OCCASIONAL REPORTS

Centre for Policy Research in Maritime Studies
[C-PRiMeS]

NAVIC
Concept Notes
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About this Series

The Ministry of Ports, Shipping, and Waterways (MoPSW) has launched a strategy in which two distinct cells have been formed: Viksit Bharat Sankalp (ViBhaS), which focuses on providing policy direction for the development of a sustainable and prosperous maritime sector, and Neel Arth Vision Implementation Cell (NAVIC), which concentrates on the execution of action plans to operationalise these policies. Both cells operate through their respective functional cells, which encompass all organisations affiliated with the MoPSW.

The Indian Maritime University (IMU) serves as the nodal office for National Categories #9 and #13, with IMU faculty and staff also participating in discussions across all other functional cells. All participating IMU faculty have worked on possible studies which may be undertaken. The proposals are placed broadly as ‘Concept Paper’, ‘Research Paper’ and as ‘Policy Recommendation’.

C-PRiMeS invites feedback and ideas on these proposals. We also invite stakeholders to support the projects which may be relevant and appeal to their interests. We also invite subject matter experts to be part of our consultant team.

This will be an ongoing series under the Maritime India Vision and Maritime Amrit Kaal Vision.

The centre wishes to thank Dr. Malini V. Shankar, Vice Chancellor, Indian Maritime University, for the support and contribution.

Concept paper, Research paper and Policy recommendation

Capt. S. K. Pathak, Associate Professor, IMU Kochi Campus

Concept Paper

CREATION OF DISASTER MANAGEMENT PLAN (MAKV 2047 Theme: Lead the World in Safe, Sustainable & Green Maritime Sector)

Of India's 7,516 km coastline almost 5,700 kilometres are highly vulnerable to the impacts of tropical cyclones and related hydro-meteorological hazards. This results in recurrent loss of life and properties. Natural disaster losses equate to up to 2% of India's Gross Domestic Product (GDP) and up to 12% of Central government revenue. The Indian subcontinent is the worst affected region of the world which is exposed to nearly 10% of the world's tropical Cyclones. An effective Disaster Management Plan (DMP) helps to minimize the losses in terms of human lives, assets and environmental damage and resumes working conditions as soon as possible (MAKV 2047). This can also include the manmade disaster in Beirut (Lebanon) that occurred on 4 August, 2021 causing at least 218 deaths, 7,000 injuries, and US$ 15 billion in property damage, as well as leaving an estimated 300,000 people homeless.

Some of the Ports like Cochin port have developed Disaster management Plan. Indian Maritime University can collaborate with institutes like NIDM (National institute of disaster management) New Delhi and develop a robust Disaster management Plan for Major and non-major ports to adopt the best practices in the world. A customized plan needs to be developed for each port. This will minimize the loss of life and property.

Research Paper

DETERMINATION OF MINIMUM SAFE MANNING LEVEL ON A MERCHANT VESSEL: AN OBJECTIVE APPROACH

The determination of Minimum safe manning levels, their evaluation and approval have been particularly questioned. The research findings indicate that the detailed principles listed in International Maritime Organization Resolution A.1047 (27) (IMO, 2011) for establishing minimum safe manning are not adhered to in most instances.

The purpose of this paper is to highlight the issues related to the workload assessment procedure for determining the minimum safe manning level on merchant vessels. Presently, the framework for determining the minimum safe manning by the administration and companies mainly focuses on the size, engine power of the vessel and route of the vessel. Workload is an interaction between the operator and their task. Workload is a latent variable. Workloads should be determined to find a correlation with the safe manning on ships. NASA-TLX and Bedford Workload scale will be administered using the survey design method to collect the data on the measurement of workload on vessels of similar type, size and route.

The Shipping companies and Maritime administration will be benefitted as the data will be helpful in deciding upon the safe manning levels of personnel on-board a merchant vessel.

Policy recommendation (MAKV 2027 Theme 8: Strengthen India's global maritime presence)

The IMO Assembly Strategic Plan covers a six-year period and is an expression of the Member States' commitment to ensuring the fulfilment of the Organization's aims and objectives in a uniform manner on a global basis, and to setting clear priorities for the purpose of achieving them. Each of the strategic directions for every 6 years is monitored through performance indicators. One of the indicators includes the number of proposals submitted to IMO. India ranks 21 in the number of submissions at IMO, its submissions are at least 3 times less than other leading voices at IMO (MAKV 2047).

