored away from dust as it may block the nozzle openings. Careful stowage is needed.

Needs periodic cleaning and maintenance.

Conclusions

As a result of the research done by us in this paper in the field of safety management on merchant vessels, we can safely conclude that the use of the methods outlined in this paper can aid in increasing the safety index of a ship, improving life of crew members onboard as well as preventing any machinery damage due to fatigue. We've taken into consideration the problems faced due to the use of the air nozzle jackets and marine ear muffs and can safely deduct that if the basic general measures are taken then there would be no damage to the jacket or earmuff or to the bearer. The ideas mentioned in this paper are not widely used in the shipping industry due to lack of research regarding the same but they are quite popular among the elite militaries of different countries since they too have to undergo harsh environments with high temperatures and communicate with each other over the noise from the gunshots in the battlefield. Implementing such ideas in the shipping industry is quite possible although it may require someexpense at the start but those are negligible considering the overall expenditure a shipping company does for its other equipment.

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BOOK REVIEW
AN EMPIRICAL STUDY OF BEHAVIORAL PATTERN OF SEAFARERS: AN INDIAN EXPLORATION

Vinod K. Mangwani
Tolani Maritime Institute, Pune.
vinodm@tmi.tolani.edu

S. Kanungo, S. D. Pohekar, D. D. Mundhra and W. Jacob, An Empirical Study of Behavioral Pattern of Seafarers: An Indian Exploration, NotionPress, 2018, viii+187pp, ₹325. ISBN: 9781642491647

The international shipping industry carries out nearly eighty percent of the world trade by volume. According to UNCTAD's Review of Maritime Transport 2017, in 2016, 10.3 billion tons of cargo was transported. Indubitably, the import/export of food and other commodities would not be possible sans shipping. It would not be an exaggeration to say that shipping is the life blood of the global economy. The operations of merchant ships accounts for over half a trillion US dollars annual income (only on account of the freight). Different countries derive benefits from building, owning, registering, operating and even scrapping ships. The world fleet is registered in more than 150 countries providing jobs to more than a million seafarers from almost all the countries.

In terms of cargo carrying capacity the top five ship-owners are Greece, Japan, China, Germany and Singapore, having a combined market share of 49.5 per cent of deadweight tonnage; the five largest flag registries are Panama, Liberia, Marshall Islands, Hong Kong and China, enjoying a market share of 57.8 per cent; four countries – India, Bangladesh, Pakistan and China – together accounted for 94.9 per cent of ship scrapping in 2016 (page 36 of UNCTAD's Review of Maritime Transport 2017). Thus, there are opportunities galore in the shipping domain for India.

However, the life of a seafarer is fraught with risks– man-made and natural. The savant bard, Shakespeare, captured the hazards in the life of a seafarer in Merchant of Venice succinctly in the statements,

"But ships are but boards,
sailors but men: there be land-rats and water-rats,
water-thieves and land-thieves–I mean pirates; and
then there is the peril of waters, winds, and rocks." [Act I, Scene III]

A seafarer is constantly exposed to the vagaries of nature and might have to spend considerable time far away from home. Understanding the difficulties, problems and complexities which a seafarer faces might help in mitigating them. The work under review is a classic exposition of the experiences and perspectives of 566 seafarers. The opening pages of the work under review:

- capture the changes in the design and operations of argosies,
- provide information about the first autonomous and fully electric cargo ship YaraBirkeland,
- provide cursory information about The Trans-Asian Railway Network Agreement and The Belt and Road Initiative,
- list a few recent instances of cargo fraud, piracy, cyber-crimes, oil spills, sinking of vessels, fire on vessels, drug trafficking, etc.

The initial pages set the tone of the book.

The tome under review contains a questionnaire (Appendix I of the book). After the pilot study the authors redesigned the questionnaire which is listed in Appendix II of the book. The questionnaire in Appendix II appears to be comprehensive. The first part of the revised questionnaire contains twenty items, and the second part contains sixty-four items. The questionnaire was floated using Google forms and the authors obtained answers from over 566 respondents. The book presents the responses to the items in the questionnaire in a pictorial form. The questions are aimed at obtaining responses from seafarers pertaining to their lives on ships. A few sample items from the questionnaire (included in Appendix II) are:

i. On most of the ships I am free to work the way I like,
ii. There is scope for creativity in my job,
iii. There is no lack of intellectual challenges,
iv. There are absolutely no salary/pay disparities between different nationalities,
v. There is no difference in the promotion/ opportunities provided between those who follow safe working practices and those who don't,
vi. My profession is a dangerous profession (transmission of venereal diseases, drug-trafficking, piracy, help not readily available), etc.

The book might be of great help to researchers who have just begun their research-journey, to the policy-makers in a shipping company and to anyone interested in gaining an overview of viewpoints of seafarers on a random basis. The book contains cursory references to the opportunities in the maritime domain.

The book enlists few of the challenges faced by the seafarers. For instance, while joining/signing-off, the seafarers are treated like terrorists in several countries and are bound by extremely stringent rules. The seafarers are often not allowed shore leave at many ports by the authorities and the reasons ascribed are security, or the town being far from the port. Although the port authorities can easily provide bus services from the ships to the port exit so that there are no security breaches, but even then no steps have been taken in this direction so far. Even when the world speaks of GPS, GIS, RFID, space tourism, the truth is that cheap internet facilities have not been available on-board hitherto. Accommodation spaces, cabins and beds are sometimes too small. Many seafarers feel that they have to keep working on the same technology for an interminable period which may lead to stagnation in learning. Quite often the seafarers are forced to extend their contracts by more than a month because their ship is trading in countries where repatriation costs are exorbitant. The cooks on board a vessel, though highly skilled, are not interested in serving sumptuous meals as they are paid less salary and hardly have any help. As a result the quality of food being served on board suffers and hygiene is being compromised. In many countries, especially in South American countries, the ship chandlers supply provisions of very poor quality at exorbitant rates. There are many seafarers who have to suffer from crab culture and politics on-board.

However, the authors of the book could have gathered the opinions from the immediate families of the seafarers, psychologists in order to add more value to the book. The book does not have inferences and statistical assessment of the answers given by the 566 respondents.

With the introduction of newer regulations pertaining to the operation of ships and the introduction of blockchain technology the shipping industry is witnessing massive changes at a very fast pace. The book contains no references to the effects of blockchain technology on shipping in general.

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