ISSN: 0974-8474
Volume 15, 2022 March
Tolani Maritime Institute, Pune - 410507
www.tolani.edu

Bulletin of

MARINE SCIENCE AND TECHNOLOGY

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

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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.

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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 info@tmi.tolani.edu

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- 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.
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- 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.
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- 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.
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- 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.
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Template to Write The Article
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Technical Publication Committee - Message

We are pleased to present the 15th issue of **Bulletin of Marine Science and Technology (BMST)**. **Tolani Maritime Institute (TMI)** has been successful year after year in imparting Marine Education at pre-sea and post sea level because of its strength of faculty members, other resource persons in the organization and the facilities available for the research and industrial project work. TMI has created its benchmark in the Marine Education area.

The year has brought unimaginable change in work culture of industries and especially in education field. This has happened because of pandemic situation across the world. In the country education is going through the reformation at the school and college level. “Technology has the potential to achieve universal quality education and improve learning outcomes. But in order to unleash its potential, the digital divide must be addressed”. As online classes have been used as an alternative to regular classes under the circumstances of the COVID-19 pandemic, internet and technology services should be considered as a necessity and not a luxury. There is a need to work collaboratively with other universities, edutech companies and industries to bring about innovative solutions in making digital learning hassle-free and effective.

After the COVID-19 pandemic, education is moving to a blended mode of teaching-learning. Educationists, academic leaders and others are constantly trying to find out whether the students are actually intellectually engaging with the course and its materials when they are at home or at any other place away from the university campus and when there is no scope for face-to-face learning. Teaching-learning to continue on an online platform like Moodle requires students to understand how the course will be carried out online, including discussions from textbooks, class room activities, home works and submissions and assessments. There is a need to make the students understand the structure and requirement of the course when carried out on a digital platform. Some tools can be used to make the presence felt by the participants of the online course such as asking student’s personal information, encouraging interaction exchange between students, supporting video communications so that the facial expressions of the students and their voices are also clearly seen and heard.

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. The BMST issue 15th is dedicated to all those who have contributed directly/indirectly in keeping the light of knowledge on.

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

Technical Publication Committee
Tolani Maritime Institute, Pune

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INTERACTION BETWEEN SHIPS IN SHALLOW WATER

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ABSTRACT

In the last year article I had explained about Squat, Banking and cushioning effect of ships using basic concept of water level around ship and its movement i.e. Water flows from higher level to lower level, taking the easiest (fastest) path to lower level.
In this article, I am explaining the Interaction between the two vessels, especially when in narrow channel or restricted waters using the same principle of water level and its movement around the ship. Here we need to understand the movement of water when two ships are in close proximity.
Before starting to explain, let's recap on the facts utilized in the article published in the last year BMST.

Keywords

Interaction between ships, Ship Handling

Introduction

From the last article of mine: We know squat, at present as we have been taught throughout the studies of ship handling is because of drop in pressure using Bernoulli's principle.

As simple phenomena we all know "Moving ship pushes the water in the direction of the movement.' That means the level of water is lower at stern of the ship as compared to water at the bow (because it takes time for water to flow down to the stern of the ship and water level balances) and it is a continuous process as long as ship is moving.

If you imagine ship to be in open deep sea, imagining the same would be difficult to visualize but considering the ship in shallow and narrow channel, it becomes quite easy.

Taking clue from the narrow channel, it does happen in deep sea too, albeit at a lesser extent as there is lot of water around to fill up the space fast at stern of the ship. Now let's learn about displacement. Displacement is the amount/volume of the water displaced by the ship's hull at any given time. This amount of water displaced is equal to the weight of the ship in water and thus it is called displacement. As long as there is no change (addition or removal) in the weight of the ship, the displacement remains same. Also, as long as there is no change in the distribution of weights inside the ship, the underwater volume of the ship won't change.

With these facts, we can comfortably assume that the displacement and under water volume of the ship does not change while at sea (Ignoring small changes due to fuel consumption).
Now combining both the above facts, when there is drop in sea level at the stern

part of the ship (because of the ship's movement ahead), the stern part of the ship is bound to sink a little to displace the same amount of water which is equal to the displacement of the ship.

This partial sinking of ship is squat.

Having explained differently but easier way about Squat, Cushioning and banking effect, here going one step ahead, I am going to explain the interaction between the two ships when in narrow channel using the same basic concepts used in my last article.

As we all know, interaction is how two ship behaves wrt to each other when both moving in narrow channel and is critical situation in ship handling and more so for students naïve to the profession. I hope this article be of help for fresh students to understand the concept of ship handling following the concept they know from their knowledge prior getting into this profession. This will make teachers' life also easier to explain the ship handling to fresh (as well as experienced) students.

Now here is the explanation how ships interacts in narrow water.

Interaction means how two ships behave when passing side by side in narrow channel.

Possible scenarios

• Both ships moving in opposite direction

• Both ships moving in same direction

When both the ships are moving in opposite direction:

Situation 1: Bow close to Bow

Since both the ships are moving ahead, both would be pushing the water ahead causing rise in water level at bow of both the ships. So when both the ships are in close range (Bow to Bow), it is a scenario where water walls (at the bow of both the ships) are going to hit each other causing further rise in water level between the two ships and pushing bow of both the ships away from each other in the direction of the water flow away from each ship's bow towards respective bank of the channel on opposite side, which is at lower level when compared to water level between bow of both the ships. (Remember the simple rule, narrow the gap more would be the water level e.g Tsunami waves at near to the shore).

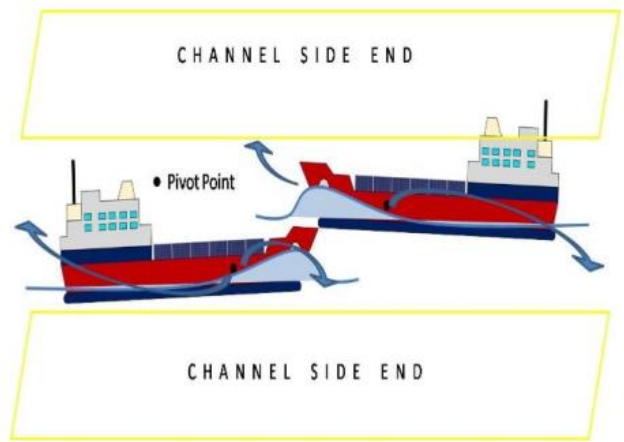

Figure 1: Bow to Bow in Narrow channel

Now when bow moves away from each other, obviously stern would move in the opposite direction rapidly i.e. towards each other (means stern of both the ship moves into course of other ship) Please note that location of Pivot point which is forward of 1/4th of the length of the ship from the bow, helps in this swift swinging of the stern of the ships. (See the explanation of (Pivot point at the end of this article).

Action Required

To control the swift movement of bow away from other ship, helm has to be given towards the other ship, so as to maintain the ship heading on course i.e. somewhat parallel to each other. Here higher water level between the two ships helps to keep them away (Kind of cushioning effect) while helm movement helps to straighten the ship's heading/course.

Situation 2: Both ships parallel to each Other

When bow aligns with the middle part of other ship, it is a situation where bow of one ship is approaching stern of other ship. In this case the water wall at bow of each ship is being pushed forward continuously and since water at the stern of other ship is at lower level, water finds the easiest route to level down by flowing towards the stern of other ship. This would also cause bow to slightly swing towards the stern of other ship. (Mind it; it is applicable to both the ships). This will also cause stern to swing away from bow of other ship because of

i) Pivot point and
ii) Water flow past stern of other ship.

NOW IMAGINE, both the ships' bow swings towards stern of other ship AND stern of each ship would be swinging (under the effect of Pivot point) away from other ship.

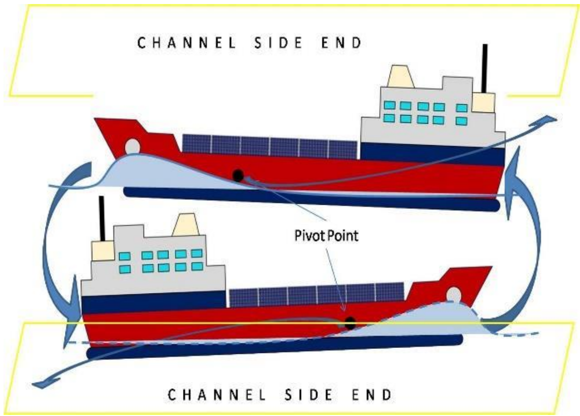

Figure 2: Side by side in Narrow Channel

In this case, it feels like both the ships are aligning with the wake/path of other ship.

Action Required

Continuous monitoring is required to prevent ships swinging too fast into other ship, before both are past clear of each other. Helm to check swinging of the ship's bow into the stern of other ship would be required, just enough to maintain course parallel to each other.

CAUTION: If swing is not controlled, it is quite possible that stern might come in contact with the end of the channel or into shallow water towards the side ends of the channel. AND on the contrary

If too much helm is given, it could cause stern to swing towards other ship faster in an effort to prevent bow swing, because stern is moving under the effect large lever from pivot point.

Situation 3: Stern close to stern of other ship

Continuing from previous situation where both the ships are parallel to each other. As stern of both the ships are coming closer previous helm (away from other ship) has to be neutralized to prevent stern moving swiftly towards stern of other ship (Always remember here lever up to stern from pivot point is larger than normal).

Both the ships should aim to align the course into the middle of the channel.

Here since water level at the stern (of both ships) is also expected to be same, we do not expect stern movement because of water level difference or flow of water, but nevertheless it is possible if there is large difference in size of both the ships.

Now to understand two important characteristics of ship movement

Wheeling Effect (Transverse Thrust)

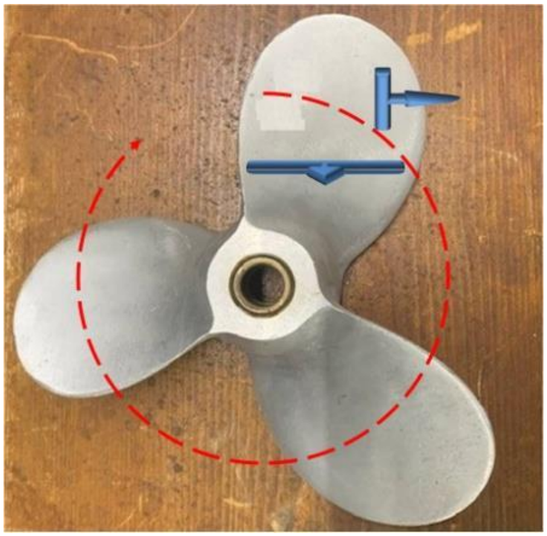

Figure 3: RH Propeller

Understand step wise

- ➢ Right handed propeller moves clockwise (When seen from astern of the ship) to push the ship ahead.
- ➢ This causes water, when seen from rudder side, being pushed away from the ship. (Imagine the same by seeing the picture of the above RH propeller)
- ➢ Going by the rule (To every action, there is equal and opposite reaction), ship moves in the forward direction.

I am sure this much is understood, as it is not very difficult to imagine.

Next is to understand the wheeling effect

- ➢ Since propeller blades are not flat, blades pushes the water in both longitudinal (i.e. right astern of the ship to give ahead movement to ship) and in the athwartship direction (i.e. towards Port & Starboard side of the ship) as shown in the picture with the help of arrows. Ahead speed is the resultant of water pushed in the astern direction and wheeling effect (or transverse thrust) is due to the water pushed in the athwartship direction.
- ➢ When propeller is rotating, upper half of it is in shallow water as compared to the lower half of the propeller. That is because lower blades are at deeper level than upper blades.
- ➢ Upper blades in the shallow water pushes the water towards starboard side of the ship and lower blades in the deeper water pushes the water towards port side of the ship. (Same principle here as well, to every action there is equal and opposite reaction)
- ➢ Since the propeller is rotating at same speed, the thrust produced by blades at deeper side is slightly more than the thrust produced by the blades at shallow side because the resistance overcome by the blades at deeper side is more as compared to resistance at shallow side of the propeller blades. OR you can also understand that this is because of pressure at lower half of the propeller is more than that at the upper half of the propeller.
- ➢ SO, when moving in forward direction, the stern of the ship slightly swings/moves towards the starboard side of the ship (Because of the resultant transverse thrust of upper and lower blades).

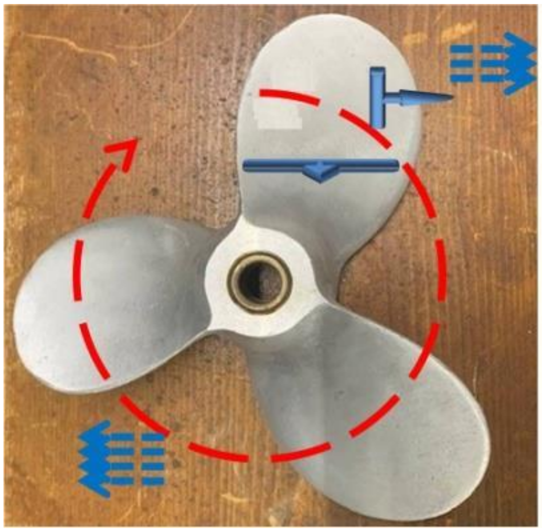

Figure 4: RH Propeller with difference in Longitudinal and Transverse thrust

- Location of Pivot Point at approx 1/4th length from bow (when ahead movement is started) provides big lever and helps in this starboard canting of the ship i.e. transverse thrust.
- As the speed of the ship increases, this effect becomes negligible as compared to head movement of the ship and is not felt to that extent.

Why It is important to understand this in the context of ship in shallow water

a. In shallow water difference in thrust produced by upper half and lower half of the propeller is comparatively more than in deep sea.
b. Speed at which ship is moving is less as compared to speed followed at deep sea causing transverse thrust even more prominent here.
c. Pivot point is still forward of 1/4th point from the bow in shallow waters.

Pivot Point: Going by the definition, we know pivot point is the point at which ship would pivot or rotate. So it is kind of balancing point on which ship rotates/turn when moving in water.

It's easier to grasp the definition as it is, but for students it becomes difficult to understand the location of the same while learning maneuvering of ship. Since pivot point plays a very important role in maneuvering of ship, student should be able to judge the approximate location of the pivot point, if not exact location, to be able to grasp the reason behind the ship's behavior in particular condition and situation.

Here I am trying to explain the same with the help of lever, which I am sure, will be helpful for students (and others) to judge the pivot point location.

As we know very well, that water level around ship is not same all the time, reason might be that ship is trimmed, ship is moving (ahead or astern or even when turning) except when ship is upright at even keel in calm water in stopped condition.

When ship is trimmed, it is obvious that water level would be different. We have seen in above interaction explanation that, when ship is moving ahead, it actually pushes the water ahead and that causes rise in water level ahead as long as ship is moving ahead. (That means difference in water level even for EK ship when moving ahead).

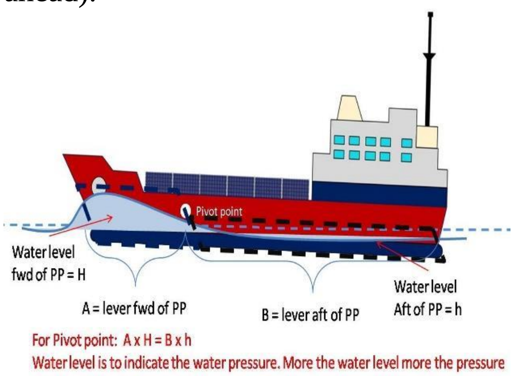

Figure 5: Lever from pivot point on moving ship

As seen in this picture, ship is moving ahead. This causes rise in water level at bow which gradually drops towards the stern (shown in the pic). In shallow water this difference is very much prominent and visible as compared to ship in open sea, where difference is less.

So going by the above, It becomes easier to judge the location of PP by following the thumb rules as follows:

a) Zero speed means, drafts F&A will affect the PP, Ship trimmed by stern will have PP slight aft of the miship point of the ship.
b) Speed causes the water level rise at the bow. More speed means higher water level at the bow and thus PP will be forward of Midship.
c) Shallow depth of water (when ship is moving) exaggerates the affect as water level rise at the bow is higher than that in open sea. So PP is expected to be still fwd of the location as when ship is in open sea at same speed (Please note we generally assume as 1/4th from bow of the ship when in open water).

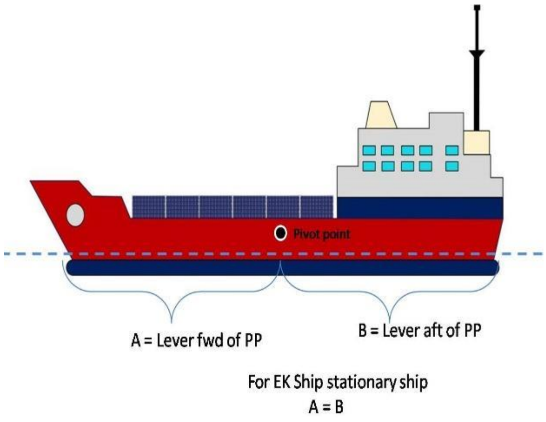

Figure 6: Lever from pivot point on stationary EK Ship

Why It is important to understand this in the context of ship in shallow water:

In shallow water because of rise in water level ahead of the ship causes PP to shift even more forward as compared PP in deep sea, thus creating larger lever between PP and stern of the ship.

Recap of Facts which are basis of explanation in this article:

a. Ship moving ahead would cause rise in water level at bow of the ship, more so in shallow waters.
b. Water always flows from higher to lower level
c. Water takes the easiest/fastest route to lower level
d. Any floating object in water will also flows in the direction of the water (Like we know drifting in shipping terms)
e. There won't be change in the underwater shape of the ship as long as there is no change in the weight and weight distribution on it.

References

[1] Internet for suitable picture of ship for the drawings in the article.

EXERGY ANALYSIS OF WASTE INCINERATION PLANT USED IN MARINE VESSELS

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ABSTRACT

The marine incinerator is a third group of continuous combustion devices for the disposal of waste oil and sludge from machinery systems and oil contaminated materials. Domestic garbage and some cargo associated solid wastes, and in some cases even sewage, are disposed of by incineration. Marine pollution regulation Annes I, encourages the use of incineration by permitting the required engine room sludge tank capacity to be significantly reduced. This marine incinerator is an oil-fired spinning cup burner with efficiency in the range of 75-85%. Assessment of exergy loss aims to identify the process and components of exergy losses in a system. The irreversible creation of entropy induced by the nonideal performance inherent in the waste oil disposal systems and components causes these exergy losses throughout the system. The approach adopted evaluates the existing incineration system, and exergy is calculated based on a final heat-sink reference. The maximum work available is in the initial energy source of the system. The highest irreversibility is found at the combustion chamber and the exergy loss is 32010.503 kJ. A computational fluid dynamic study of the existing spinning cup burner is performed to investigate the enhancement of the combustion process. Atomization is visualized by the thermal and velocity contour of the fuel stream through the nozzle of the burner of this incinerator.