One IMO Cell should be set up at IMU under C-PRiMeS. This should include national and international experts who can foresee the gaps and identify the problems to be focused on a particular committee/subcommittee. This can increase the number of India's proposal submissions to various committees and subcommittees at IMO. This cell can also assist DG shipping in the speedy implementation of various conventions that India is yet to become a signatory and revise the existing rules that India has already signed.

Concept paper, Research paper and Policy recommendation

R. Prasanna Kumar, Associate Professor, IMU Chennai Campus

Doubling the seafarers count from India: challenges and solutions

Introduction

India for centuries has been an active seafaring nation & an important manpower supplier to shipping from the Stone Age to the current modern times. Today it boasts of a well-established ecosystem that trains & prepares a large number of candidates every year for a career in shipping. Indian seafarers are in high demand internationally for their professional competence, and besides manning ships of different flags/nationalities, they occupy many key positions in the shipping industry worldwide.

There was a progressive growth in the number of Indian seafarers from 73,610 in the year 2010 to today's level of 285,454. Maritime India Vision 2030 envisioned increasing the seafarer count to double the present numbers of 250K. In this active seafarers count, of which 151,840 were ratings & 98,231 were officers.

Doubling the number of seafarers from India would require addressing several challenges across multiple dimensions, including training, infrastructure, policy, and market dynamics. Here are the key challenges:

Training and Skill Development

Capacity of Training Institutes: Limited availability of maritime training institutions and their ability to handle increased enrolment without compromising quality.

Skill Gap: Align training with the evolving demands of the global shipping industry, such as digitalization, automation, and green shipping technologies.

Quality of Training: Variability in the standards of education and practical training across institutions.

Regulatory and Certification Bottlenecks

Compliance with International Standards: Meeting the stringent requirements of the International Maritime Organization (IMO) and other global standards.

Certification Backlogs: Delays in processing certifications, renewals, and endorsements.

Flag State Preferences: Preference by certain flag states for seafarers from specific countries, creates barriers for Indian seafarers.

Employment Opportunities

Global Competition: Competing with seafarers from other countries, particularly the Philippines, China, and Eastern European nations, which are also prominent suppliers of seafarers.

Over-reliance on Certain Roles: Limited diversification of Indian seafarers into specialized or senior-level roles.

Recruitment and Placement Issues

Exploitation in Recruitment: Concerns about unethical practices, such as fraudulent agents.

Unemployment and Underemployment: Managing a potential oversupply of seafarers if industry demand does not match the increased output.

Infrastructure and Logistics

Inadequate On-board Training Berths: Insufficient availability of ships for cadets to complete mandatory sea-time training.

Training Facilities: Need for modern simulators and infrastructure to train seafarers for advanced technologies, such as LNG carriers and autonomous vessels.

Awareness and Perception

Public Awareness: Limited understanding of maritime careers among Indian youth, particularly in rural areas.

Perception of the Profession: Concerns about job security, work-life balance, and career growth opportunities deter some potential candidates.

Government Policies and Support

Bureaucratic Hurdles: Lengthy processes for approvals, inspections, and licenses for training institutions.

Inadequate Financial Support: Limited availability of scholarships, loans, and subsidies for maritime education and training.

Flagging Out of Ships: Indian shipping companies registering their vessels under foreign flags can limit job opportunities for Indian seafarers.

Industry Trends

Automation and Digitalization: Increasing automation in shipping reduces demand for certain roles, necessitating a shift in training towards specialized, tech-oriented skills.

Environmental Regulations: Training for compliance with green shipping regulations like IMO 2020 and decarbonisation initiatives adds complexity.

Potential Solutions

Addressing these challenges requires a coordinated effort between the Indian government, shipping companies, training institutes, and international organizations. Strategies could include:

- Expanding and modernizing training infrastructure.
- Streamlining regulatory processes.
- Promoting the profession through campaigns and scholarships.
- Strengthening partnerships with global shipping firms to ensure job placements.

Based on the above note, the roadmap for achieving the vision of reality should be developed.

Concept paper, Research paper and Policy recommendation

Capt. Parag Mehrotra, Assistant Professor, IMU Navi Mumbai Campus

Concept Paper

MIV 2030 focuses on the development of skilled seafarer communities in India, aiming to increase the percentage of Indian seafarers in the global maritime workforce. Achieving this goal requires enhancing the quality of maritime training to meet the latest industry standards. Information and Communication Technology (ICT) in maritime training plays a pivotal role in achieving this objective. Proper utilization of ICT can significantly improve training effectiveness and accessibility, aligning with global trends. To maximize its potential, it is essential to develop and implement sound policies that facilitate the integration of ICT in seafarer training. One of the major research in this domain is to understand how to best harness ICT and create the necessary policies to support this transformation.

Research Paper

Study of the Impact of Information and Communication Technology in Maritime Training

Information and Communication Technology (ICT) in education refers to the use of digital tools to enhance teaching, training, and learning. ICT supports students in developing skills, fostering critical thinking, and improving learning outcomes. It also enables teachers to enhance their instructional methods, streamline classroom management, and better engage with students. In maritime education, ICT plays a crucial role in increasing student engagement and improving knowledge retention. When ICT is integrated into lessons, students become more engaged and tend to learn faster compared to traditional teaching methods. This is because technology offers diverse opportunities to present content in more interactive and enjoyable ways, making learning both fun and dynamic.

Examples of ICT in maritime education include: Computers, Tablets, Interactive, whiteboards, Software applications, the internet, Cloud storage, Blogging and social networking and Planning tools. Nowadays all maritime training institutes are using ICT widely for training seafarers and ICT is contagiously improving the quality of seafarers. Many researches have proved that use of ICT in many other types of education is very advantageous and in maritime education also the result is the same.

Benefits of ICT in education

Access to Resources: ICT provides students with access to a wide variety of resources, including learning materials, audio-visual content, and online projects.

Personalized Learning: ICT enables students to learn at their own pace and in ways that align with their individual learning styles.

Improved Academic Performance: ICT helps students develop new skills, enhance creativity, and improve concentration and information retention.

Better Classroom Management: ICT assists teachers in saving time and managing classrooms more efficiently, enhancing overall productivity.

Distance Learning: ICT facilitates distance learning, allowing students to study remotely without the need to be physically present in a classroom.

Policy recommendation

The following Policies are recommended to increase the percentage of skilled seafarers in the International shipping market:

ICT Training for Maritime Trainers and Teachers

Policy Objective: Establish mandatory ICT training programs for maritime trainers and educators to ensure they are proficient in using digital tools, e-learning platforms, and modern teaching methodologies.

Action: Develop and offer regular training workshops, certifications, and support for maritime trainers to enhance their ICT skills.

Curriculum Integration and Digital Tools

Policy Objective: Ensure that the maritime training curriculum incorporates ICT tools and technologies that align with international standards and emerging trends in the maritime industry.

Action: Develop digital platforms and online resources that complement traditional maritime training, including simulations, virtual classrooms, and interactive learning modules.

Concept paper, Research paper and Policy recommendation

Dr. Amarish Kumar Shukla, Faculty, IMU Kolkata Campus

Development of Light Weight Composite Foam and its Performance Evaluation for Marine engineering Applications

Project Summary

In the present scenario, there is a demand for lightweight, high strength, and environment friendly materials. Aluminium is a well-known lightweight material, but the monolithic aluminium alloy suffers a poor mechanical, wear and corrosion resistance due to low hardness which acts as a barrier for its industrial applications, particularly in the field of marine, automotive and aerospace sectors. These problems could be overcome by using secondary reinforced particles such as silicon carbide, aluminium oxide etc. The reinforcement of second ceramic particles into monolithic aluminium alloy requires tailoring the microstructure, mechanical, tribological, corrosion and properties of matrix material to enhance its application on a large scale. The reinforcements of ceramic particles in an appropriate ratio, improved strength to weight ratio, enhanced elastic modulus, and other mechanical properties of composites (Shukla et al. 2023, Rohatgi et al. 2006). However, the reinforcement of these aforementioned ceramic particles increases the overall cost, energy consumption, and density of the final product (Shukla et al. 2021, Shukla et al. 2019, and Singh et al. 2014). The cost of composite could be minimised by the use of lightweight microballons, without compromising the strength of the composite. In addition, the addition of a foaming agent helps to lower the density and increase the plateau strength of the foam. The melting casting route allows the development of aluminium foam with a uniform distribution of reinforced particles compared to other manufacturing methods. However, there are many obstacles in achieving the mixing of reinforced micro balloons, uniform pore size and shape, and desirable properties.

Objectives

The aims and objectives of the proposed project are to develop lightweight and high strength aluminium foam and to understand the microstructure, porosity distribution, mechanical properties, wear, and corrosion properties of aluminium foam. In this study, the aluminium foam will develop by using the melting and casting route. The effect of foaming temperature and stirring speed on the porosity fraction and mechanical and corrosion properties will be examined. Finally, the optimization of process parameters in terms of optimised porosity and their strength will be delivered through a detailed structure-property parameter. The developed foams are characterised by their nature and the degree of porosity. The porosity fraction depends on several parameters such as foaming agent, molten temperature and stirring speed. These processing steps play a key role in the development of foam. In the present project, the aluminium foam will be used for the crashworthiness and corrosion resistance applications for marine and defence applications. The strength of the foam is directly correlated to the density of the foam. So, optimisation of density and strength is important for developed foam. As specified earlier, the proposed project will be divided into two parts:

Part I: Development of foam by varying processing parameters to optimise the density and strength of the developed foam.