Keywords

Exergy analysis, exergy loss, rational efficiency, atomization, incineration.

Introduction

The Sun flame incinerator unit installed at ship-in-campus Prabhu-Vidya Tolani Maritime Institute, Pune is a capacity of solid waste disposal is 50 kg/hour and liquid waste oil is 64 lit/hour. It is the most recent addition to the rotary cup burning system. The pre-mix flame with primary air and secondary air from induced draft fan is a combination of tried-and-true heat transfer techniques. Light Diesel Oil (LDO) is used in this boiler, which is fed via a gear pump for main burner with 75 kg/hour capacity. High speed diesel oil is used for initiation of flame through pilot burner which is energized up to 7 to 10 kV tension.

The irreversibility of distinct components of this incinerator is revealed in this investigation. Refer to Figures (1 and 2) and Table 1, the input streams of fuel, air, and waste oil with their associated pumps are considered, and the output streams of exhaust created and heat energy. The rotary cup burner is explored in a computational fluid dynamic simulation with a light diesel oil combustion.

Figure 1: Incinerator

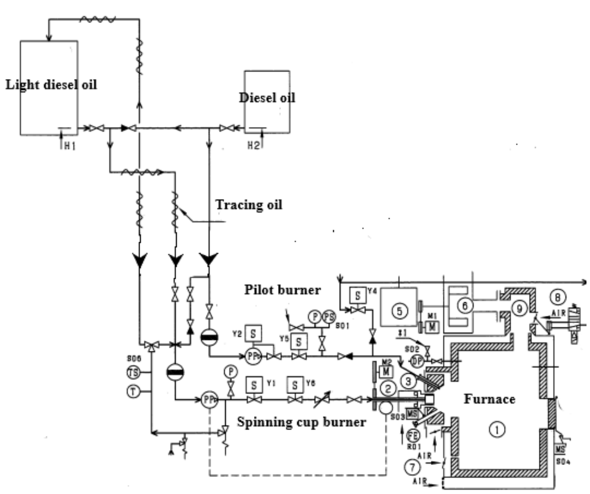

Figure 2: Fluid flow of incinerator

1. LITERATURE REVIEW AND OBJECTIVE

In Ahern's [1] "book on the exergy method of energy systems analysis," the author used the enthalpy-entropy diagram to depict the results of a power plant's exergy analysis. Moran [2] stated, "availability is the maximum amount of work obtainable from the combined system as the control mass is brought into equilibrium with the environment." George Tsatsaronis [3] defines several terminologies used in exergy analysis and exergy costing, analyses symbol alternatives for exergy and other exergoeconomic variables, and gives wording for the remaining terms. As per S. K. Som et al. [4], "internal thermal energy exchange linked with high-temperature gradients induced by heat release in combustion reactions is a key source of irreversibility." An advanced exergetic study was performed by Aline Bhering Trindade et al. [5] to discover the potential for improvement in the incineration steam cycle. Exergy destruction was categorised into four categories: endogenous, exogenous, preventable, and unavoidable. With all of this, it was determined that overall plant exergy destruction could be decreased by 8.4% by increasing plant component efficiency while using the best available technologies and operating settings, resulting in an avoidable total cost of \$2′830,624 per year. In T. J. Kotas' book [6], the author creates a thermodynamic exergy load and calculates the rational efficiency of thermal plant components. When compared to the plant configuration without flue gas recirculation in the marine incineration system, Giorgio Vilardi et al. [7] proposed that flue gas recirculation guarantees a higher level of energy recovery (up to +3%) and, at the same time, lower investment costs for the lower flow rate of fumes actually emitted. Industrial steam boilers established a methodology for analysing thermodynamic exergy properties and exergy input and output resources. Using a commercial flux heating simulator, Giuseppe Liuzzo et al. [8] conducted simulations of two incineration processes, with and without flue gas recirculation. The simulation results show that the proposed technique allows for a higher degree of energy recovery (up to +3%) while also lowering investment expenditures in the equipment and machinery that make up the plant's air pollution control section. A numerical example of mercury emission quantifies the previously mentioned issues and shows that flue gas recirculation reduces mercury emissions by 50%. Shikalgar et al. [9] conducted the comparison of the wire tube condenser to the hot well condenser; it is concluded that the hot-wall condenser will increase more heat flux into the refrigerator cabin. N.R. Kristiansen et al. [10] investigated a maritime waste incinerator for waste heat harvesting using thermoelectric generators (TEG). The application was assessed using mathematical modelling to optimise the heat exchanger and a few important TEG design parameters. When optimising for maximum power, an 850-kWth incinerator can extract 58 kWel at a cost of 6.6 US$/W, according to the estimate. The flow parameters and physical behaviours of particles through nozzles have been numerically examined, as shown by Pal et al. [11-12]. According to a computational fluid study of combustion, inappropriate air circulation causes reduced heat transfer at the water tubes boiler.

The objective of the study of this waste oil incinerator is to identify the components with highest exergy loss. The rational efficiency of the incinerator and fluid flow in the rotary cup burner will enhance the incineration of waste oil and solid waste.

2. MATERIALS AND METHODS

Assessment of exergy loss rate in the marine incinerator to analyze the performance of waste disposal plant by the exergy method is carried out and shown in Figure (2) and (3). The following steps are followed:

a. Mass balance and energy balance of various components of the incinerator is satisfied and presented in figure (4) and (5).
b. A long narrative form is used that discusses each process and calculation in detail. Then the analysis is made in the block form, and finally, the estimate alone is summarized in tabular form. Results of these calculations are tabulated in the recommended table 1 document that shows the location and type of all exergy losses in the system.
c. Computational fluid dynamic is performed to calculate the optimum fuel velocity for better atomization.

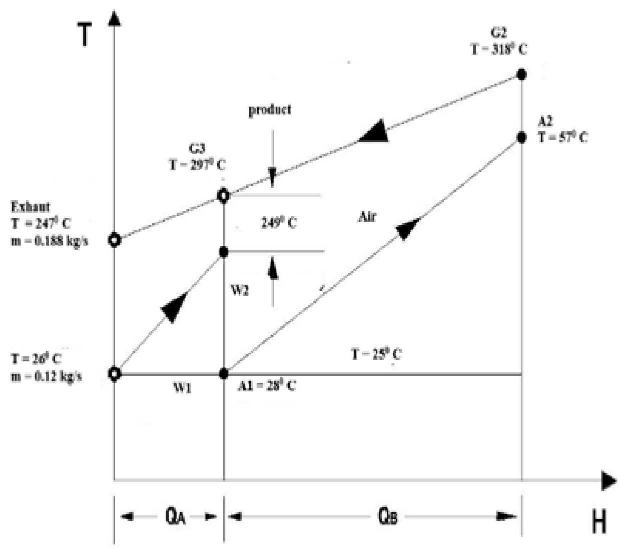

Figure 2: Enthalpy-temperature of incinerator

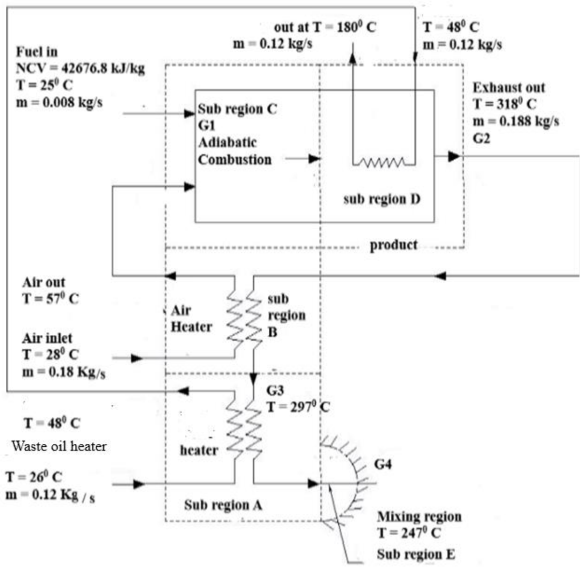

Figure 3: Schematic diagram of incinerator

2.1 Experiment on Incinerator

This incinerator of Sun flame OSV 30 capacity of 30 kg/hour installed at Tolani Maritime Institute, Training Ship Prabhu-Vidya operates for one hour then the steady operation is established. In this process, the fluid flows through a controlled volume steadily. Experiments were conducted for parametric analysis of parameters such as pressure, the temperature of jacket water and the fuel flow through the rotatory cup burner. The various parameters of the experimental investigation are shown in Table 1 and Figure 2.

Mass and energy balance of Incinerator

A. Incoming stream to control volume

Sub-region **A**, waste oil heater: mw x Cpw X Tw - - - (1)

Waste oil heater: 150.88 kW

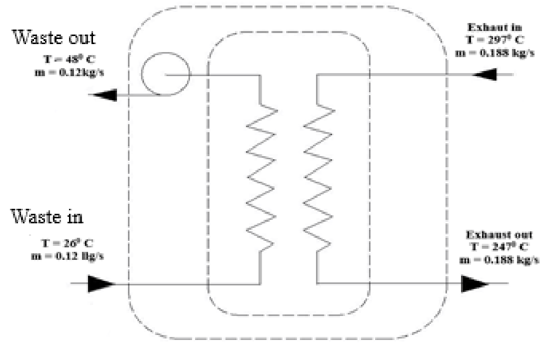

Figure 4: Mass and energy balance of Waste oil heater

Subregion **B**, Air preheater: ma x Cpa X Ta - - - (2)
Air preheater: 55.2 kW

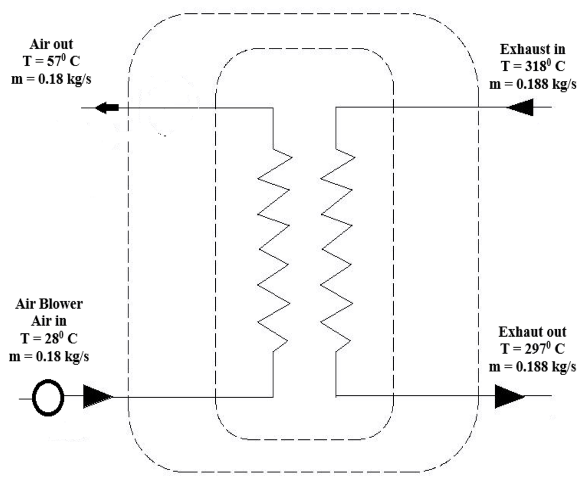

Figure 5: Mass and energy balance of Air heater

Subregion **C**, Fuel combustion at the furnace: mf x NCV
Fuel combustion: 341.78 kW

B. Outgoing stream to control volume

Sub region D, exhaust generation: ms x Cps X Ts - - - (3)
exhaust generation: 333.64 kW
Sub region E, Exhaust gas out: mg x Cpg X Tg - - - (4)
Exhaust gas: 103.62 kW

3.1.2 Mass balance of Incinerator

Incoming stream mass = outgoing stream mass
mw + ma + mf = msteam + mg - - - (5)
0.308 kg/sec = 0.308 kg/sec

3.1.3 Energy balance of Incinerator

Incoming stream energy = outgoing stream energy
Refer to figure 4, and 5 and equation (1-5)
547.86 kW = 437.27 kW + 110.59 kW (cooling loss)

2.2 Exergy balance of incinerator

B. Incoming stream to control volume

The system of this incinerator is performed by evaluating the losses in work associated with components process and operating procedures. The transmission of thermal exergy between two streams in air, water, or steam generator occurs by conductive, convective, or radiant heat transfer. An exergy efficiency is also considered in this analysis.

$\phi = 1.0401 + 0.1728(h/c)$ - - - (6)
Chemical exergy of the LDO ϕ = 4541.65 kJ / kg

3.2.1 Exergy balance of sub-region A

$I_A = (E_{G3} - E_{G4}) - (E_{W2} - E_{W1})$ - - - (7)
Exergy balance of sub-region A, I_A = 9.697 kJ

3.2.2 Exergy balance of sub region B

$I_B = (E_{G2} - E_{G3}) - (E_{A2} - E_{A1})$ - - - (8)
Exergy balance of sub region B, I_B = 1.8104 kJ

3.2.3 Irreversibility of the combustion process sub region C

$I_C = E_{F2} + E_{A2} - E_{G1}$ - - - (9)
Ic = 32010.503 kJ

3.2.4 Exergy balance of sub-region D

$I_D = (E_{G1} - E_{G2}) - (E_{S2} - E_{S1})$ - - - (10)
I_D = 12242.519 kJ

3.2.5 Exergy balance of sub-region E

$I_E = E_{G4}$ - - - (11)
I_E = 1966.826 kJ

3.2.6 Rational efficiency of the plant

$\Psi = E_{s2} / E_{f2}$ - - - (12)
Ψ = 0.043 = 4.33%

Table 1: Exergy analysis of sub-region of incinerator

Subregion	Exergy Input kW	Exergy Output kW	Exergy loss kW	Exergy efficiency
A	13.056	3.358	9.697	25.71%
B	3.845	2.035	1.81	53%
C	45417.14	13407.03	32010.5	30%
D	13407.03	2802.72	12242.51	20.90%
E	45417.14	1966.82	43450.32	4.33%

2.3 Computational fluid analysis of rotary cup burner cup

The Ansys 13.2 code is used to do numerical calculations on the rotary cup burner. This software Ansys 13.2 solves the Navier-Stokes equations in dynamic form. The effect of atomization of fluid flow over the burner nozzles illustrated in figure (7-9) is studied using the conventional k–w turbulence model. In this K-omega model, the standard model with the two-step reaction is used for the atomization analysis. The X-Y plane geometry of a rotary cup burner with cup diameter R = 0.5 mm is used for validation with experimental results. Refer to Figure (6) and Table 2.

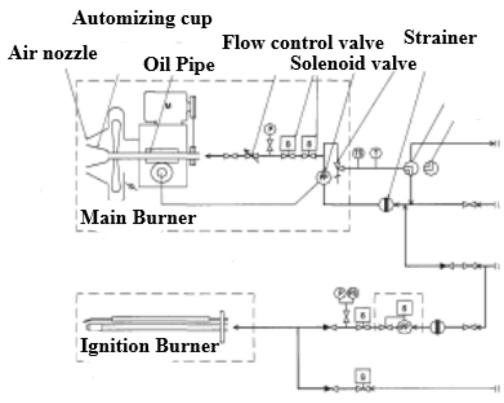

Figure 6: Rotary cup and ignition cup burner

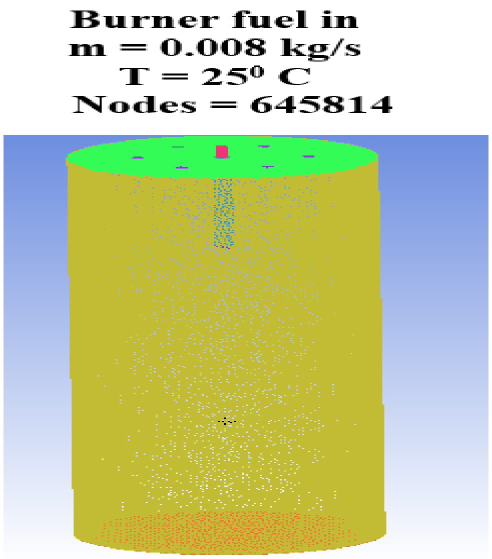

Figure 6: Meshing of the rotary cup

2.4 Burner meshing

Rotary cup burner meshing is carried out with Tetrahedrons. Single Step reaction model is used for the solver. Refer to figure (6)

The meshing cardinals are as follows: -

Table 2: The meshing of the rotary cup

Sr no.	Cardinals	No. of elements
1	Number of Tetrahedrons	3279055
2	Total Number of Faces	359088
3	Total Number of Elements	3279055
4	Enthalpy per [mol] of Total Number of Nodes	645814

3. RESULTS AND DISCUSSION

The exergy loss is calculated using the incinerator parameter and computational fluid analysis of the burner cup is performed by using equations (1-12). An exergy assessment based on the thermodynamics' law was implemented in this research from the incinerator experiment data. Figure (7) depicts the stream's energy input and energy loss in the sub-region of the system. Figure (8) represents the fuel velocity curve in the cup region, with increasing velocity near the cup output. Figure (9) depicts the temperature distribution at the burner cup. Figure (10) depicts the fuel automation in the X-Y plane. At a cup diameter of 4 mm, fuel atomization is at its best. A variable of momentum and mass with a time step is depicted in Figure (11).