Part II: To understand the effect of processing parameters such as foaming agents, the temperature of utilised molten metal, stirring speed, and foaming time, on microstructural, porosity distribution and mechanical behaviour of developed foam.

Part III: To study the corrosion behaviour of developed foam.

Keywords

Aluminium foam, stir casting, microballoons, mechanical properties, corrosion.

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Concept paper, Research paper and Policy recommendation

Dr. Deepak Mishra, Assistant Professor, IMU Kolkata Campus
Shabnam Parveen, Assistant Professor, IMU Kolkata Campus

Study the implementation of HVDC subsea cables in India to reduce GHG emissions and attain a sustainable marine ecology

Introduction

The ambitious goal of the Greenhouse Gases Emissions (GHGe) Strategy was adopted by the International Maritime Organization (IMO) in 2018. The strategies emphasized reducing Greenhouse Gas (GHGs) emissions to 50% of their 2008 levels. IMO, 2021 has a target of reducing 1.5% of carbon dioxide from 2023 to 2026 every year [11].

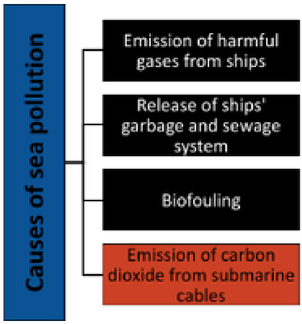

Fig 1 Factors contributing to sea pollution

The major marine carbon contributors are electric power generation through submarine sea cables and transportation. The demand for power is increasing steadily, which invariably increases the CO2 burden. Various High Voltage (HV) technologies capacitate the requirements of a sustainable future. Transmission of power over long distances using an HV transmission system increases efficiency and provides optimal transmission voltage. A High Voltage Alternating Current (HVAC) transmission system is simple as it implements stepping up of the generated power for suitable transmission by the transmission lines. In comparison with HVAC, High Voltage Direct Current (HVDC) might be complex and has high capital cost as it incorporates an aggregation of AC/DC converters, but it has comparatively low power losses over long distances [1].

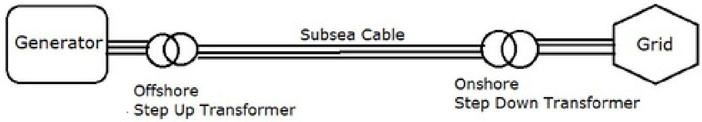

Fig 2 The basic structure of the subsea HVAC power transmission system

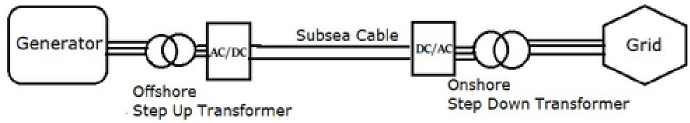

Fig 3 The basic structure of the subsea HVDC power transmission system

The non-existence of induced losses in armouring, neighbouring cables and metal structures gives better utilization (kV/mm) in HVDC cables [2-3] [5].

A higher average working electric field of the cable insulation at the rated voltage can be obtained in HDVC cables than in HVAC cables. Subsequently, if the average working electric field is high, the cable will be cheaper for a given rated voltage due to thinner insulation. Insulation compounds for HVDC cables have a better forbearance to rated voltage than those for HVAC cables, enabling better utilisation of HVDC versus HVAC cable insulation.

HVDC saves fossil fuel consumption and CO2 release in the case of fossil fuel-powered plants which implies the high generation of the amount of electrical energy transmitted to the loads. Alongside Corona Effect (CE) the interference with nearby submarine communication lines is more in HVAC.

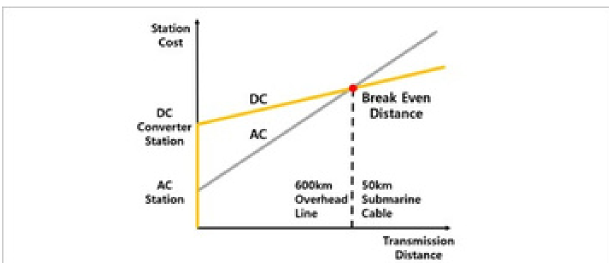

Fig 4 Cost Analysis of HVDC vs. HVAC submarine cables [4]\

Table 1 Comparison between HVDC and HVAC transmission system cable

HVDC	HVAC
No. of Cables – 2	No. of Cables - 3
Ohmic losses – Conductor	Ohmic losses – Conductor
	Induced losses – Armouring, Neighbouring Cables, Sheath

Basically, two types of transmission cable systems exist for HVDC – extruded cables and paper-insulated cables [3]. Since the 1950s paper insulated mass impregnated cables have been very popular. The extruded cable technology was first discovered in the laboratory by the joint Japanese industry, at that time Electric Power Development Co., Furukawa Electric Co., Fujikura, Hitachi Cable, and Sumitomo Electric Industries, and by the European manufacturer, ABB [6].