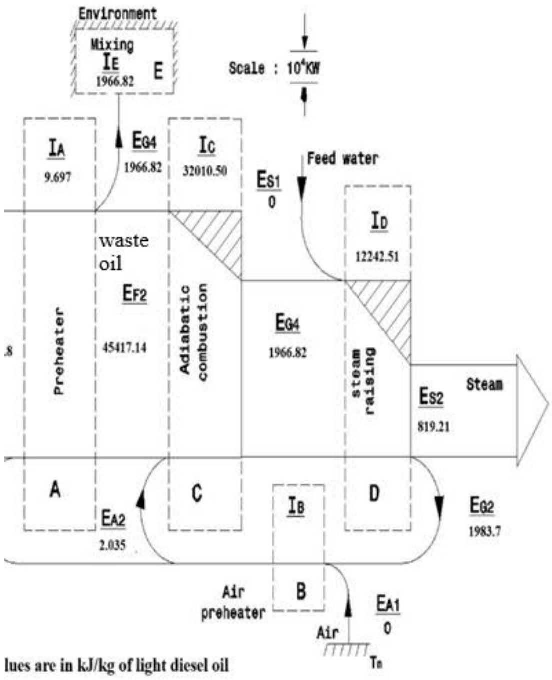

Figure 7: Grossman diagram of incinerator

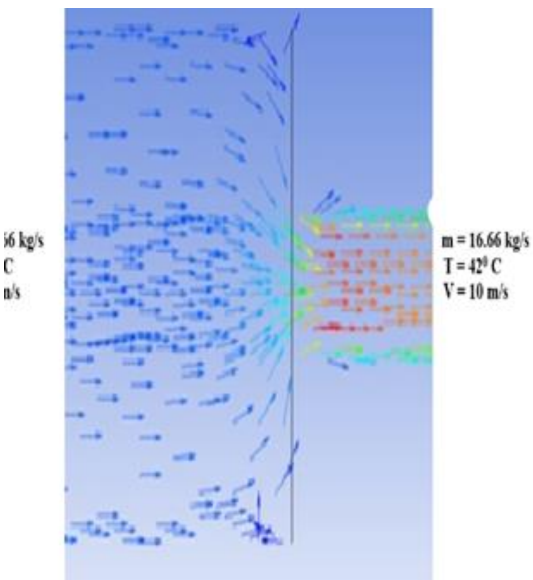

Figure 8: Velocity contour of fuel of burner cup

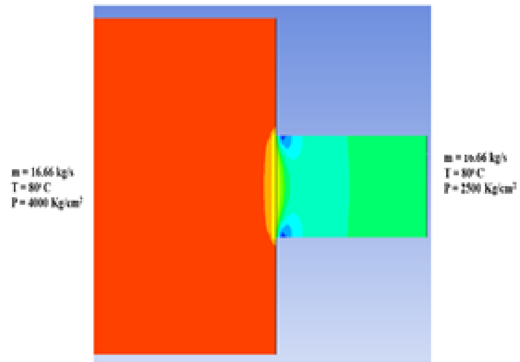

Figure 9: Temperature of the fuel flow of burner

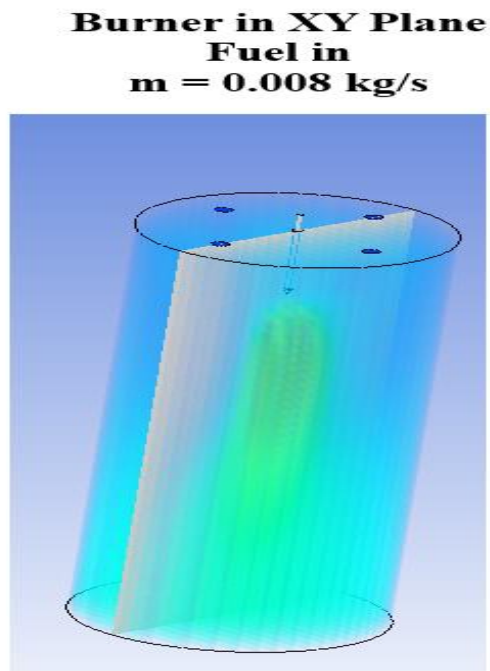

Figure 10: Atomization of fuel in the X-Y plane of a burner cup

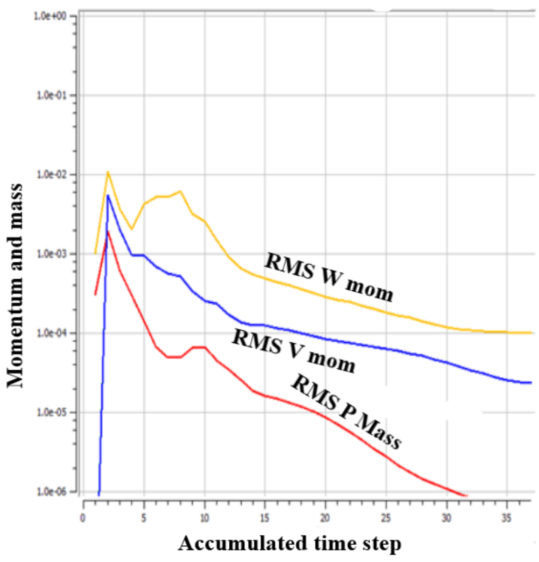

Figure 11: Variation of momentum and mass with an accumulated time step of the burner cup

4. CONCLUSIONS

This study was conducted on an incinerator to determine the thermal performance indicator with various components irreversibility, and the following conclusions were reached: -

a) The results of energy balance between incoming and outgoing streams are in equilibrium with a loss of 110.59 kW due to heat dissipation.
b) The analysis of the experiment revealed that the incoming and outgoing stream mass is conserved and noted to be 0.308 kg/sec.
c) The maximum irreversibility is found out at the combustion chamber is 32010.503 kJ due to uncontrolled chemical reactions.
d) The rational efficiency of this incinerator is 4.33%.
e) Energy analysis of heat exchanger of waste oil heater, air heater and exhaust generator are found to be in equilibrium condition.
f) The numerical analysis shows that the steam-assisted burner cup is enhanced fuel atomization with an increased velocity of 10.272 m/s.

ACKNOWLEDGEMENTS

This study takes place on the Tolani Maritime Institute's ship-in-campus in Induri (India). The authors are grateful to Dr Sanjeet Kanungo (Principal) and the rest of the staff for their unwavering support and advice.

NOMENCLATURE

ϕ	Chemical exergy	[kJ]
Ψ	Rational efficiency	
mw	The mass flow rate of feed water [kg/h]	
ma	The mass flow rate of air [kg/h]	
mf	The Mass flow rate of fuel [kg/h]	
msteam	The Mass flow rate of steam [kg/h]	
mg	The Mass flow rate of exhaust gas [kg/h]	

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GRID CONNECTED SOLAR PHOTOVOLTAIC SYSTEM: A CASE STUDY

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ABSTRACT

This paper gives brief idea of grid connected solar photovoltaic system in Indian scenario. Traditionally electricity is generated and used by conventional energy sources like coal. If renewable sources like solar are used or connected with traditional system then pollution control and clean energy can be obtained. While considering grid connected system, metering, other assembly like inverter set-up and battery charger with battery set-up plays important role.

Keywords

Grid –interconnection of electricity distribution system, SPV-solar photovoltaic system

Introduction

Electrical grid is interconnected network for transmission or delivery of electricity from generation station to consumer end. India initially was having five sectors of grid such as -Northern, Eastern, Western, North Eastern and Southern region. In 2003 all five regions or sectors are interconnected to make India as one electrical grid. Renewable energy sources like solar and wind, most of the times act as standalone or individual systems as energy providers. As all renewable energy sources are situation and territory dependent, they might not fulfill the energy needs of all the times. So whenever renewable energy sources are not available or available with low intensity grid energy can fulfill the energy requirements. Grid connected renewable energy sources are more effective and are able to maintain continuity of power supply. If electricity produced by grid is excessive, it can be fed back into the grid. Here "Net-metering" of electricity is considered. Electricity tariff is the difference between electricity used from grid and electricity provided to grid. This eliminates the expenses of electricity storage devices like batteries. This paper considers solar energy connected to grid energy.

1. SOLAR ENERGY AS RENEWABLE ENERGY:

Solar energy can be used as thermal energy and as electrical energy. Solar collectors convert solar radiation into heat, which can be utilized for various applications. Solar Photovoltaic converts solar energy into electricity using semiconducting materials that exhibit the photovoltaic effect. Here solar PV system is considered for electrification of individual houses or as standalone system. There are different types of solar cells, which forms solar panel and later array, which converts solar energy into electrical energy.

Different types of solar cells like Crystalline silicon cells, Monocrystalline cells, Polycrystalline cells, Thin film solar cells are used to form solar panel. In these panels, cells are connected in series and parallel combination to fulfill load requirement.

2. BASIC GRID CONNECTED SOLAR PHOTOVOLTAIC SYSTEM AND RELATED EQUIPMENT

This system is possible with and without the use of batteries. Figure.1 shows the system without batteries and Figure.2 shows with batteries.

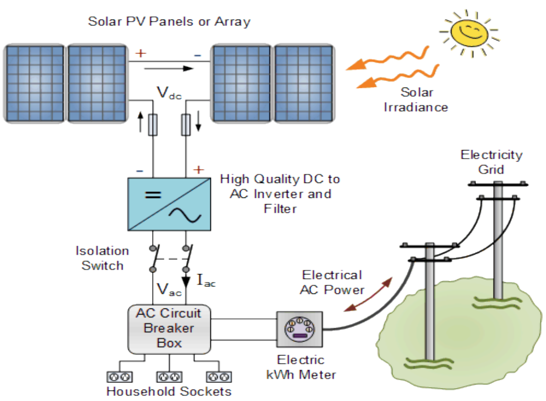

Figure 1: Grid connected solar photovoltaic without batteries

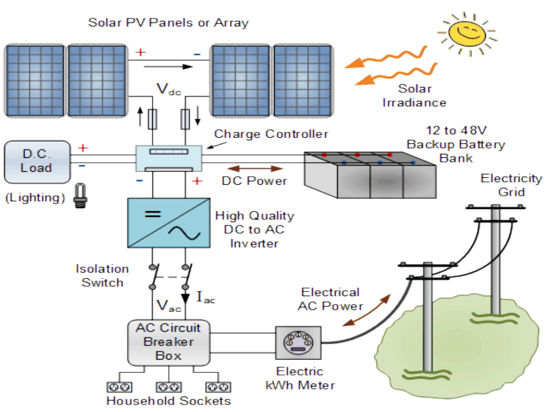

Figure 2: Grid connected solar photovoltaic with batteries

A PV system with battery storage is basically the same as for the grid connected PV system with the addition of the batteries and charge controller. The battery charge controller determines whether the power generated by the solar panels is needed for home use, to run low voltage equipment and lighting or whether it will charge the deep-cycle backup batteries to be used later on. The DC current leaving the controller passes through the DC to AC inverter, transforming it into electricity usable by general household appliances. Any surplus electricity not being consumed or used by the home can be sent to the electricity power grid.

Assembly required for connecting RE energy, here solar photovoltaic energy with grid system and the load is called as "Balance of System". Following units are required as a part of BOS. Except solar PV array system, reaming is called as BOS.

1. Power conditioning equipment
2. Safety equipment
3. Meters and instrumentation

2.1. PV array and electrical grid: by considering the load requirement of house or standalone load, PV array system is installed. Existing grid is taken into connection with solar PV system.

2.2. Power conditioning unit: Solar Power Conditioning unit (SPCU) is an integrated system that provides the facility to charge the battery bank through either a Solar or Grid. An SPCU (solar power conditioning unit) will consist of the following parts: Solar charger, Inverter, Grids (main utility) charger, Output selector mechanism, Battery mechanism, and Control algorithm.

Inverter: Inverter converts DC into suitable AC with proper frequency to match with grid.

2.3. Safety Equipment: AC Breaker Panel and Fuses: The breaker panel or fuse box is the normal type of fuse box provided with a domestic electricity supply and installation with the exception of additional breakers for inverter and/or filter connections.

Safety Switches and Cabling: A photovoltaic array will always produce a voltage output in sunlight so it must be possible to disconnect it from the inverter for maintenance or testing. Isolator switches rated for the maximum DC voltage and current of the array and inverter safety switches must be provided separately with easy access to disconnect the system. Other safety features demanded by the electrical company may include earthing and fuses. The electrical cables used to connect the various components must also be correctly rated and sized.

2.4. Metering system: Electricity Meter system: The electricity meter also called a Kilowatt hour (kWh) meter is used to record the flow of electricity to and from the grid. Twin kWh meters can be used, one to indicate the electrical energy being consumed and the other to record the solar electricity being sent to the grid. Also, a single bidirectional kWh meter is available to indicate the net amount of electricity taken from the grid. With a grid-connected system, when renewable energy system generates more electricity than requirement, at that moment, the electricity goes onto the electric grid for utility to use elsewhere. Net metering provides benefit to a consumer. In this, a single, bi-directional meter is used to record both electricity consumed from the grid and the excess electricity fed back into the grid. The meter spins forward when electricity is used from the grid, and it spins backward when RE generation exceeds and fed into the grid. Electricity tariff is difference between consumed units from grid and provided RE units to the grid. In case, provided units to grid are more than consumed units, power Provider Company pays for extra units fed to grid, based on terms and conditions.

3. CASE STUDY FOR DOMESTIC LOADS

For a family of 5 people (Indian scenario) in house, with 5 to 6 units consumption of electricity per day, required solar panel setup is estimated.

Table 1: appliances and units consumed per month

Appliance	Minimum wattage	Minimum units consumed in an hour	Number of hours of working of appliance per day	Total units per month
Air conditioner	800 W (optional)	0.8 KWh	3	72
42 inch LED TV	110 W	0.11 KWh	4	13.2
Ceiling fan	60 W	0.06 kWh x 4 =0.24 kWh	6	43.2
Fridge/Freezer	150 W	0.15 kWh x24 = 3.6	24	40 assumed
LED lamp bulbs	7 W	0.007 kWh	12	2.52
Electric geyser	1000 W	1 kWh	1	30

Total units consumed approximately in a month= 200.92

Number of units consumed per day = 200.92/30 = 6.69 kWh

In general,1 kW of solar panel has 3 PV panels each of 330 Wp, hence each solar panel generates **1.33 KWH** of electricity in a day and 40 KWH of electricity in a month.

So number of panel required are = 5 to 6 in number

Above calculation gives idea of SPV system for domestic purpose. Extra units are generated can be provided to grid or power company. In short system will look as below –

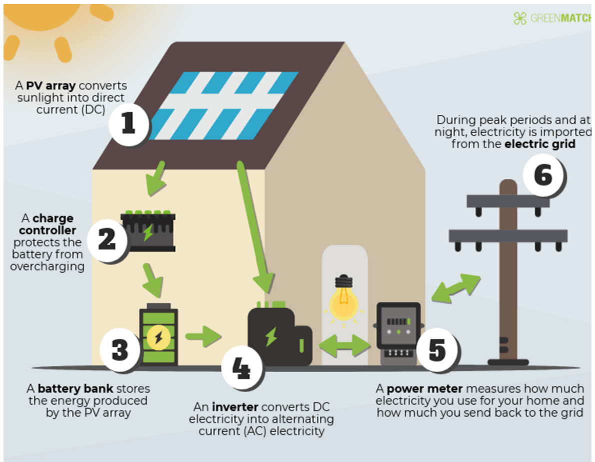

Figure 3: Grid connected SPV for individual house with all assembly

CONCLUSION

This paper gives introduction of grid connected system and estimate of solar panel required for individual housing. Scope for work here is to calculate reduction in electricity tariff by considering different states and different power providers. Later trading of electricity concept will be implemented and consumers will be free to trade electricity units with respective power providers.

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EMPLOYABILITY-BRIDGE: THE NEED OF 2030

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ABSTRACT

There is a cutthroat competition in the techno-world, and the employability of a graduate has become a challengeable task for the technical institutions. The colleges are taking various training sessions for their students to improve employability skills. The proposed approach E-Bridge (Employability – Bridge) fulfils the industry requirements and further meets the Graduate Attributes for Outcome-Based Education as given by the National Board of Accreditation (NBA).

This approach has been implemented in the first and second year of B.Tech Marine Engineering and Nautical Technology undergraduate degree program at Tolani Maritime Institute – Marine Engineering College located in Pune. In this paper, a practical survey resultbased on Graduate Attributes mapping is clearly shown. It has been observed that the employability skills of students have improved further with E-Bridge

Keywords

Outcome-based education, Employability-Bridge, Enhanced Employability Bridge, Graduate attributes (GAs)

1. Introduction

In the present scenario, finding an engineering graduate with enough subject knowledge and excellent business skills has become a difficult task [1]. It is very rarely an employable graduate can be found [4] [5]. There is a vast improvement in engineering from the last several decades, and at present, the prominence is given to the employability of an engineering graduate. Even now, there is a need for innovative methodologies to improve the education system so that the institutions generate industry-ready graduates. Outcome-based education is one of the approaches widely used. Findings of the NASSCOM-McKinsey Report 2005 indicate that while more than three million students graduate from Indian colleges and the nation produces 500,000 engineers annually, only a very small percentage are directly employable by the industry. Only around 25 per cent of technical graduates and 10-15 per cent of other graduates are estimated to be suitable for employment in the offshore IT and Business Process Outsourcing industries [2]. Industries expect more creativity and life-long learning from graduates to be recruited [3]. A considerable amount of investment is made on graduates to fill the gap by training them. The National Board of Accreditation of India adopted Outcome Based Education (OBE) which expects a graduate to have specific attributes by the time one graduates. These attributes include the following [7]:

- GA1. Engineering knowledge
- GA2. Problem Solving Skills
- GA3.Design/Development for Engineering solutions
- GA4.Conduct investigations of complex problems
- GA5. Modern tool usage
- GA6. Engineer, Safety, and Society
- GA7. Ethics
- GA8. Environment and Sustainability
- GA9. Individual and Teamwork
- GA10.Communication

GA11. Project Management and Finance

GA12. Lifelong Learning

Some of the Graduate Attributes are met through an approach called E-Bridge which is already in practice in our institution. The four activities of E-Bridge are (a) Group Discussion (GD) (b) Debate (DB) (c) Two-minute Elevator Bite (EB) and (d) Case Study Presentation (CS) [6]. Outcome-based approach could be further enhanced to attain number of graduate attributes as compared to the earlier implementation. This paper discusses these enhancements that lead to an improvement in the attainment of Graduate Attributes (GAs).

2. Employability-bridge

The degree programme offered by colleges / universities is the bridge between a candidate and the industry. Universities and colleges play a crucial role of a facilitator of making the candidate industry-ready. However, the onus of transforming the raw candidate into an employable candidate lies not only with the serving institute/university but with the candidate as well. Therefore, all the stakeholders of this process need to look it positively. In today's job scenario, a practical approach towards making the candidates employable is the need of the hour. The employability bridge is formed with such practical pillars which aims at sustainability in this competitive job market. The following image explains the employability bridge in detail.

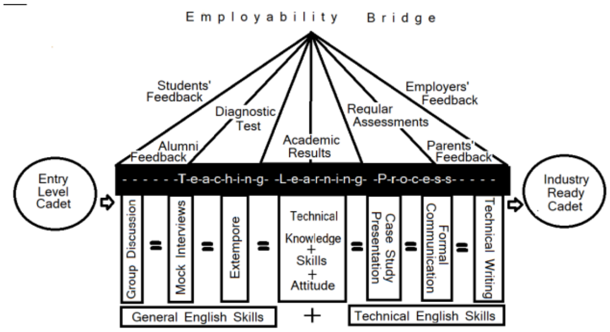

Figure 1. Block diagram of EE-Bridge

One of the essential factors of being employable is communication skills through which one can articulate employability. Moreover, communication in English plays a vital role in the life of a seafarer. The prospective seafarers have to be well-versed not only with general communication in English but Maritime English as well. The cadets at Tolani Maritime Institute (TMI) come from varied backgrounds. Their proficiency in English in most of the cases is not at par with others. Furthermore, poor English skills also create hindrance in understanding other core subject affecting their overall performance. To address this problem, the cadets are asked to take a proficiency test in English which helps the teacher in understanding the weak areas of the cadets. To improve students' communication skills, our college introduced a program called Employability bridge (E-bridge) in the year 2018-19. As a part of a syllabus, the cadets of the first-year study English course in the first semester which focuses on short stories, prose, drama, poem and basic grammar. The activity-based approach of teaching the texts helps the students improving their vocabulary and at the same time, finetunes their grammar and expressions. The fun-way of dealing with the English course also lightens the burden of information overload of the technical subjects.

Language is a practical life skill which helps in expressing oneself, solving problems, negotiating, public speaking and performing day to day tasks. The cadets at TMI also have to go through a practical course called Communicative English Lab, which focuses on the application of the language skills in life-like situations. These activities help the cadets in understanding how to deal with the situation in a professional manner using proper language skills. The course includes accent neutralisation, formal correspondence through emails and letters, reports on various situations, notifications, Standard Maritime Communication Phrases (SMCP), presentations, groups discussions, debates, and mock interviews, etc. All these activities are closely linked with employability prospects of the cadets.

It has been observed that students are acquiring higher levels of Bloom's taxonomy by participating in this programme. Though communication skills are essential, a step-motherly treatment is given to these skills not only by the students but many teachers as well. For them, only technical communication is essential and not just speaking in English. Hence, poor language skills are not taken seriously until somebody gets a setback from the industry or directly affect employment. Moreover, there is resistance in accepting the weaknesses and lack of positive attitude for working on it.

Nonetheless, because of the positive encouragement from the management, the attidude of teachers and students has changed. this has become a regular practice in all departments as the participation of students is very less when the option is given to them. English and communication skills are also integrated with other technical courses and Technical Paper and Project course is offered at a later stage of graduation where cadets have sufficient technical knowledge, and research attitude is developed amongst them.

The teaching and learning process is a road on the pillars of the employability bridge. It can be better controlled with the help of various strings like the feedback coming from employers, parents and mainly from the cadets, diagnostic tests, internal tests, results and analysis. All these strings help in strengthening the teaching-learning process and fulfilling the industry requirements. The feedback system keeps the teachers and trainers on their toes and helps them bring innovation in their methodologies and delivery of their lectures. These methods are further enhanced and implemented to improve the students' creative thinking and to attain more graduate attributes.

3. Proposed methodology

The idea is to make the cadets meet the challenges in the present complex and competitive world and make them industry-ready. In this paper, the proposed methodology is Employability Bridge which enhances the employability prospects of the candidates and hones their personality and skillsets to meet the industry requirements. In this, the cadets are put through various practical activities like Group Discussion (GD), Extempore (ET), and Mock Interviews (MI), which focus on general English and limited technical knowledge. Further, as cadets develop their technical skills, it is supplemented with technical English as well as subject-specific case studies, technical writing and formal communication at the workplace. Here, the cadets are expected exhibit a good command not only on the language skills but their main domain as well. This is a stage where the cadets are getting ready to become employable. This is a continual process, and both the language and technical teachers need to work together.

The employability bridge model is a continual process during the graduation period. A step-wise distribution of skillsets integrated with the regular teaching and learning process pushes the cadets towards becoming employable / industry-ready. It does not incur any financial investment on the part of the cadets or the institute but only a thoughtful investment on the part of teachers and instructors. In this process, the teachers and instructors play the role of a facilitator and allow the learning to happen a fun and exciting task. Here, cadets are allowed to use their creativity, existing knowledge, and experience under the guidance/observation of the teachers and instructors.

The beauty of this module is that it can be extended to all the courses under the university syllabus. The overall implementation can be easily understood by the block diagram given in figure 1. Here a topic or a puzzle is given to the students at the first level. After that problem analysis and development of solutions is done by the students at the second level. In the next level, the events are conducted and the assessment is done according to the scheme of evaluations of each activity. Sample assessments of the I and II year students for CGD and BEB are given in table 5 and table 6. After that results are published. Feedback through polling system is taken for any modification or any improvements to be considered from students. All these feedbacks will help for the efficient implementation of the entire E-Bridge process.

A. Group Discussion (CGD)

Group Discussion is one of the ways of testing the employability skills of candidates. Many companies use it as a tool for selecting suitable candidates for working in their working environment. Through this exercise, the companies check if the candidates have effective communication skills with a problem-solving attitude, people handling capabilities, leadership qualities, general knowledge, soft skills, and so on. In this activity, the groups for discussion are made with three categories A, B, C based on academic performance. Each group is given a topic to discuss well in advance so that the students can search for the information related to the topic. The teacher explains to them the dos and don’ts of the Group Discussion. It takes 30 minutes for this activity where the students are given ten minutes for preparing their points and 20 minutes for the discussion on the topic. The students are also expected to use the appropriate expressions suitable for the Group Discussion. This activity improves the team work and communication of students.

The scheme of evaluation of students is given in table 1.

No.	Attributes	Marks
1	Leadership skills / Team Player	10
2	Communication Skills (Non-verbal, i.e. Vocal & Body Language)	10
3	Problem solving skills/ Persuasive skills/ Reasoning Ability	10
4	General Awareness (content related)	10

5	Use of Language (Grammar, sentence construction, vocabulary)	10
	Total	50

Table 1. Scheme of Evaluation for GD

B. Debate (DB)

This activity helps the students to think about the pros and cons of any situation given to them. It also helps to increase their confidence levels in the students. In this activity, the topic is given on the spot and they are asked to discuss the positive and negative shades of the topic. This activity provides them with a platform for exhibiting their viewpoints using appropriate language skills. Formal or informal debate at times also helps in breaking the monotony of the class and develop interest. The students can also get in a competitive mood and will help in developing rational thinking, manners, organization of thoughts, presentations, persuasion skills and public speaking.

The evaluation of debate activity is done as in the table2.

No.	Attributes	Marks
1	Presence of mind	10
2	General Knowledge	10
3	Problem solving skills/ Persuasive skills/ Reasoning Ability	10
4	Confidence	10
5	Use of Language (Grammar, sentence construction, vocabulary)	10
	Total	50

Table 2. Scheme of Evaluation for DB

C. Extempore :

Prepared presentations give the students enough time to think and organise their thoughts properly. Impromptu speech or spontaneous speaking helps the students think and develop a presence of mind. It also helps their brain react fast to the situation.

No.	Attributes	Marks
1	Presence of mind	10
2	General Awareness	10
3	Problem solving skills/ Persuasive skills/ Reasoning Ability	10
4	Confidence	10
5	Use of Language (Grammar, sentence construction, vocabulary)	10
	Total	50

Table 3

D. Case Study Presentation (CS)

In the case study presentation, the students are given a project related to the latest trending technology from their respective branch. They are asked to prepare material regarding that project such as the technology involved, advantages and disadvantages etc. The material submitted by them is thoroughly reviewed by the experts and then accepted for presentation. This helps the student’s presentation skills which further increases the quality of presentation in academic examinations also. The case studies also help in developing the subject knowledge, technical vocabulary and understanding of the problem areas. The students also develop the ability to solve the problems in real-time and come up with viable solutions.

In this activity, the evaluation of the student is done by considering the aspects in table 4.

Attribute	**Marks (1)**	**Marks (2)**	**Marks (3)**
Subject Knowledge	No idea on concept	Understand the concept but unable to give real time examples	Clear concepts with good examples and applications
Problem analysis	Unable to analyze problem	Identifies problem to some extent	Analyses problem very well
Development of solutions	Unable to develop solution	Develops partial solutions	Develops apt solution
Complex problem investigation	Unable to find cause of problem	Can investigate simple problem	Investigates complex problems
Modern tool usage	No utilization	Less utilization	Optimum utilization
Environment and sustainability	Not subjected to environment and sustainability	Subjected but not up to the mark	Subjected to environment and sustainability
Individual and team work	No unity, no effort	Good effort but no unity	Good effort and good unity
Communication	Unable to communicate	No fluency but able to explain concept	Good communication

Table 4. Scheme of Evaluation for CS

E. Feedback System (FB)

Feedback System is used to improve the quality of the E-Bridge process. The quality here is judged by maximum voting to the yes or no questions like, (1) Does your analysis and problem-solving ability improved? (2) Whether this activity directs to the employability? (3) Does your communication skills improved? After assessing their feedback, the process is improved further if any needed.

E-Bridge includes the above activities (CGD, BEB, PS) along with Debate (DB) and Case Study Presentation (CSP) of E-Bridge.

R.No.	Subject Knowledge	Environment and sustainability	Individual and team work	communication
	3	2	3	3
	2	2	3	3
	3	2	3	2
	2	2	2	2
	2	2	3	2
	3	1	2	2
	3	1	2	1
	2	1	3	3
	3	2	3	3
	2	1	3	2

Table 5. Sample assessment for CGD

R.No.	Subject Knowledge	Problem analysis	Development of	Complex problem invest	Engineer and soci	Communication
	3	3	2	2	1	3
	3	2	3	1	1	3
	2	2	2	1	1	3
	2	2	1	2	1	2
	3	3	2	3	2	2
	3	2	2	1	1	3
	3	3	2	2	1	3
	2	2	1	1	1	3
	3	3	3	2	2	3

Table 6. Sample assessment for BEP

4. Results and discussions

The outcome of E-bridge activity included some of the graduate attributes listed out by the NBA. Table 7 presents this mapping.

GAs	Group Discussion (GD)	Debate (DB)	Elevator Pitch (EP)	Case Study Presentation (CSP)
GA 1	*	*	*	*
GA2				
GA3				*
GA4				
GA5				
GA6		*		
GA7				
GA8				
GA9	*			*
GA10	*	*	*	*
GA11				*
GA12				

Table 7. Mapping of E-Bridge to Graduate Attributes

The enhanced employability bridge includes the activities Clustered Group Discussion (CGD), Debate (DB), Brainstorming Elevator Bite (BEB), Case study Presentation (CS) and Polling System (PS). The activity, CGD helps the students to fulfill the Graduate Attributes (GAs-1,7,9,10) Engineering Knowledge, Individual and Teamwork and Communication. As the topic given in CGD is related to the current subject, they acquire Knowledge. The poor student can be able to compete the good student which results in Individual and Teamwork. With open discussions the Communication skill of the students is also improved. As the students should not copy the statement of others, they will be trained to maintain professional ethics to some extent.

The second activity DB makes students attain Engineering Knowledge, Engineer, and society, Environment and Sustainability, communication (GAs-1,6,8). In Debate, while defending themselves, the students learn about Engineer and Society. They also come to know how to sustain in such an environment.

The BEP maps to Engineering Knowledge, Problem Analysis, Design/development of solutions, Modern tool usage, communication and importance of Life-long learning (GAs-1,2,3,5,8,10,12). As the students are asked to give a solution for a complex problem related to their Engineering subject, they acquire the GAs 1,2,3 and 5. The thirst of knowledge makes them to find solutions for problems they come across, thus maintaining continuous learning or life-long learning.

With a Case Study Presentation, the students can gain subject Knowledge, Problem Analysis, Design/development of solutions, Conduct Investigations on complex problems, Modern Tool Usage, Ethics, communication and Project management and Finance (GAs-1,2,3,4,5,7,8,9,10,11). As the students are asked to perform a research survey and draw conclusions, they gain knowledge of project management and Finance.

Feedback System (FS) allows students to gain Engineering Knowledge and ethical practice. This activity shall train them towards ethical practices at a later stage of their professional life. Feedback System also teaches them the benefits of lifelong learning.

GAs	CGD	DB	BEB	CS	PS
GA 1	*	*	*	*	*
GA2			*	*	
GA3			*	*	
GA4				*	
GA5			*	*	
GA6		*			
GA7	*			*	*
GA8	*	*	*	*	
GA9	*			*	
GA10	*	*	*	*	
GA11				*	
GA12			*		*

Table 8. Mapping of Enhanced E-Bridge to Graduate Attributes

The Enhanced E-Bridge activity (EE-Bridge) is observed to have mapping to few more graduate attributes than the earlier E-Bridge activity. This mapping is presented in table 8.

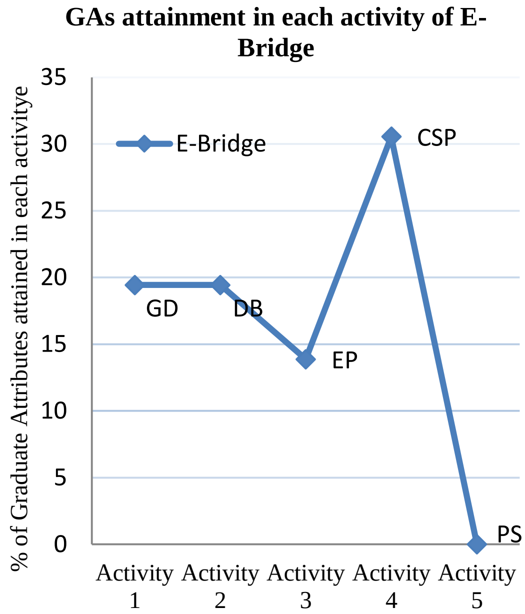

Figure 2. GA's attainment in each activity

The percentage of GA's attained in each activity of E-bridge is shown in figure 2. The difference in the level of attainment of each GA in E-bridge can be clearly observed in the figure 3.

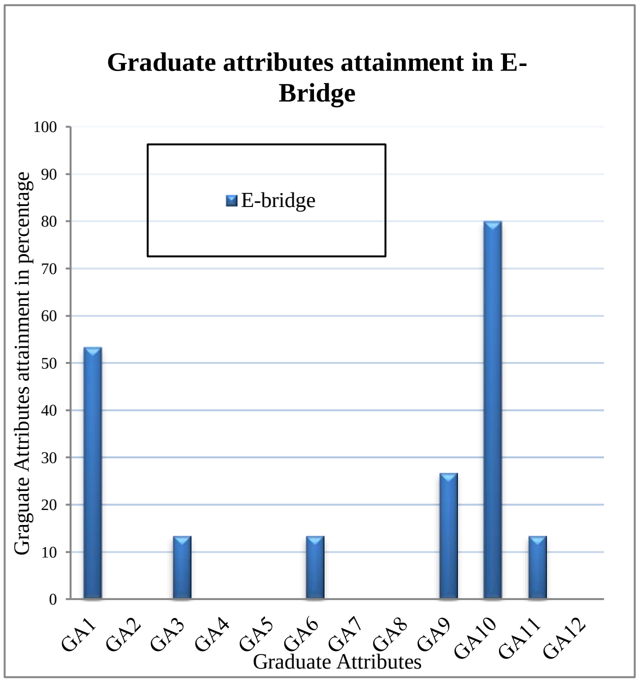

Figure 3. Comparison of GA's attainment

5. Conclusion and future scope

Thus, the proposed methodology E-Bridge helps to attain more number of Graduate Attributes expected by the NBA adopted Outcome Based Education (OBE). Student's problem solving capability and analytical thinking are improved. By implementing this process, engineering graduates will be able to challenge and solve any complex problems of society with ethics and knows the benefits of lifelong learning.

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BLENDING METHANOL IN VEHICLES TOWARDS MINIMIZING AUTOMOTIVE POLLUTION

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ABSTRACT

The worldwide energy policy also aims to reduce greenhouse gas emissions occurred due to traditional fuels and thus developing renewable energy became an important part of this policy. Nowadays transport sector has decreased its reliance on oil which generally contributes to hazardous environmental impact and to achieve this some alternative transport fuels such as biofuels, hydrogen and natural gas emerged up as a helping hand. Adding methanol into diesel or gasoline permits the mixture to possess an entire combustion with the presence of oxygen which increases its combustion efficiency and reduces greenhouse gas emission. This paper discusses significance of methanol as a fuel for IC engines and its applicability in various sectors.

Keywords

Alcohol fuel, anhydrous ethanol blends, better fuel vaporization, high energy content, higher blending octane, iso-butanol.

Introduction

In the past few years, alternative fuels on internal combustion engine (ICE) recently has fetched public attention due to concern for environmental protection, and desires on reducing reliance on fossil fuels and meeting the present rigorous regulation. Alcoholic fuels are one among the alluring alternative fuels as it can be produced from renewable resources and is oxygenated. To produce better engine operation in spark ignition engine, methanol fuel is a popular substitute alcoholic fuel which could be blended at lower blending ratio with gasoline. However, there are some problems considering the properties of methanol, particularly the characteristic like vapour lock and its content of energy. Alcoholic fuels having higher carbon molecules like iso-butanol have higher energy content and are capable of displacing more petroleum gasoline compared to the methanol-gasoline blend.

Methanol 15 (M15) In Petrol Reduces Pollution

Methanol is a neat burning drop in fuel which can replace both petrol & diesel in transportation & LPG, wood, kerosene. It is capable of replacing diesel in Railways, marine sector, generator sets, power generation and methanol-based reformers may be the best compliment to electric and hybrid mobility. The economy obtained from methanol is a way to achieve the dream of complete hydrogen-based fuel systems. Methanol burns efficiently in all internal combustion (IC) engines, produces no particulate matter, no soot, almost zero SOX and NOX emissions towards near nil pollution. The gaseous version of methanol – di methyl ether blended with Liquefied petroleum gas

(LPG) can form an excellent alternative for diesel in giant trucks and buses. Methanol 15% (M15) in gasoline is capable of reducing pollution by 33% and more than 80% pollution can be reduced by sole replacement of diesel by methanol. The production of methanol can be done from Indian high ash coal, municipal solid waste, biomass, natural gas and stranded and flared gases. India can reach the target of producing methanol @ Rs.19 a liter through right technology from Indian coal and all other feedstocks. world is readily moving towards renewable methanol from CO2 which is the best part and the perpetual recycling of steel plants emitted CO2, CO2 into methanol, geothermal energy, effectively air to methanol.

Price of Production of Methanol

Since, India is manufacturing all of its methanol from imported fossil fuels, it should use coal for methanol production that is anticipated to make it economically viable to produce methanol in India. India must set up a pilot plant for methanol production which would be followed by a commercial plant. As there is no commercial coal to methanol plant in India, it might be troublesome to calculate the precise cost of per unit methanol production, though; there have been pretty fair estimates of the same as Coal to methanol technology is a proven technology across the globe.