The rate of power transportation by a pair of HVDC Light cables depends on the cable design and on the laying conditions. A cable pair that is laid deeply, and closely spaced in the ground with high thermal resistivity in a warm country will have a smaller power transportation rate than a cable pair with opposite conditions. Hence implementation of HVDC cables should be encouraged, but due to the variable climatic conditions around the year, the comparative study of GHGe with respect to power generation will be variable for India when compared with other cold countries of Europe.

At COP26, India announced its target of achieving zero carbon footprint by 2070. This will be an important milestone in the climate change mitigation initiatives. The per-capita emissions (1.8 tons CO2) are low, yet India is the third-largest emitter globally, emitting a net 2.9 gig tons of carbon dioxide equivalent (GtCO2e) every year as of 2019. About 70% of these emissions are driven by six sectors: power plants, steel manufacturing plants, automobile industry, aviation, cement, and agriculture.

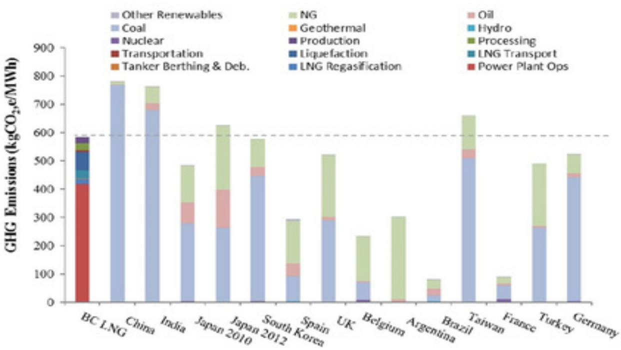

Fig 5 Life cycle of Greenhouse Gas Emissions (GHGe) of electricity generation for various countries [5]

Dating back to 2008, the per-unit-weight power (PHVDC) carried by an HVDC extruded cable was reported as ranging between 20 and 50 MW/kg, whereas the per-unit-weight power(PHVAC) carried by an HVAC extruded land cable was reported as ranging between 10 and 20 MVA/kg[3]. Depending on the cable design and cross-section these ranges can vary.

In this way, let us assume the per-unit-weight power PHVDC, subsea = (20 + 50)/2 = 35 MW/kg for HVDC extruded submarine cables and PHVAC, subsea = (10 + 20)/ 2 = 15 MW/kg for HVAC extruded submarine cables. These are some rough estimates which are taken for future prediction of CO_2 emissions.

In India after 1 year of operation i.e. 8760 hours (hyear)

$$WHVDC = PHVDC \times hyear = 35 \times 8760 = 3.07 \times 10^5 \text{ [MWh/kg]}$$

Thereby saving a yearly amount of

$$GHGHVDC = WHDVC \times GHGe = 3.07 \times 10^5 \times 790 = 2425.3 \times 10^5 \text{ [tons/kg]} \quad (1)$$

Similarly,

$$WHVAC = PHVAC \times hyear = 15 \times 8760 = 1.31 \times 10^5 \text{ [MWh/kg]}$$

Thereby saving a yearly amount of

$$GHGHVAC = WHVAC \times GHGe = 1.31 \times 10^5 \times 790 = 1035 \times 10^5 \text{ [tons/kg]} \quad (2)$$

From the above calculations, we can say that the ‘per-unit-weight of cable’ amount of GHG saved per year with the HVDC extruded cable is greater by nearly a factor of two compared to the amount of GHG saved per year with the HVAC extruded cable.

The laying environment is different, even though the European Union (EU) has significantly achieved lower GHGe over the past two decades [6-7]. HVDC is going to be the transmission technology of our future, as transmission by HVDC diminishes the losses, and costs and needs less space compared to HVAC transmission [1]. In this global scenario that is ever more stressed by the growing emissions of greenhouse gases, HVDC transmission is a solution to transport sustainable energy to regions of consumption, decarbonise the power and energy system, and foster the reliability and resilience of inter-connected HVAC/DC transmission grids. HVDC transmission cables will play a fundamental role in making a cleaner, achievable, sustainable and affordable energy mix available to all. This will not only increase public acceptance of transmission grids but also improve the quality of life of future generations.