It is estimated that a 1600 tons per day of methanol plant will require a capital expenditure of ~INR 1200 Crores which would be able to produce methanol at INR 17-19 per liter which is comparable with the cost of imported methanol. Whereas, presently, the per liter cost of methanol production in India is INR 25-27 or even more depending on the volatility in the price of imported natural gas. Apart from using coal as a feedstock, biomass/municipal solid waste and flared natural gas can also be used for methanol production, but the continuous availability of latter would be a challenge. Therefore, coal seems to be a promising fuel for producing methanol in India. Since, Coal to methanol is a proven technology; India must tap its large coal reserves to produce methanol (and DME & Olefins) to use it as a substitute or drop-in fuel for gasoline and (diesel). Weak global coal prices and stricter environmental laws are likely to offer firm coal to methanol margins.

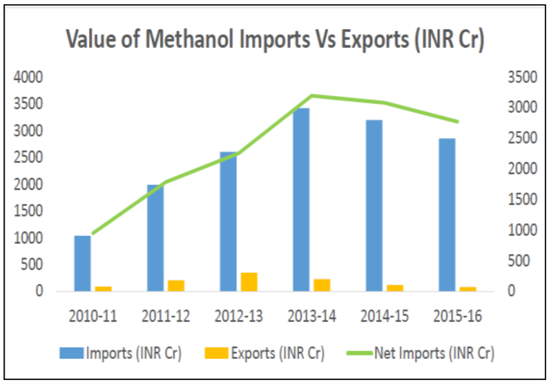

Figure 1: Worth of Methanol Imports Vs Exports (INR Cr)

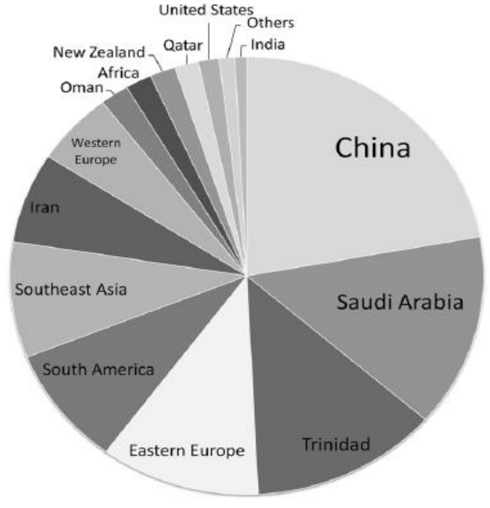

Figure 2: Global Methanol Production

Conclusions

India is heading towards achieving 20% of its fuel demand to be covered by methanol by 2018. Brazil also assures that 20% of the fuel supply demand of gasoline could be covered with ethanol by 2020. It is remarkable that Brazil already utilized ethanol in different fuel blends since mid 70's. Renewable methanol by capturing carbon dioxide back from the atmosphere is turning into highly regarded and observed by the globe as the abiding solution to energy known to mankind. Methanol is a vital solution to the burning drawback of urbanly pollution worldwide.

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CYBER SECURITY IN SHIPPING

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ABSTRACT

In recent days, navigation of ship is achieved by receiving the signal from satellite. Satellite act as intermediate between transmitter and receiver. From shore-station the signal is transmitted to ship through satellite. Hacking is the problem occurring during navigation of ship. Suppose if an operator unknowingly connects his hacked device to any system of the ship, the data in the ship can be hacked through the device. Once the data has been hacked, it will be easy for the hijackers to control the navigation system of the ship. In order to avoid this a coding should be done in such a way that it should auto generate random password for every minute. Thus, by this way we can avoid the hijacking of ship navigation.

Keywords
Signal, hacked device, satellite, hijackers, navigation system.

Introduction

Ships are increasingly using systems that rely on digitisation, digitalisation, integration, and automation, which call for cyber risk management on board. As technology continues to develop, information technology (IT) and operational technology (OT) on-board ships are being networked together – and more frequently connected to the internet. This brings the greater risk of unauthorised access or malicious attacks to ships' systems and networks. Risks may also occur from personnel accessing systems on board, for example by introducing malware via removable media. In 2017, the International Maritime Organization (IMO) adopted resolution MSC428(98) on Maritime Cyber Risk Management in Safety Management System (SMS).

The Resolution stated that, an approved SMS should consider cyber risk management in accordance with the objectives and functional requirements of the ISM Code. As a result of this assessment, a profile is developed, which can help to identify and prioritise actions for reducing cyber risks. This profile is used as a tool for aligning policy, business and technological approaches to manage the risks. These profiles were created by the United States Coast Guard and NIST's National Cybersecurity Centre of Excellence with input from industry stakeholders. Both cyber security and cyber safety are important because of their potential effect on personnel, the ship, environment, company and cargo. The aim of this document is to offer guidance to ship-owners and operators on procedures and actions to maintain the security of cyber systems in the company and on-board the ships.

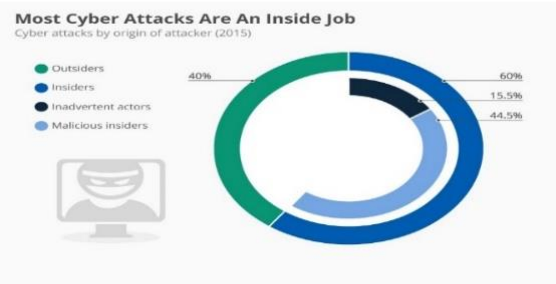

FIGURE 1. Statistics Of Cyber Attacks

2. Main work

In a shipping context a cyber risk may be an failure of an onboard GPS receiver due to a fault with the equipment, extending right through to catastrophe scenarios of vessel systems being attacked and the vessel being disabled, run aground or taken by the malicious third parties. Although the catastrophe scenarios are possible the likelihood of such an incident for most companies is low.

The risk of electronic equipment failure are generally well recognised in the industry and critical equipment will often be required to have redundancy, spares will be carried or manual operation will be possible should the electronics failed.

What has been less well recognised until recently is the risk of electronic systems being subjected to unauthorized access or malicious attacks – lets call them "Cyber Threats". Recently there has been a focus on this area and the steps that might be taken to defend shipping companies from unauthorized access or malicious attacks. The defences taken to defend systems are known as "Cyber Security".

A secure network depends on the IT/OT set up on-board the ship, and the effectiveness of the company policy based on the outcome of the risk assessment. Control of entry points and physical network control on an existing ship may be limited because cyber risk management had not been considered during the ship's construction. It is recommended that network layout and network control should be planned for all new buildings.

2.1 Cyber Risk

Cyber risk means any risk of accidents, incidents, financial loss, business disruption or damage to the reputation of an organization through failure of its electronics systems or by the persons using those systems.
Advances in technology means that ships systems are not only being networked together but are also connected to the world wide web. This means that ships are now more vulnerable to cyber threats than previously.

It can affect a company's bottom line, damage its reputation or disrupt its business. At the more extreme end of things there is the possibility that malicious groups or individuals may seek to cause shipping accidents although the risks of this are currently thought to be low for most companies.

2.1.1 Types of Cyber Attack
2.1.1.1 Untargeted attacks:

Where a company or a ship's systems and data are one of many potential targets. These are likely to use tools and techniques available on internet, which can be used to locate, discover and exploit widespread vulnerabilities that may also exist in a company an onboard ship.

- Malware
- Phishing
- Water holing
- Scanning

2.1.1.2 Targeted attacks:

Where a company or a ship's systems and data are the intended target. These may be more sophisticated and use tools and techniques specifically created for targeting a company or ship.

- Brute force
- Social engineering
- Denial of service
- Spear-phishing
- Subverting the supply chain

2.1.2 Stages of Cyber Attack

The length of time to prepare a cyber attack can be determined by the motivations and objectives of the attacker, and the resilience of technical and procedural cyber risk controls implemented by the company, including those onboard its ships.

When considering targeted cyber attacks, the general observed stages of an attack are:

- Survey
- Delivery
- Breach
- Pivot

2.2 Consequences of Cyber Attack

2.2.1 Cargo management systems

Shipment-tracking tools available to shippers via the internet. Tracking is not directly between the shipper and the ship. Interfaces of this kind make cargo management systems and data in cargo manifests and loading lists vulnerable to cyber attacks.

2.2.2 Bridge systems

The increasing use of digital, network navigation systems, with interfaces to shoreside networks for update and provision of services, make such systems vulnerable to cyber attacks.

A cyber incident can affect all systems associated with navigation, including ECDIS, GNSS, AIS, VDR and Radar.

2.2.3 Propulsion and machinery management systems

The use of digital systems to monitor and control onboard machinery, propulsion and steering makes such systems vulnerable to cyber attacks.

The vulnerability of these systems can increase when used in conjunction with remote condition-based monitoring.

2.3 Cyber Security

Cyber security is the body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorized access.

It is achieved through the following ways:

- identify the roles and responsibilities of users, key personnel, and management both ashore and on board
- identify the systems, assets, data and capabilities, which if disrupted, could pose risks to the ship's operations and

safety

- implement technical and procedural measures to protect against a cyber incident and ensure continuity of operations
- implement activities to prepare for and respond to cyber incidents.

2.3.1 Communication systems

Availability of internet connectivity via satellite and/or other wireless communication can increase the vulnerability of ships. The cyber defence mechanisms implemented by the service provider should be carefully considered but should not be solely relied upon to secure every shipboard system and data. Included in these systems are communication links to public authorities for transmission of required ship reporting information. Applicable authentication and access control management requirements by these authorities should be strictly complied with.

2.4 Identification of Threats

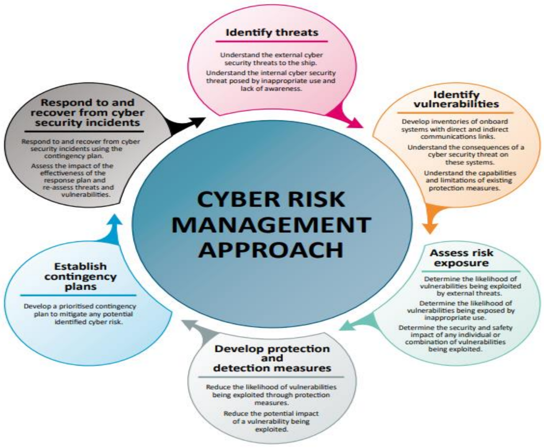

FIGURE 2. Cyber Risk Management Approach

GROUP	MOTIVATION	OBJECTIVE
Activists	• Reputational damage • Diruption of operations	➢ Destruction of data ➢ Publication of sensitive data ➢ Media Attention
Criminals	• Financial gain • Commercial espionage • Industrial espionage	➢ Selling stolen data ➢ Ransoming stolen data & system operability ➢ Arranging fraud transport of cargo
Opportunists	• The Challenge	➢ Getting through cyber security defences ➢ Financial gain
State Sponsored Organisation	• Political gain espionage	➢ Gaining knowledge ➢ Disruption to economies and national infrastructure

TABLE 1. Motivation and objectives

2.5 Cyber Security Protection Measures

2.5.1 Technical protective measures:

- Limitation to and control of network ports, protocols and services
- Configuration of network devices such as firewalls, routers and switches
- Physical security
- Detection, blocking and alerts
- Satellite and radio communication
- Wireless access control
- Malware detection
- Secure configuration for hardware and software
- Email and web browser protection
- Data recovery capability
- Application software security (patch management)

2.5.2 Procedural protective measures:

- Training and awareness

- Controlled access for visitors
- Upgrades and software maintenance
- Anti-virus and anti-malware tool updates
- Remote access
- Use of administrator privileges
- Physical and removable media controls
- Equipment disposal, including data destruction
- Obtaining support from ashore and contingency plans

2.6 Recovery Plan

Recovery plans should be available in hard copy on board and ashore. The purpose of the plan is to support the recovery of systems and data necessary to restore IT and OT to an operational state.

To help ensure the safety of onboard personnel, the operation and navigation of the ship should be prioritized in the plan. The recovery plan should be understood by personnel responsible for cybersecurity.

The incident response team should consider carefully the implications of recovery actions (such as wiping of drives), which may result in the destruction of evidence that could provide valuable information as to the causes of an incident.

Recovery of OT may be more complex especially if there are no backup systems available and may require assistance from ashore. Details of where this assistance is available and by whom, should be part of the recovery plan, for example by proceeding to a port to obtain assistance from a service engineer.

2.7 Secured Work Environment

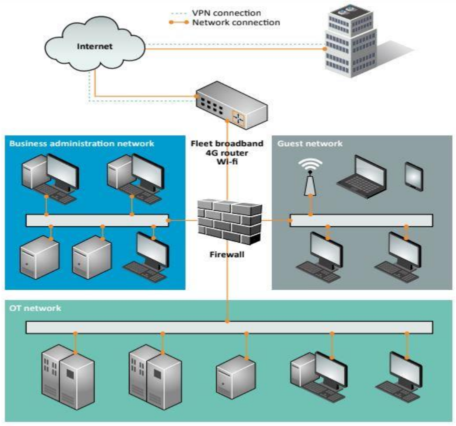

FIGURE 3. Example of an Onboard Network

2.7.1 Clear Screen Policy

- Lock your computer (Ctrl-Alt-Del)
- You are responsible for any activity performed using your logon id.
- Do not share your username and password with anyone.
- Always shutdown or log off when your work is over or during extended break's.

2.7.2 Clean Desk Policy

- At the end of the working day & during extended break (lunch) tidy your desk & lock your sensitive files in drawers /cabinets
- Clear sensitive or classified information from the printer immediately.
- A messy desk is a vulnerable desk.

2.8 We can make the difference

2.8.1 Don'ts

- Share password with anyone
- Share credentials or vital information with unknown
- Read unsolicited mails

- Forward junk and chain mails
- Use official Email IDs for personal communication
- Install pirated or unauthorized software
- Discuss important or sensitive topics in public
- Save passwords or credentials while on public internet.
- Use data upload sites, webmail for sharing sensitive information
- Use your colleagues credentials to access any resource
- Try to stop/ disable the Anti-virus real-time or scheduled scan process

2.8.2 Do's

- Lock your machine while leaving it unattended
- Use strong passwords and change them regularly
- Clean your desk while leaving for the day
- Use Internet judiciously
- Use printing judiciously
- Use Mobile devices judiciously
- Be attentive while on social networking sites or platforms
- Destroy documents no longer in use
- Co-operate with the IT engineer while machine is scanned with antivirus
- Co-operate while security patches are being installed / applied
- Regularly backup your important data and files.
- For backup of Video files, contact IT Department
- Report and respond to security incidents and breaches.
- Practice these policies and encourage others to do so as well

3. Conclusions

Some aspects of cyber risk management may include commercially sensitive or confidential information. Companies should, therefore, consider protecting this information appropriately, and as far as possible, not include sensitive information in their Safety Management System (SMS). Whilst the causes of a cyber-safety incident may be different from a cyber-security incident, the effective response to both is based upon training and awareness. In section 2.4, this paper described essential cyber security measures that should be undertaken on a ship. It explored how a ships facility interconnects, and, as an example of a cyber-threat, how hackers fabricate GPS signals.

It is, therefore, important that senior management stays engaged throughout the process to ensure that the protection, contingency and response planning are balanced in relation to the threats, vulnerabilities, risk exposure and consequences of a potential cyber incident. Company plans and procedures for cyber risk management should be incorporated into existing security and safety risk management requirements contained in the ISM Code and ISPS Code.

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3D PRINTING TECHNOLOGY IN MARITIME INDUSTRY

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ABSTRACT

Maritime industry, despite being conservative to changes, it has scope for the usage of a new methodology in construction of various devices and components. it is better known as 3D printing or the Additive Manufacturing technology (AM). This technology has flourished in various other sectors. The new technology comes with benefits for the companies that choose to adopt. As AM is starting to consolidate in the industry, it offers a variety of changes in the shipping industry. Additive Manufacturing (AM) or 3D printing has potential of being more cost effective, cleaner and mass manufacturing of parts.
The AM technology deals with addition of material unlike the existing technology of subtractive manufacturing. The process uses voxels as basic block building elements placed in layers to develop the desired component. The AM technology has been emerging out successfully in the global landscape and has huge growth opportunities in the coming years in maritime sector. Due to low market awareness, cost constraint and lower domestic production this technology has been facing hurdles in shipping industry. This process has been successful in developing numerous prototypes in marine industry. Considering the characteristics of maritime sector and the advantages of the AM process, the AM process is seemed to have a large scope of development in the upcoming years.

Keywords

Additive Manufacturing, automobile, Printing, Shipping

1. Introduction

Additive Manufacturing (AM) which is also known as 3D printing has been already implemented in various sectors like (automobile and consumer products, medical, industrial, aerospace, etc.). It is based on the principle of the construction in layers by converting the data from the software in 3D form into physical objects. By using this method, we can produce functionally incorporated components including spare parts in single production step but in small batches. We obtain a lot of benefits from this technology one of which is that we obtain flexible production with no extra expenditures of manufacturing. We achieve this by transforming the designs of 3D data made in the software into physical objects, without the need of any additional tools. Moreover, by using the principle of the construction in layers we can produce functionally incorporated components in single step production, so this obviates the assembly of components. When we compare it with conventional production it has numerous advantages like better design specifications, low manufacturing time, high energy efficiency, emission free etc.

Maritime assets are capital-intensive and their out of service time has economic consequences. They usually operate away from the base at remote locations and are on continuous move. Some other sectors which share similar characteristics are aerospace, defense units and automobile. We will explore how lessons learnt from various sectors can be applied to shipping industry.

In this presentation, we firstly discuss about the available technology which can be used and is currently being used and understand the concept of additive manufacturing, materials which can be layered into components. Then we step into the understanding the characteristics of maritime sector and how it has been adapting to the changes in technology. Further we see how 3D printing can be used in the maritime sector. Next, we are going to discuss how ports can be used as manufacturing hubs. We move on to explain the supply chain used in the production process using this technology and we put together the advantages and disadvantages of using this technology in the shipping industry.

Followed by applications which are being developed or those which are already developed using this technology in the maritime field. Then we look at some mathematical calculations involving the manufacturing cost. Lastly we discuss about the process of Additive Manufacturing.