Proposed Methodology

In India, the demand for power has been increasing due to its developments and population additions. HVDC can be the future as it has already proven its merits in the EU and because of this, the GHGe has reduced over the years. We can use the same for our environment by assessing the methodology by performing HVDC system modelling and stability analysis using PSCAD, and MATLAB. Thereafter an attempt can be made to implement the same for real-life HVDC cables from a region and monitor the GHGe scenario over a year. Along with the HVDC, the contribution of GHGe from other sources should also be monitored.

Conclusion

Once formulated under a proper laying environment the implementation of HVDC subsea power cables will be able to help India to achieve its ambitious goal that was mentioned in COP26 i.e. to become a carbon-neutral society by 2070.

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Concept paper, Research paper and Policy recommendation

Dr. Deepak Mishra, Assistant Professor, IMU Kolkata Campus

Advances in Electrical Drives for Modern Ship Propulsion System

Introduction

In recent times, ships based on electrical propulsion are gaining popularity with continuous growth of submarines and medium capacity container ships. With rapid development of power electronics devices, the application of synchronous and induction motors are becoming the favourite choice as a propulsion system compared to conventional propulsion systems.

As per the requirement of power and structure of the propulsion system, several electrical propulsion systems have been evolved recently based on two-level and multilevel converters [1-3]. In order to explain this, various arrangements have also been reported that either integrate all electrical components in only one power system or segregate the mechanisms in several power systems depending on the requirement of large power [3-5].

Figure 1 shows the various types of propulsion system used according to the requirement of power.

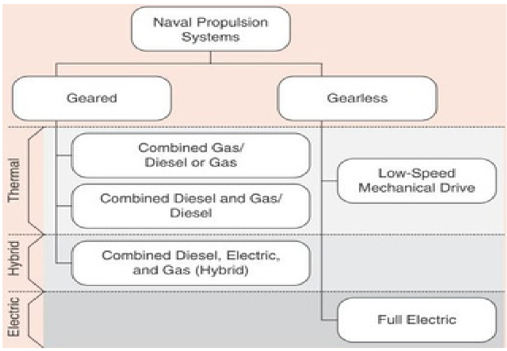

Fig 1 Several types of propulsion system used as per the power requirement

Thermal Combined Propulsion Systems or Diesel–Mechanical Propulsion System

This propulsion system is mainly based on a combination of different thermal cycle machines (i.e., diesel engines and gas turbines) with different nominal speeds, which are selected to work alone or together via a synchronous clutching system, depending on the operating requirements of a vessel. The propulsion system involves a shafting configuration and the propeller. The most suitable mechanism must be selected based on the application and power requirements. Power developed from the engine is converted to the mechanical rotation of the crankshaft with the propeller using a gearbox to drive the propulsion system [6-8]. The gearbox is required for smaller ships to reduce engine speed and reverse shaft rotation; however, it is not required for large ships as reversing can be performed by reversing the engine rotation. The main disadvantages of combined propulsion systems relate to the complexity of the gearing system and the large machinery space required for the main and auxiliary equipment. In the case of thermal combined propulsion systems, there is no fall-back plan, so there might be the possibility of failure of any components which ultimately leads to the loss of propulsion. Figure 1 shows the diagrammatic representation of a simple diesel–mechanical propulsion system.

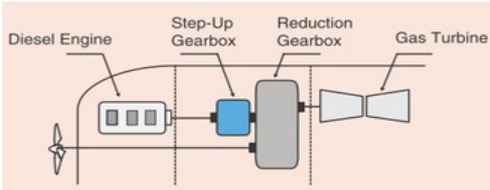

Fig 2 Simplified diesel–mechanical propulsion power system.

Hybrid Propulsion Systems

The hybrid propulsion system uses a combination of diesel engines or gas turbines with electric motors, as illustrated in Figure 2, to provide a wide range of propeller speeds. One of the main advantages of this configuration concerns an increase in efficiency at low loads. Hence, less fuel consumption, fewer emissions, and a small footprint are achieved. However, the main drawback stems from the oversized design of the main generators that are necessary to provide power to the electric machine for propulsion and the ship's auxiliary services [8-9].

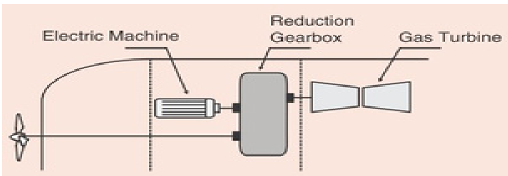

Fig 3 Simplified hybrid propulsion power system.

For the aforementioned reasons, the concept of the advanced hybrid drive system (AHDS) has been proposed for fuel savings at low ship speeds [1-4]. Diesel–electric powered by Gensets consists of a direct mechanical drive such as a diesel engine to provide high speeds connecting through a gearbox and to the propeller. Additionally, an electric motor coupled with the same gearbox or directly to the propeller could be used to provide propulsion for lower speeds and avoid overloading the main engine.

Full-Electric Propulsion Systems

Full-electric propulsion is a configuration in which the main prime mover is an electric motor directly connected to the propulsion shaft, with or without a gearbox. Electric power is provided by generators operated by a gas turbine, a diesel engine, or a combination of both. The main advantages of full electric propulsion include better dynamic performance (start-up, changes in speed, and regenerative braking), reduced fuel consumption due to the more efficient and flexible use of generators that work within their minimum specific fuel consumption region, and the possibility of having shorter shaft lines because only the electric motor must be installed close to the propeller.

Moreover, outer azimuthal pods also offer flexibility to allocate the generators elsewhere on a ship (they do not require dedicated machinery spaces), as shown in Figure 3, thus reducing the required mechanical area and providing extra watertight compartments, which improves a ship's stability conditioning (machinery spaces are flooded areas).

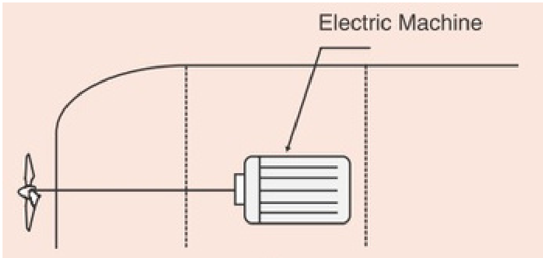

Fig 4 Simplified fully electrical propulsion power system.

Based on the structure of electric propulsion, it can be divided into two parts (1) Segregated Power System (SPS) and (2) Integrated Power System (IPS).

The segregated power system (SPS) results in two separate electrical systems, one dedicated to providing power for propulsion and the other reserved for feeding auxiliary loads As a consequence of this particular arrangement, the generator sets dedicated to each system do not have the ability to interact with other systems since they have their own voltage and frequency. In the SPS, nearly 90% of the installed power is dedicated to propulsion, making this structure very attractive for applications where a high level of manoeuvrability is required [1-2]. However, most of the time, the generators operate below the rated load, increasing emissions. The excess power is not available for the auxiliary loads, hence reducing the power grid flexibility as well as the availability and redundancy of the propulsion system.

In integrated power systems (IPS) the total power required by the propulsion system and the service loads is supplied by several generators connected to the medium-voltage bus and then distributed to the low-voltage bus through transformers [9]. The propulsion motors are fed from power converters, which are connected directly to the main bus bar, and the service loads are fed from a low-voltage busbar, using step-down transformers. The main features of an integrated grid architecture include flexibility, availability, and system redundancy. The IPS also offers the ability to manage the generated and delivered power, optimizing the number of running generator sets, which enhances fuel efficiency and reduces emissions.

Control Strategies

Control strategies are required in any electrical propulsion with an AC or DC distribution system. Both systems with droop control as the most promising primary control strategy when compared to heuristic control or equivalent consumption minimization strategy in which the droop control demonstrates a reduction in fuel consumption of 5–10% [1]. Speed droop control and voltage droop control are the types of droop control available in the system; each operates in a similar methodology but with different inputs. Different controllers can be used to assess the performance of a system.

Proposed Methodology

The present work is aimed at improving the performance of electrical propulsion systems. The steps outlined below briefly explain the methodology that will be undertaken for the proposed research work. Initially, the work will be started based on simulation of various types of ship propulsion (mentioned in the introduction part). The performance of the system will be observed using different combinations of controllers and types of alternative fuels. Thereafter, an attempt will be made to maximize fuel efficiency, reducing emissions while keeping sufficient load on vessels. Further, several energy management systems strategies such as the ECMS, RB and MATLAB optimization toolbox can be explored to make the system economic.

Conclusions

Once formulated, the proposed methodology will be able to extract reliable and pertinent information regarding the best fuel and suitable controller for the system.