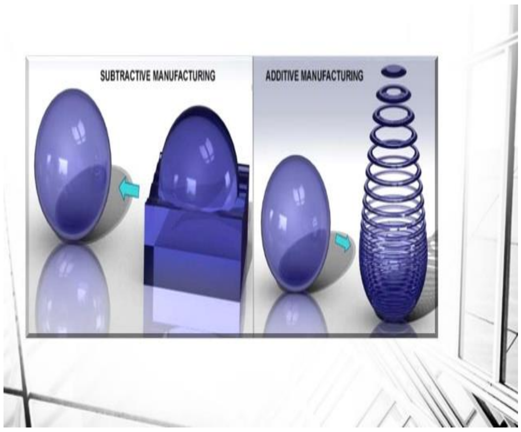

Fig. 1 Difference between additive and subtractive manufacturing process

2. Available Technology

Additive Manufacturing is the official industry standard term (ASTM F2792). It is also known as additive fabrication, additive processing, freeform fabrication and additive layer manufacturing. Voxel is the basic block in the AM technology, Addition of numerous voxels in a specific design in layers we obtain the desired structure. In some processes the material is squirted, squeezed or spread and in others fused, bind or glued. The power source is thermal, high powered laser beam, electron beam, Ultraviolet laser or Photo curing. The raw materials for the process are polymers, metals, ceramics, composites and biological materials. The starting materials could be liquid filaments/paste, powder or solid sheet. Currently the most common metallic materials are steels, pure titanium, titanium alloys, aluminum casting alloys, nickel based super alloys, cobalt-chromium alloys, gold and silver.

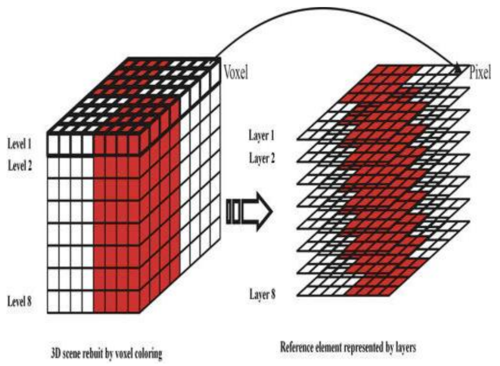

Fig.2 Construction of element using voxels arranged in layers

AM houses several processes and are classified into seven types:

1. Binder Jetting
   AM process where in a liquid bonding agent is deposited to join powered materials together.
2. Direct energy deposition
   AM process where thermal energy fuses or melts the materials together as they are added.
3. Material Extrusion
   AM process that allows for depositing material via a nozzle.
4. Material jetting
   AM process where droplets of materials are deposited
5. Powder bed fusion
   AM process where thermal energy fuses or melts materials from a powder bed.
6. Sheet welding
   AM process where sheets of materials are bonded together.
7. VAT photo-polymerization
   AM process where liquid photo polymer in VAT is cured by light.

3. Characteristics of The Maritime Sector

The Maritime Industry has been following its traditional and orthodox techniques for a long time. It has offered a significant amount of resistance to new technologies but has accepted a few technologies taking into consideration its advantages environmentally and economically. Before the introducing the AM or 3D technology in this sector it becomes necessary to understand its characteristic nature, so the following points are in view with the nature of the maritime sector.

Maritime assets are capital intensive and downtime has financial consequences. The working environment of vessels is governed by the dynamics of the ocean which in turn provides an environment in continuous motion. The ships are subjected to constant motion and carry out its operation in remote areas away from the ports. So the ships are isolated from repair facilities and spare parts storage. The working environment here is highly corrosive with turbulence and vibrations caused by the machineries, non-calm weather and rough seas.

The maintenance networks are involving many components such as the owner of assets, system integrator, original equipment manufacturers (OEM), service providers and their logistic service providers. The outgoing vessels have workshops onboard staffed with technicians, who have to solve the problems of the mechanical equipment that appear while working in harsh conditions.

4. Additive Manufacturing in Maritime Sector

Maritime will not be left out of technological developments on the information technology. However, there are only a few published case studies of applications in real situations, there are initiatives in place. Apart from general prototyping applications, there are about parts maker tests and application in ships both in defense and commercial sector.

The largest container carrier company in the world, Maersk line has found out a way to produce spare parts onboard by the means of 3D vessels. In 2015 the company had revealed that it switches to the use of fabrication of spare parts by installing 3D printers on the container vessels. It used ABS thermoplastic materials to build the components. However, the company believes in the use of the powder based metal laser sintering printers in order to enhance variety of processed components. The company plans to remove the hauling of spare parts of the container vessels. The 3D printing process would not only benefit the container vessels but also revolutionize the tankers.

Damen Shipyards Group, RAMLAB, Promarin, Autodesk and Bureau Veritas teamed up to print a premium boat propeller, WAAMpeller which weighs 180 kg approximately and has a diameter of 1300 mm. This propeller was constructed using Wire Arc Additive Manufacturing (WAAM) process which used a bronze alloy.

Fig. 3 Picture of a boat propeller better known as WAAMpeller

- The Italian startup Livrea and the American software company Autodesk have come together to produce the first 3D printed yacht. The traditional Sicilian method gave way to the AM or 3D techniques for printing of entire yachts.

Fig.4 3D printed Yacht by Livrea and Autodesk

- To maximize the output from the tidal currents, scientists have made efforts to harness this energy by turning to 3D printing. The researchers printed two turbines with diameter 150mm*100mm which possessed mechanical functionality, lower costs and great strength.

5. Ports As Additive Manufacturing Hubs

Merchants and Defense vessels are dependent on the ports for maintenance, repair and replacement of the machineries onboard. Ports are expected to be potential additive manufacturing hubs. The ports are static in nature and are not subjected to any movement so ports can flourish as AM hubs another thing which can enhance ports as AM hubs is large spaces for printing of parts and storing the printed parts.

6. Spare Parts Supply Chain In Maritime Industry

In the maritime industry we constantly use machineries and equipment for specific operations. The vessels work in extreme working conditions making safety and reliability requirements critical.

The IMO and various classification societies have laid down restrictions and regulations on the type and quality of the components manufactured in order to prevent untimely and unexpected breakdown of components. Usually failure of machineries can occur anytime due numerous reasons in case of severe damage machineries needed to be replaced so availability of spare parts becomes a question. Carrying spare item of each device is also practically not feasible. Hence supply chain of spare parts plays an important role.

Consider a merchant or a defense vessel travelling at a certain speed at a given point of time and is found to be at position A, so in case of failure of any machinery onboard it needs to be replaced or repaired immediately. Here the supply chain of 3D printed spare parts comes into picture, as soon as the machinery breaks down a signal is sent to the technical department on shore who receive the information regarding the issue and refers it to the procurement department. The procurement department as the name suggests collects the parts required for the machinery considering all the dimensions of machineries and prints it completing its duty by sending it to the supplier. The Supplier plays a crucial role which involves transporting the additive manufactured parts to the vessel from the port. When the vessel reaches position B it receives the printed parts from the supplier and thus the machinery is brought back to working condition, this is how the supply chain in the maritime industry is structured.

To bring about the effectiveness and make the AM technique sustainable in the maritime sector each component of the supply chain has to perform its function appropriately. Even if a single component fails to accomplish its duty, major failure of the supply chain can take place.

7. Advantages And Disadvantages Of AM

Though 3D printing technology or AM has flourished in other sectors such as aerospace, aeronautical, architecture, automobile, commercials, etc., there's no significant contribution in the maritime sector of the aforementioned manufacturing process. However the detailed study of the same proves to be advantageous in mere future. As this process is additive in nature, it does not involve wastage of material by removal of excess unwanted chunk of material as in the subtractive manufacturing process. The basic benefit from this technology is less use of material, lower production cost which is directly proportional to the amount of material used. The time taken to prepare a component through 3D manufacturing is way too less in comparison with the existing traditional manufacturing process.

The world's largest 3D printed boat was built in mere 72 hours. The durability, strength and robustness are commendable when the 3D printed structures are subjected to stress and forces of higher order when they are expected to meet with minimal damage. The maintenance and the labor required is drastically less thus reducing the initial cost.

However, as the process seems to be beneficial in various aspects of production and maintenance there is a threat of prevailing disadvantage as the printing process is dependent on the gravitational forces of attraction, the construction seems to be problematic on the vessel due to the stability of the ship. When the ship makes way through the water it undergoes various motions wherein the center of gravity changes with time thus making the ship motion dynamic in nature. So the process faces major disadvantages as the ship is not static.

8. Applications of AM in Maritime Sector

Though additive manufacturing is new to the maritime sector, it has made progress to produce working models along with few basic prototypes.

1. PRINTING OF SUBMARINES
   Recently a 3D printed submarine prototype was brought into existence for the U.S. Navy.
2. MANUFACTURING OF BOAT PROPELLERS
   Various groups have come together to prepare a 3D printed propeller named WAAMpeller.
3. PRINTING OF SPARE PARTS FOR NAUTICAL RACING
   Using Direct Laser Metal Sintering (DMLS) innovative design of racing boats came at much lower costs.
4. MAPPING OF SEA FLOORS
   Recently a Canadian company International Submarine Engineering (ISE) with the help of EBAM and VB processes is undertaking mapping of arctic seafloor.
5. PRINTING OF SPAREPARTS
   Durable, Robust, Strong, Cost effective, light weight and time effective spare parts are manufactured.
6. PRODUTION OF YATCHES
   LIVREA yatch was printed by American software company Autodesk.
7. PRODUTION OF DRONES
   The U.S CICADA Navy drones have emerged out as a new advantage of 3D printing.
8. PRINTING OF CHAIN MAIL IN SHIP
   This medieval instrument of protection was put back to use in a new way by the masterminds of NASA.
9. PRODUCTION OF TURBINES
   Another advantage of 3D printing which helps to harnessing tidal current energy by the production of turbines.

9. Mathematical Calculations

- Material cost
  Material cost = p * pi * (D/2)^2 * L * price
  Where p = density of material D = diameter of filament L= Length of filament used Price is the cost of material per unit weight.
- Labour cost
  Labor cost = T * R T= time needed to finish the job. R is the cost per 1 hour of 3D printing.
- Final Price
  Final Price = (material cost + labor cost) * (markup) Markup is ratio of profit to cost.

10. Additive Manufacturing Process

The process of additive manufacturing starts with developing of a 3D model by using various designing software's like Tinker CAD, Blender, BRL-CAD, etc. As per the plan of the parts to be produced, 3D models of appropriate dimensions and structural features are worked on in these software's. This model in the form of software is sent to the 3D printing machine in the format of an instruction file and then direct transformation of 3D data stored is simply supported by supply of raw materials to the machine.

11. Case Study

The Oak Ridge National Laboratory in collaboration with the U.S. Navy which created a submarine hull prototype using the Big Area Additive Manufacturing (BAAM) in mere 4 weeks. The submarine printed was 30 feet long, comprising of 6 carbon fiber composite material. The average cost of manufacturing of a submarine on an average is $700000 and expected time to build a submarine hull takes up to 3-5 months. By the use of 3D technology, the construction is expected to reduce by 90%. After successful completion of the concept of hull, the next step will be taken to create a watertight version that will be tested in the wave version that will be tested in the wave pool at Carderock. This will help to enact the actual conditions a submarine has to face in the oceans.

Fig Picture of 3D printed submarine hull prototype by the U.S. Navy

12. Conclusion

After a detailed study of the AM or 3D printing process, all the aspects such as working procedure, raw materials, advantages, disadvantages, applications and supply chains this is regarded as a boost to the maritime sector in various dimensions such as reducing of production time, initial production cost, maintenance, weight and manpower.

However, the process is successful in manufacturing of prototypes and a few full scale designed structures.3D printing is seen as a potential change in production of various other vessels, turbines, propellers and other structures against the conventional construction methods.

The production process requires fundamental knowledge of working with design software and the rest manufacturing process being a mere cosplay.

Installation of 3D printing machines on ship is a task of concern but ports are seen as potential additive manufacturing hubs. This brings in the effectiveness of the supply chain to be established between the port and the vessels.

The AM manufacturing technology uses various principles for production such as joining of powdered materials using a liquid bonding agent, fusing of material using thermal energy, curing of liquid photopolymer in vat.

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WHICH CAREER ANCHOR ARE YOU RIDING ON?

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ABSTRACT

The present article discuss various career anchors and their relationships with individual's formidable career anchor type on which individual career rode for decades and for some other' who becomes the job hoppers as their career anchor flukes does not hold ground and keep finding the suitable seabed to ride on their career drive ,thereby keep dragging between one job to other, one company to other to find anchor berth to achieve the job satisfaction This paper briefly discusses career anchors pattern with professionals' values, from the career concept perspective.

Keywords: Career anchor, Values, Job hopers, Career management

Introduction

Career Anchors are the individual characteristics suitable for a chosen job's roles and responsibilities or career path individuals are drawn towards. Most Professionals usually align with an individual's underlying perception of their talents, skills, attitudes, values and purpose in life. The concept of the Career Anchors was introduced by Edgar Schein. A Career Anchor is something that develops over time and evolves into a self-concept, shaping an individual's personal identity or self-image and includes: Talents, skills and abilities - the things that we believe we are good at, and not so good at. Knowledge about different types of career anchors and identifying individual strong career anchor can help individuals to plan and manage their career.

Career Anchors

Every individual has specific in borne talent, likes and dislikes. These are the things that individual believe will bring him/her happiness, fulfilment and the opportunity to succeed. These factors can be termed as career anchors. Career Anchors are built on individual understanding of their own skills and abilities, individual personal motives and life circumstances and individual underlying attitudes and values. One can develop one's understanding through a career anchors identification and working on it. Career Anchors method was developed in the mid-1970s by Edgar Schein - a leading organizational psychologist and specialist in corporate culture. Career anchor theory aims to determine the main professional motives, study a person's system of value orientations, social attitudes to career and work in general. Schein named them a set of "career orientations

Different Career Anchors

There are eight career anchor's themes and has shown that people identify primarily with one or two. The anchors can enable people to recognise their preferences for certain areas in their job which can help career planning

- General Management
- Technical & Functional
- Autonomy and independence
- Security and stability
- Entrepreneurial creativity
- Service and dedication to a cause
- Pure challenges
- Lifestyle

Understand yourself better to find your perfect job

Career Anchors are formed during the early schooling days and through social interactions as a result of such experience gained in the early years of adolescence life as well upon joining into a career professional training like mandatory National Defence Academy(NDA) training for armed forces officers or JAT Regimental Training Centre Bareilly for infantry Training to Army Jawans or Pre Sea Training for Merchant Marine at Maritime Training Institutions .Career anchors & orientations created through such professional training are considerably stable and can remain constant for a long time.

Identifying career anchors allows individual to understand individual strengths and weakness with respect to career selection that will provide financial profits and bring inner satisfaction from work.

Career Orientations Inventory

Use the following scale to rate how true each of the items is for you. How to rate each item is shown below?

Never true for me	Occasionally true for me	Often true for me	always true for you
1	2 or 3	4 or 5	6

Instruction

For each of the forty items developed by Edgar Schein, individual is required to rate how true that item is for an individual in general by assigning a number from 1-6. The higher the number, the more that item is true for individual taking the carrier anchor test. For example, if the item says "I dream of being the MD of a company". Individual would rate that as follows:

"1" if the statement is never true for him/her. **"2"** or **"3"** if the statement is occasionally true for him/her. **"4"** or **"5"** if the statement is often true for individual. **"6"** if the statement is always true for the induvial taking the carrier anchor test. Avoid over thinking one needs to select most appropriate rating as closely related to individual but without a self-brain storming

- I dream of being so good at what I do that my expert advice will be sought continually.
- I am most fulfilled in my work when I have been able to integrate and manage the efforts of others.
- I dream of having a career that will allow me the freedom to do a job my own way and on my own schedule.
- Security and stability are more important to me than freedom and autonomy.
- I am always on the lookout for ideas that would permit me to start my own enterprise.
- I will feel successful in my career only if I have a feeling of having made a real contribution to the welfare of society.
- I dream of a career in which I can solve problems or win out in situations that are extremely challenging.

- I would rather leave my organisation than to be put into a job that would compromise my ability to pursue personal and family concerns.
- I will feel successful in my career only if I can develop my technical or functional skills to a very high level of competence.
- I dream of being in charge of a complex organisation and making decisions that affect many people.
- I am most fulfilled in my work when I am completely free to define my own tasks, schedules and procedures.
- I would rather leave my organisation altogether than accept an assignment that would jeopardise my security in that organisation.
- Building my own business is more important to me than achieving a high-level managerial position in someone else's organisation.
- I am most fulfilled in my career when I have been able to use my talents in the service of others.
- I will feel successful in my career when I have been able to use my talents in the service of others.
- I dream of a career that will permit me to integrate my personal, family and work needs.
- Becoming a functional manager in my area of expertise is more attractive to me than becoming a general manager.
- I will feel successful in my career only if I become a general manager in some organisation.
- I will feel successful in my career only if I achieve complete autonomy and freedom.
- I seek jobs in organisations that will give me a sense of security and stability.
- I am most fulfilled in my career when I have been able to build something that is entirely the result of my own ideas and efforts.
- Using my skills to make the world a better place to live and work is more important to me than achieving a high-level managerial position.
- I have been most fulfilled in my career with I have solved seemingly unsolvable problems or won out over seemingly impossible odds.
- I feel successful in life only if I have been able to balance my personal, family and career requirements.
- I would rather leave my organisation than accept a rotational assignment that would take me out of my area of expertise.
- Becoming a general manager is more attractive to me than becoming a functional manager in my current area of expertise.
- The chance to do a job my own way, free of rules and constraints, is more important to me than security.
- I am most fulfilled in my work when I feel that I have complete financial and employment security.
- I will feel successful in my career only if I have succeeded in creating or building something that is entirely my own product or idea.
- I dream of having a career that makes a real contribution to humanity and society.
- I seek out work opportunities that strongly challenge my problem solving and/or competitive skills.
- Balancing the demands of personal and professional life is more important to me than achieving a high-level managerial position.
- I am most fulfilled in my work when I have been able to use my special skills and talents.

- I would rather leave my organisation than accept a job that would take me away from the general managerial track.
- I would rather leave my organisation than accept a job that would reduce my autonomy and freedom.
- I dream of having a career that will allow me to feel a sense of security and stability.
- I dream of starting up and running my own business.
- I would rather leave my organisation than accept an assignment that would undermine my ability to be of service to others.
- Working on problems that are almost unsolvable is more important to me than achieving a high-level managerial position.
- I have always sought out work opportunities that would minimise interference with home or family concerns.

Career Anchoring Scoring Instructions

In the section below, you will find blank spaces for each of the forty items arranged in order so that you can easily transfer the numbers from your rating sheets onto the scoring sheet. After you have transferred all of the numbers, add up the columns and divide by five (the number of items) to get an average score for each of the eight career anchor descriptions outlined below.

TF		GM		AU		SE		EC		SV		CH		LS	
1		2		3		4		5		6		7		8	
9		10		11		12		13		14		15		16	
17		18		19		20		21		22		23		24	
25		26		27		28		29		30		31		32	
33		34		35		36		37		38		39		40	
total															
+5		+5		+5		+5		+5		+5		+5		+5	
Ave.															

Discussion

General Management

If individual key Career Anchor is general managerial, what one would not give up is the opportunity to climb to a level high enough in an organisation to enable him/her to integrate the efforts of others across functions and to be responsible for the output of a particular unit of the organisation. Such people want to be managers. They like problem-solving and dealing with other people, they thrive on responsibility. To be successful, they also need emotional competence

Technical & Functional

These individuals enjoy being good at specific tasks and will work hard in order to develop the specific skills necessary to complete them. This kind of person likes being good at something and will work to become a guru or expert They like to be challenged and then use their skills to meet the challenge, doing the job properly and better than almost anyone else.

Autonomy and Independence

If your key Career Anchor is autonomy/independence, what you would not give up is the opportunity to define your own work in your own way. If you are in an organisation, you want to remain in jobs that allow you flexibility regarding when and how to work. If you cannot stand organisational rules and restrictions to any degree, you seek occupations in which you will have the freedom you seek, such as teaching or consulting. You turn down opportunities for promotion or advancement in order to retain autonomy. You may even seek to have a business of your own in order to achieve a sense of autonomy; however, this motive is not the same as the entrepreneurial creativity anchor. These people have a primary need to work under their own rules and 'steam 'They avoid standards and prefer to work alone.

Security and stability

Anchor is security/stability, what you would not give up is employment security or tenure in a job or organisation. Your main concern is to achieve a sense of having succeeded so that you can relax. The value is illustrated by a concern for financial security (such as pension and retirement plans) or employment security. Such stability may involve trading your loyalty and willingness to do whatever the employer wants from you for some promise of job tenure. You are less concerned with the content of your work and the rank you achieve in the organisation, although you may achieve a high level if your talents permit. As with autonomy, everyone has certain needs for security and stability, especially at times when financial burdens may be heavy or when one is facing retirement. People biased in this way, however, are always concerned with these issues and build their entire self? Images around the management of security and stability. These people seek stability and continuity as a primary factor of their lives They avoid risk and are generally 'lifers' in their job.

Entrepreneurial Creativity

If your key Career Anchor is entrepreneurial creativity, what you would not give up is the opportunity to create an organisation or enterprise of your own, built on your own abilities and your willingness to take risks and to overcome obstacles. You want to prove to the world that you can create an enterprise that is the result of your own effort. You may be working for others in an organisation while you are learning and assessing future opportunities, but you will go out on your own as soon as you feel you can manage it. You want your enterprise to be financially successful as proof of your abilities. These people like to invent things, be creative and most of all to run their own businesses They differ from those who seek autonomy in that they will share the workload They find ownership very important
They get easily bored Wealth, for them, is a sign of success.

Service/Dedication to a Cause

If your key Career Anchor is service/dedication to a cause, what you would not give up is the opportunity to pursue work that achieves something of value, such as making the world a better place to live, solving environmental problems, improving harmony among people, helping others, improving people's safety, curing diseases through new products and so on. You pursue such opportunities even if it means changing organisations, and you do not accept transfers or promotions that would take you out of work that fulfils those values. Service-orientated people are driven more by how they can help other people than by using their talents They may work in public services or in areas such as human resources.

Pure challenge

If your key Career Anchor is pure challenge, what you would not give up is the opportunity to work on solutions to seemingly unsolvable problems, to succeed over tough opponents, or to overcome difficult obstacles. For you, the only meaningful reason for pursuing a job or career is that it permits you to succeed in the fact of the impossible. Some people find such pure challenge in intellectual kinds of work, such as the engineer who is only interested in impossibly difficult designs; some find the challenge in complex, multifaceted situations, such as the strategy consultant who is only interested in clients who are about to go bankrupt and have exhausted all other resources; some find it in interpersonal competition, such as the professional athlete or the salesperson who defines every sale as either a win or a loss. Novelty, variety and difficulty become ends in themselves, and if something is easy, it becomes immediately boring. People driven by challenge seek constant stimulation and difficult problems that they can tackle Such people will change jobs when the current one gets boring, and their career can be varied.

Lifestyle

If individual's key Career Anchor shackled in lifestyle anchor, such individual would not give up in a situation that permits him/her to balance and integrate individual personal needs, family needs, and the career related requirement. Such individual wants to bridge major sectors of work life balance together toward an integrated whole, and therefore need a career that provides enough flexibility to achieve such integration. Such individual may have to sacrifice some aspects of the career (for example, a geographical move that would be a promotion but would upset your total life situation), and you define success in terms broader than just career success. You feel that your identity is more tied up with how you live your total life, where you settle, how you deal with your family situation, and how you develop yourself than with any particular job or organisation. Those who are focused first on lifestyle look at their whole pattern of living Rather than balance work and life, they are more likely to integrate the two They may even take long periods of time off work in which to indulge in passions such as travelling.

Conclusion

Considering the results of the analyses (as an Example), it may be proposed that the dominant career anchors of the faculty members include job security, service and dedication, and autonomy-independence. Faculty member careers in terms of certain core values and motives that are primarily concerned with work that promotes economic security and stability as well as a healthy work–life balance. The HR, Admission department and Placement department of All MTI'S should have a good understanding of Various types of carrier anchor and should make use of career anchor inventories for selecting the right person for the right job.

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RECENT DEVELOPMENT IN IC ENGINE

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ABSTRACT

The objective of this paper is to signify various modern development in IC engines which will not just reduce the fuel consumption but will also assist in reducing emission thus more reliability. The technologies which will be discussed in the paper will be Dual fuel engine, Common rail technology & intelligent engine. Dual fuel engine can significantly reduce NOx, SOx, and particulate matter and CO2. This has lead led to recognition of the potential for marine engines fuelled by the natural gas to reduce marine environmental problem. When it is run by gas mode it will comply by IMO Tier 3 regulations. Also common rail and Intelligent engine technology has considerably improved the working efficiency of a marine engine.

Keywords

Dual Fuel Engine, Common Rail Technology, Intelligent Engines

Introduction

Internal Combustion Engines have an abundant use in every industries, but if you go a few years back the designs that are used previously are not worthy to be used presently as because modern world is not only now focusing on performance but also the industries are focusing on various other factors and one of the most important factors are weather the engines are ecofriendly as the previous designs though they are good in performance but they produce greenhouse gases to a very high extent and moreover over use of fossil fuel is also there .But nowadays global warming has become a major issue . All nations are looking for their technological advancement to make these engines ecofriendly at least to some extent. Hereby in this paper we have focused on various engine modifications that are scientifically tested and nowadays used, and the major advantages that we infer from these modifications are well discussed and how they are working as ecofriendly, efficient engines has been highlighted and discussed properly. Hope the readers will get a good understanding of the technologies related to engine modification.

Dual Fuel Engine

History of Dual-Fuel Engines

Gas engines have a very long history dating back to the invention, just 20 years after James Watt invented the modern steam engine in 1785, of a vacuum type piston engine that utilized coal gas combustion instead of steam. This is now recognized as the first-ever internal combustion engine.

Use of internal combustion engines spread rapidly after the Second World War when large amounts of cheap petroleum oil began to be produced in regions such as the Middle East. To make effective use of the natural gas produced by oil rigs as a by-product of oil extraction, this led to the burning of the gas in diesel engines by mixing it with the intake air. This was the first example of a dual-fuel engine. Many different types of dual-fuel engines have been developed since then, many of which have been either diesel-ignited gas engines that use liquid fuel to ignite the gas fuel, or mixed combustion engines in which LNG tanker boil-off gas or the by-product natural gas from oil extraction is used together with another fuel. While these types of dual fuel engines satisfied market demand when the objective was to utilize excess natural gas as a supplemental fuel, engines that use natural gas with the intention of reducing environmental impact must operate by using natural gas as much as possible.

Safety and redundancy requirements specified in ship classifications technical guidelines must be satisfied if natural gas engines are to be used on ships. That is, there is a need secure provision of backup for the case of gas-fuelled operation being lost due to a problem in the fuel supply system or engine. Dual-fuel engines that are able to switch between gas and liquid fuel are recognized as satisfying this requirement. Such switchable dual-fuel engines were first developed in the late 1990s as four-stroke engines. Practical two-stroke dual-fuel engines did not appear until 2010.

Basic Features of Gas Engines

Diesel Engine Combustion

Four-stroke diesel engines compress their intake air (or fuel mixture) by a ratio of between 1/14 and 1/16 and this increases the air temperature to between 300 and 350°C. Atomized diesel fuel is then injected into the compressed air causing it to react immediately with the surrounding oxygen, initiating combustion. The fuel burns locally, in almost the stoichiometric condition, and the high flame temperature promotes the oxidation of the nitrogen contained in the air. This is why the NOx levels for diesel combustion are so high.

Gas Engine Combustion

In the case of a gas engine, the high auto ignition temperature of natural gas means that combustion does not occur simply by injecting it into the compressed air. Accordingly, natural gas engines require an ignition source to initiate combustion. Generally, a spark plug or diesel fuel atomization is used to achieve this. In the case of a four-stroke engine, a pre-mixed homogeneous mixture of the fuel and air is introduced into the cylinder. Here, the formation of NOx can be reduced by using a pre-mixed fuel-air mixture with a leaner fuel-to-air ratio (excess air ratio > 1, meaning more air than is required by the stoichiometric ratio), because it results in a lower combustion temperature in the cylinder (see Fig. 1).

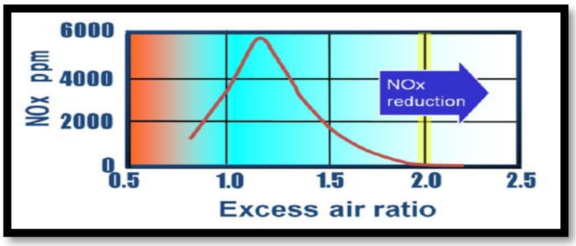


Fig. 1 Gas Engine Excess Air Ratio and NOx Emission Characteristics

The way combustion should work in a gas engine is for the ignited flame to propagate through the unburned fuel mixture until combustion is complete. However, if the thermal load and combustion pressure in the cylinder increase for some reason, such as an increase in load, the unburned fuel mixture may ignite spontaneously prior to being reached by the propagating flame. If spontaneous ignition sets off a chain reaction, this can result in serious damage to the engine due to severe pressure or temperature increases. This type of combustion is known as knocking, and it is something absolutely to be avoided in gas engines (see Fig. 2).

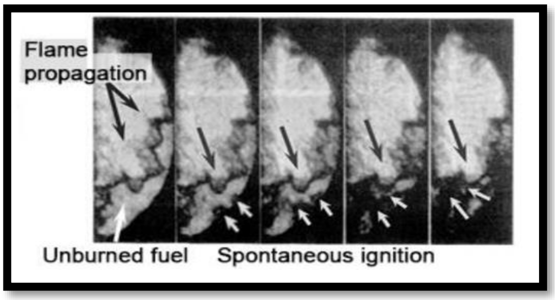
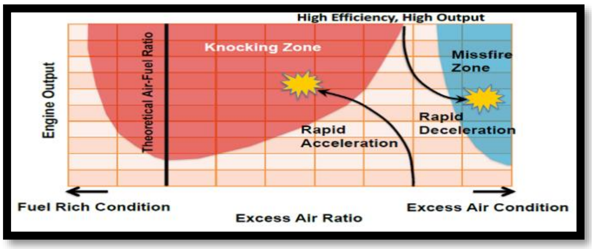


Fig. 2 Gas Combustion (Knocking)

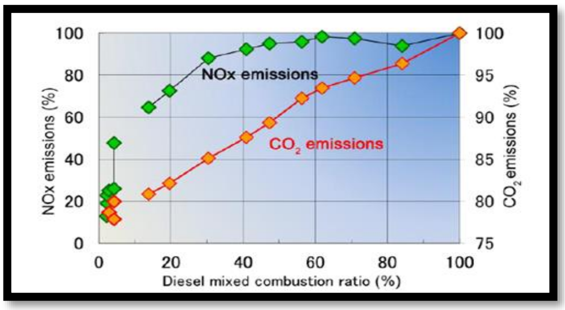
Ways of avoiding knocking include reducing the compression ratio to reduce the compressed air temperature, and increasing the excess air ratio as high as possible (using a leaner mixture) to reduce the combustion temperature. However, reducing the temperature by too much may cause misfiring due to failure of the mixture to ignite. And because misfiring may result in fires due to unburned fuel mixture



escaping into the exhaust pipe, it is something to be avoided.

Fig. 3 Combustion Characteristics of Gas Engine

Fig. 3 shows gas engine combustion characteristics, where the horizontal axis represents the excess air ratio and the vertical axis represents engine output. Knocking occurs when output is high in the region where the excess air ratio is around one, whereas the region in which misfiring occurs is at higher excess air ratios. When developing a gas engine, the combustion conditions are selected so as to avoid the excess air ratio being in the regions where knocking or misfiring occur when operating under the expected load. However, when the load varies continuously, as is the case when used for ship propulsion, there is an increased risk of knocking or misfiring due to operation deviating from the target excess air ratio. In particular, because the inlet air flow depends on the speed of the turbocharger, the engine may fail to operate under load due to the turbocharger speed being unable to follow quickly to changes in load. To achieve high output while aiming to keep the excess air ratio in the intermediate zone between the regions where knocking or misfiring occur, many recent gas engines incorporate mechanisms for adjusting the excess air ratio in accordance with operating conditions. Fig. 4 shows one such mechanism for adjusting the intake air flow. In addition to the main intake passage, it equips a bypass that returns some of the intake air to the turbocharger inlet. A bypass valve in the bypass closes under full load so that all the air discharged by the turbocharger is supplied to the engine, but it partially opens



under partial load by adjusting valve opening angle to maintain the correct intake air flow to the engine.

Fig.4 Intake Air System with Bypass

Dual-Fuel Engines

Four-Stroke Dual-Fuel Engine

Gas fuel is supplied during the intake stroke of a diesel engine, and the exhaust emissions vary according to the proportions of diesel fuel and gas fuel in the total fuel (see Fig. 5). Because the concentration of CO_2 in the exhaust gas depends on the composition of the fuel, it can be reduced by up to about 25% according to the proportions of diesel fuel and gas fuel. On the other hand, because the concentration of NOx depends on the combustion temperature, reductions in NOx can only be achieved by reducing the proportion of diesel fuel.

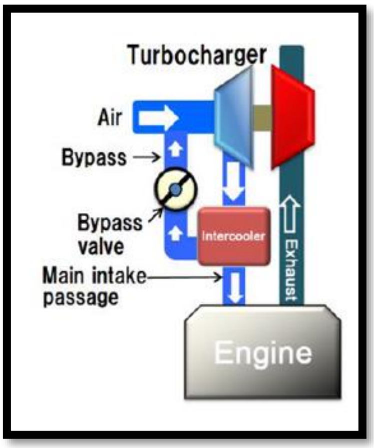


Fig. 5 Emissions in Mixed Diesel/Gas Mode

While achieving the IMO Tier 3 regulations (80% reduction in NOx) requires that the proportion of diesel fuel be reduced to 2%, no currently available nozzles are able to inject the full range of fuel injection quantities, from the amount required under rated load down to this very small quantity, in a reliable manner (without variation in the quantity injected for each cycle).To

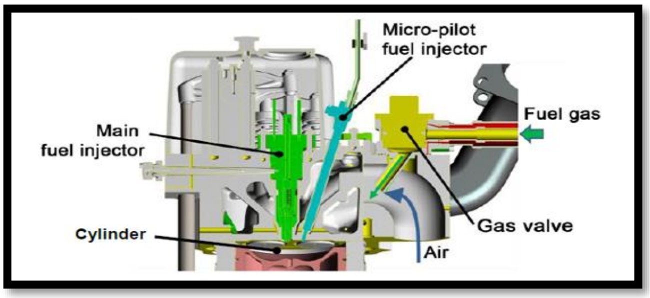


Fig 6. Cross Section of dual fuel four-stroke engine

overcome it, adding a small dedicated nozzle (micro-pilot fuel injector) that supplies diesel fuel for the ignition when operating on gas fuel is necessary. Fig. 6 shows a cross-section of a four-stroke dual-fuel engine. Gas fuel is supplied from a gas valve in the air intake manifold where it flows into the cylinder as a mixture with air. Two injectors, one is the main fuel injector used for diesel mode and another is the micro-pilot fuel injector used for gas mode, are equipped in the cylinder head, the engine can switch between diesel mode and gas mode freely with certain operating condition restrictions.

Two-Stroke Dual-Fuel Engine

Because intake air is used for scavenging in a two-stroke engine, it is not allowed to mix the gas fuel with the intake air. Instead, the gas fuel is injected into the compressed air in the same way as diesel fuel, and then ignition is achieved by injecting fuel via the micro-pilot fuel injector (see Fig. 7). Because this results in diffusion combustion, as with diesel fuel, it can reduce CO2 emissions by 20% or more, with a low level of unburned gas and CO emission and without knocking. However, the level of NOx emissions is high due to the same reason.