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Concept paper, Research paper and Policy recommendation Dr. A. Arun Premnath, Associate Professor, IMU Mumbai Port Campus

Research Paper

Innovative and Sustainable CFRP Composite Materials for Marine Structural Applications

Project Summary

Carbon fibre-reinforced polymer (CFRP) composites find its application in marine industry owing to their excellent mechanical properties such as low density, light weight, high strength-to-weight ratio, high fatigue strength and corrosion resistances. Composite materials, with specific reference to fibre-reinforced polymers, have been extensively incorporated in the marine industry Research following their early applications after World War II when composites were designed to overcome corrosion issues experienced with steel and aluminium. Over the years, composites have been developed to meet the growing and variable demand coming from the marine sector, still preserving a relevant usage for manufacturing of consolidated elements, including gratings, ducts, shafts, piping, and hull shells. Carbon/epoxy composite often employed in marine structures like ship masts, risers, and subsea pipelines [1-3]. In recent years, racing powerboats made of composites are becoming more and more common for long-lasting high performance and safety. The proposed research work will be focused on the effect of nano-SiC particles on mechanical and water absorption properties of carbon fibre reinforced epoxy composites. The composites will be fabrication using compression moldings technique [4]. The various mechanical properties such Hardness, Fatigue strength and Tensile strength will be measured using Hardness Testing Machine, Fatigue Testing Machine and Universal Testing Machine respectively. Water absorption test will be calculated with respect to sea water to determine the rate of water absorption as per ASTM standard D570. In addition to that the morphology of the specimen will be examined through scanning electron microscope. The innovative composite materials thus fabricated would be a replacement for harsh and corrosive marine structure.

Objectives

- To fabricate the composites by compression molding technique
- To study the mechanical properties of the fabricated CFRP Nano composites
- To study the water absorption characteristics of the composites for marine application
- To examine the characteristics of the fabricated composites by scanning electron microscope

Keywords:
Marine application, Carbon fibre, composites, Mechanical properties, Water absorption properties.

Expected Output and Outcome of the Proposal

The combination of light weight and durability means that ships built with CFRP composites consume less energy for propulsion, leading to lower operating costs and reduced environmental impact. This can play a crucial role in achieving sustainability goals in the maritime industry.

The proposed research holds great potential for significantly advancing the maritime industry, especially in the context of shipbuilding and repair. By introducing innovative materials in shipbuilding, you could help reduce environmental impacts while enhancing the safety and efficiency of vessels.

This aligns perfectly with the vision of Amrit Kaal 2047, which emphasizes modernization and growth in the shipbuilding industry. The integration of such advancements in the shipbuilding structure could propel India to the forefront of global shipbuilding, creating a more resilient and sustainable future for the industry.

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About C-PRiMeS

The Centre for Policy Research in Maritime Studies (C-PRiMeS) was established to meet the growing needs on policy development for India's maritime sector. With a coastline of 7,516 kilometres, more than 1,300 islands, and an Exclusive Economic Zone (EEZ) covering over two million square kilometers, India's growth is dependent on maritime sector. With over 90% of its trade passing through the Ports and vibrant ancillary industries of shipbuilding, fishing, offshore oil and gas, and deep seabed mining, India is poised to become a maritime might in the coming times.

Inaugurated on November 4, 2022, by Shri Sarbananda Sonowal, Minister of Ports, Shipping, and Waterways, C-PRiMeS is designed to support the realization of India's maritime vision outlined in Maritime India Vision 2030 (MIV-2030) and Maritime Amrit Kaal Vision 2047 (MAKV-2047).

The Centre's core mission is to provide unbiased, data-driven insights that empower policymakers to make informed decisions for the maritime sector's sustainable growth.

C-PRiMeS has several strategic objectives, such as consolidating maritime data for better policy analysis, promoting studies and research across various maritime disciplines, and establishing itself as a premier think tank in India. The Centre actively seeks collaborations with industry, academia, and government bodies to support maritime research, training, and funding opportunities.

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- Maritime Biodiversity: Exploring the preservation of marine ecosystems
- Maritime Domain Awareness and Maritime Security: Enhancing security and surveillance in maritime spaces
- Ocean Science: Researching ocean dynamics and marine life
- Maritime Conflicts: Analyzing maritime territorial disputes and conflicts
- Global Maritime Interactions: Understanding international collaborations and tensions in maritime affairs
- Maritime Heritage: Preserving and promoting the cultural significance of maritime history
- Blue Economy: Promoting sustainable economic growth through marine resources
- Ocean Governance: Focusing on global, regional, and national governance of oceans
- Maritime Legislations/Maritime Law: Studying maritime laws and their impact on governance

Through these research verticals, C-PRiMeS aims to advance India's maritime policy and contribute to global maritime knowledge and the trade.

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