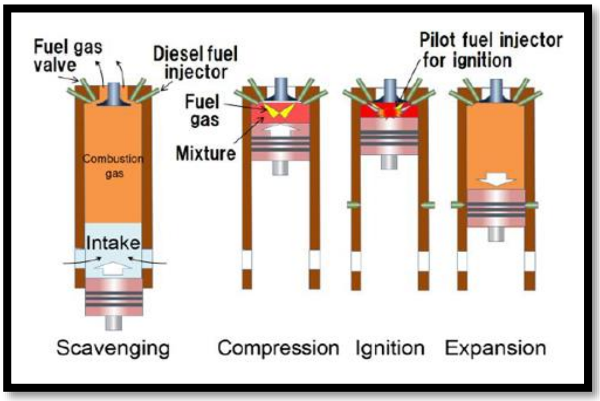


Fig. 7 Combustion Cycle for Two-Stroke Dual-Fuel Engine

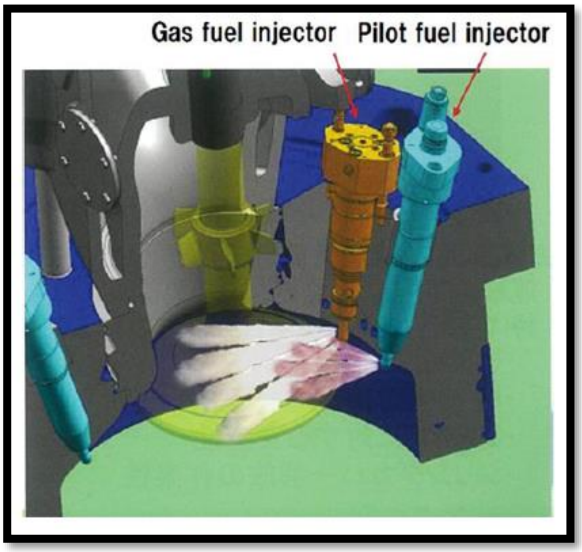
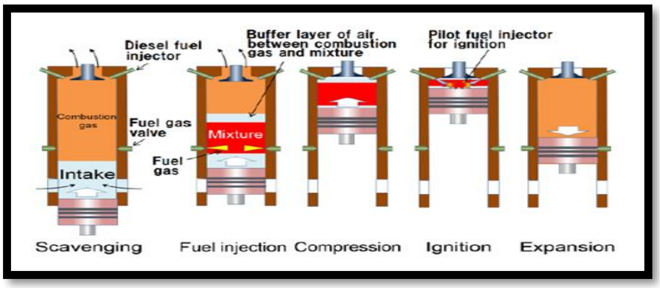


Fig. 8 Cylinder Cover Design for Two-Stroke Dual-Fuel Engine

Fig.8 shows the cylinder cover design for a two-stroke dual-fuel engine. In order to pressurize gas fuel injected into the compressed air up to 30 MPa, natural gas that has been pressurized in liquid form is vaporized and then injected into the cylinder. And because there is no risk of knocking, the switch between diesel fuel and gas fuel can be performed comparatively easily and quickly. One



proposal for improving the level of NOx emissions for two-stroke dual-fuel engines is to use a low-pressure gas fuel injection engine that can operate with a lean pre-mixed fuel mixture despite being a two-stroke engine. This involves using a fuel injection timing control method that enables the time delay of pre-mixing of gas fuel and air during the intake stroke described above that prevents the fuel-air mixture from coming into direct contact with the exhaust gas (see Fig.9). Such an engine is currently under development with the aim of achieving low-NOx emissions similar to a four-stroke engine.

Fig. 9 Combustion Cycle for Low-Pressure Gas Injection Two-Stroke Dual-Fuel Engine

Working Modes of Dual Fuel Engines

There are basically 3 modes of operation for dual fuel marine engines used on-board ships:

- When engine is well supplied with natural gas, amount of pilot fuel injected is corresponding to 6% of the total engine load. In other words, major contributor to the engine load is natural gas.
- When gas supply to the engine is constant and limited, then engine is said to be in “Specified Gas Mode”. Here gas supply is constant, but fuel oil quantity injected varies to meet changing engine load demand.
- In “Fuel Oil Only” mode, gas supply will not be available, and engine runs only on fuel oil. This mode is used when engine is unstable, such as during restricted waters, heavy weather, manoeuvring, etc.

Challenges for Dual-Fuel Engines

- Because two or more different types of fuel are combusted in the same cylinder, one of the challenges for dual-fuel engines is lubrication. Whereas lubricants with high base numbers (30 to 40 mg KOH/g) are used when operating on low grade fuel (3.5% sulphur), lubricants with low base numbers (5 mg KOH/g) are used when operating on natural gas (0% sulphur). This is why the knocking margin would be reduced in natural gas fuel mode due to the build-up of alkalis deposit and other combustion deposit on the cylinder walls that act as a heat insulator causing the combustion temperature to increase. As a result, it can be difficult to select a lubricant for dual-fuel engines that will perform effectively with both diesel mode and gas mode.
- Fuel characteristics are a problem specific to dual-fuel marine engines. Ocean-going vessels are supplied with fuel at their destinations (“bunkering”), but because the characteristics of natural gas differ depending on where it is produced, if a vessel takes on fuel with significantly different characteristics there is a risk for the engine to shut down due to knocking when it switches over to this new fuel. Currently though this problem can be overcome using particular operations such as

restricting the range of fuels that can be used or limiting output, a challenge for the future will be to develop engine technology that can deal with different fuel characteristics.

Common Rail Technology

Common rail technology is used to eliminate visible smoke from the exhaust especially at low engine load. Visible smoke generation is partly due to low injection pressure and striking of large fuel droplets on hot surface during combustion process.

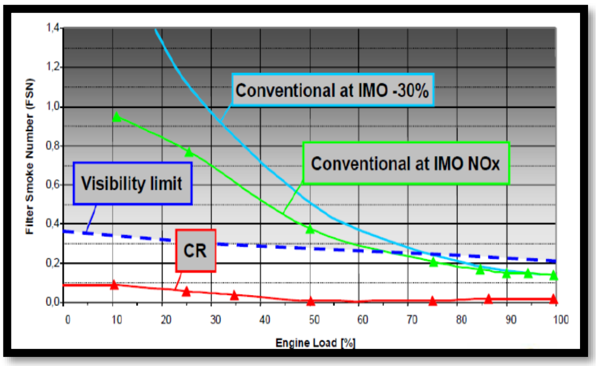


Fig. 10 Smoke Emission from Common-rail and conventional engine

Main Component of Common Rail System

It has two main component-

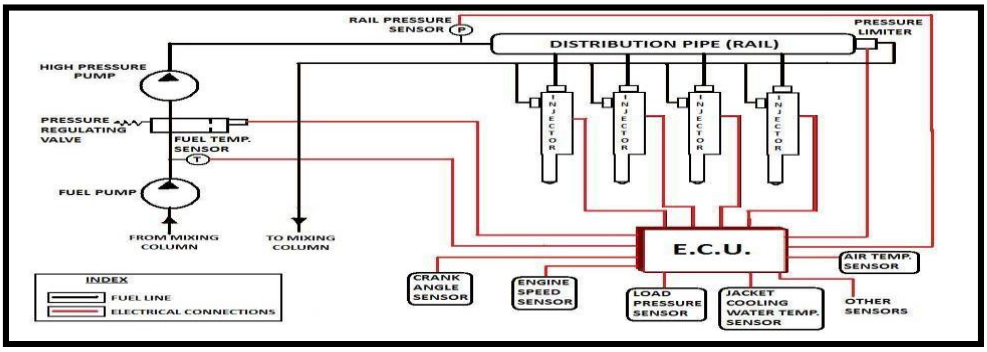


Fig. 11 Schematic Diagram of the common rail technology

- **High Pressure pump:** It helps to pressurize the fuel oil upto 1000 bar or more than 1000bar as per system design. It can be cam driven or electrical driven or both.
- **Rail Unit:** It consist of several pats such as fuel oil rail, control oil rail, servo oil rail, injection control unit, valve control unit.

Fuel oil rail: The fuel rail contains high pressure fuel of 600 -1500 bar delivered by the fuel pumps of the supply unit during engine operation. The rail pressure is regulated depending on engine load. For each cylinder, there is an Injection Control Unit (ICU) installed on the rail. The rail is heated by a trace heating piping system.

Control oil rail: The control oil rail contains 200 bar control oil (constant pressure) delivered by the control oil pumps. Control oil is used to actuate the control pistons of the ICU`s.

Servo oil rail: The servo oil rail contains fine filtered (6-micron) high pressure servo oil, ~ 80-200bar, delivered by the servo oil pumps of the supply unit, depending on engine load. For each cylinder there is a Valve Control Unit / exhaust valve actuator installed on the rail.

Injection control Unit: An ICU has two different sections-

Control oil side: The rail valves (LP1-valves) control the control oil flow to the control oil block.

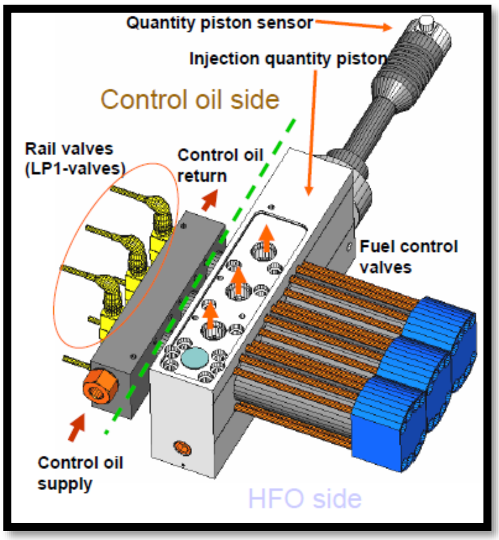


Fig. 12 Injection control unit of Wartsila RT-flex

Fuel side: The fuel control valves are actuated by pistons in the control oil block via thrust pieces. There is one valve for one injector.

The main body of the ICU includes the injection quantity piston. Its stroke measurement sensor with housing is attached to the main body.

Valve Control Unit:

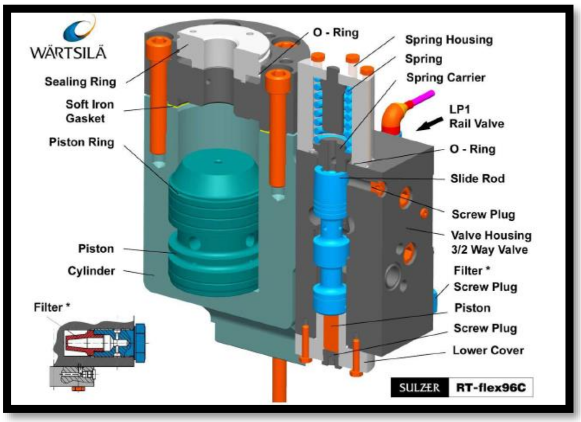


Fig. 13 Valve control unit of RT-flex96c

Advantages of Common Rail Technology

- Lower fuel consumption: Injection timing and quantity of fuel is varied during engine running to optimize engine performance.
- Reduced running costs: The reduced running costs due to extended time between overhauls and a lower part-load fuel consumption.
- High reliability and redundancy: The common-rail concept has great reliability through inherent redundancy.
- Lower NOx emissions: Electronically controlled injection timing can be optimized for fuel consumption or lower NOx emissions.
- Lower running speeds: Common rail engines can run very steadily, and without smoking, at 10–12 per cent of nominal speed.
- Design is simpler, allowing elimination of one pump per cylinder.
- Operational flexibility: Sequential cut off of fuel injectors at low loads as in case of Sulzer RT flex engines.

Intelligent Engines

What does intelligent engine mean?

The brain of the system is an electronic control system which operates the engine and the operation of the engine's system (The fuel injection, exhaust valve, cylinder lube oil and turbo charging system

Concept: -

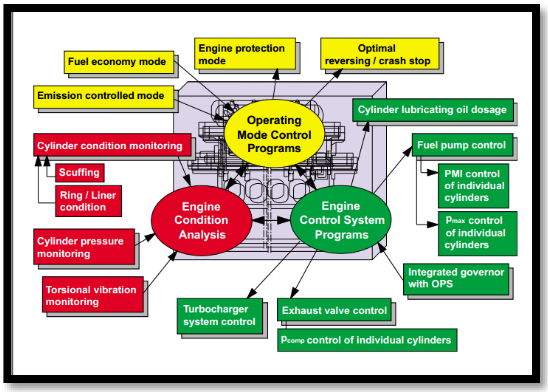


Fig. 14 Concept Diagram of Intelligent Engine

The Engine should have electronic control for fuel injection timing and shape of fuel should also be controlled electronically.

The Engine conditions should continuously analyse by EDS system.
The failures and any malfunctioning should immediately be rectified by the system.
The closing and opening of exhaust valves should also be controlled electronically.
Cylinder Lubrication system should be well tracked with respect to all engine conditions like cylinder temperature, peak pressure etc.
The engine should be capable of being operated in all loads condition.
The advent of electronic limited and injection according to the requirement of the engine led to the reduction of NOx emission.

Exhaust gas emissions flexibility:

- The engine can be changed over to various 'low emission' modes, its NOx exhaust emissions reduced below the IMO limits if dictated by local regulations.
- By appropriate selection of operating modes ships may sail with lower exhaust gas emissions in special areas, where this may be required (or be more economical due to variable harbour fee schemes) without having negative effects on the specific fuel consumption outside those areas.

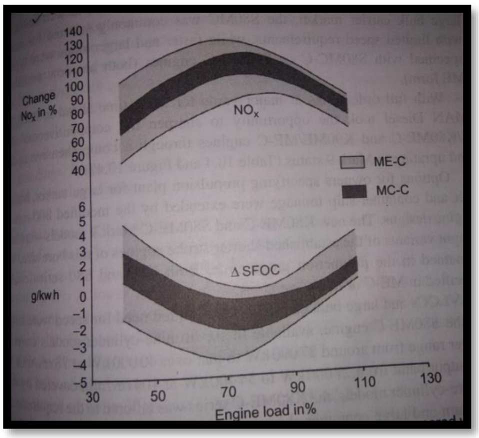


Fig. 15 Graphical Representation of NOx Emission

Operation of MAN B&W Camless engine:

Oil from the main engine LO supply or from a dedicated hydraulic supply passes through 6-micron filters before being pressurized by three engine driven axial piston pumps of the swash plate type. There are also two electrically driven pumps for start-up purposes and emergency running.

In ME engines redundant computers are connected in a network to control functions of camshaft. The Intelligent Engine consists of 4 main control unit, they are as follows: -

- Engine Control Unit (ECU).
- Cylinder Control Unit (CCU).
- External Interface Control Unit (EICU).
- Auxiliary Control Unit (ACU).

Concept of electronically controlled (camless engine) by MAN B&W:

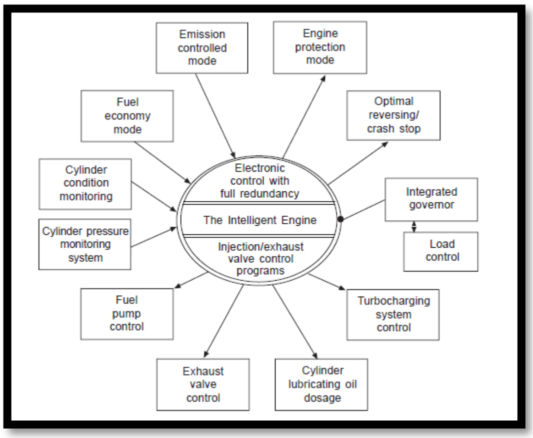


Fig. 16 Summary of MAN ME Engines

Conclusion

Both performance and preservation of environment should be given utmost importance. Thus, it is essential to develop such engine which will indeed provide such desired services. This paper is an aid to that idea. This paper concludes with a note that various development is already done and yet many more to come for better and efficient operation of marine IC engines. As we see in this paper, Dual fuel engine can reduce CO2 emission by 20-25% and NOX emission which can comply to IMO Tier 3 regulations & its operation also cost saving. In common rail technology, we see that it is reduce smoke at low load and provides more reliability & it also reduce fuel consumption. In Intelligent engine we see that emission of NOX is reduced and provide more reliability due to optimization in fuel injection. It also provides an opportunity to use the engine at various load. We expect that such technology will become a leading engine over the next decade.

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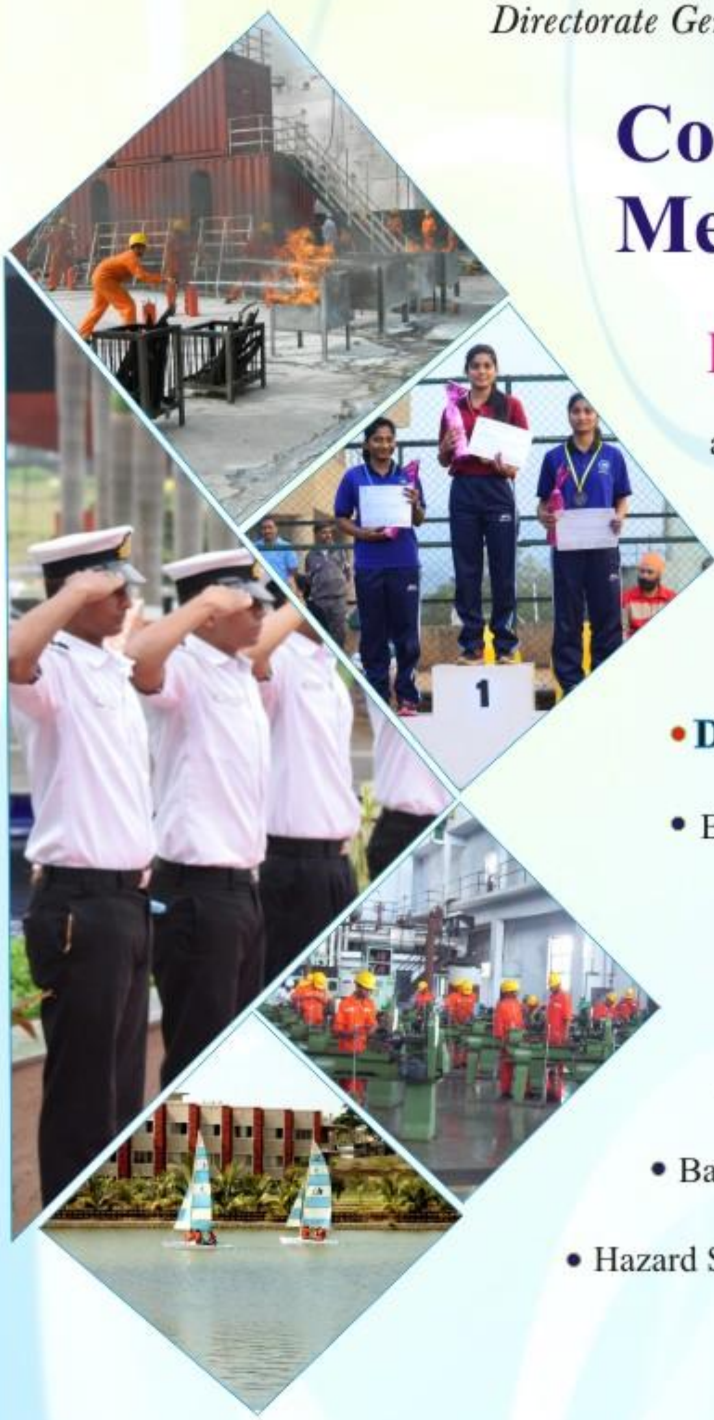

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The degree programs are affiliated to Indian Maritime University and have been awarded Grade A1 (Outstanding) by DNV. The undergraduate programs have also the distinction of being recognized by MLIT, Japan. The assigned grade reflects TMI's excellent placement track record, qualified and experienced faculty, industry leading infrastructure, strong financial standing and professional & committed promoters.

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