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Recent Developments in Removal of Hull Fouling in Ships

Emiema S.[1], Ravikumar, T.[2], and Mariappan S.[2]
[1]P.G. Scholar, Department of Fishing Technology and Fisheries Engineering, Fisheries College and Research Institute, Thoothukudi
[2]Assistant Professor, Department of Fishing Technology and Fisheries Engineering, Fisheries College and Research Institute, Thoothukudi, India

SUMMARY

Fossil fuels used in operation of the fishing vessel contribute the major cause of greenhouse emissions. Hence reducing use of fossil fuel or finding an alternative way to reduce the fuel consumption is the need of the hour. Several researchers have found that hull fouling done while the ship is drydocked helps to reduce the fuel consumption in ships. Hull fouling is the accumulation of marine organisms on the hull portion of the ship which increases the overall weight of the ship thus increasing the fuel consumption for increased frictional resistance caused in the sea. There has been several methods used for the process of hull fouling removal. They includes manual cleaning, powered rotatory brushes, contactless cleaning technology. With the advanced technology various new methods like laser cleaning, ultrasound cleaning etc has also been implemented in hull fouling. This paper describes the hull fouling and the methods to remove it.

INTRODUCTION

Fuel accounts for 50–70% of a ship's overall operating costs, making it another significant cost factor in international transportation. The marine sector has mostly concentrated on increasing energy utilisation by technological and operational methods (Rehmatulla and Smith 2015). Alternative fuels and alternative energy sources are not widely utilised in the sector. Although several energy efficiency techniques have been found to be cost-effective (Psaraftis and Kontovas, 2013), there are still plenty that might be implemented. Several methods, such as employing alternative sources of energy (solar or wind propulsion), fuels with reduced carbon emissions like liquid natural gas or biofuel are alternative methods. Other alternative method is proper drydocking the fishing vessels at certain intervals. Hull fouling on the vessels is a major problem that leads to higher fuel consumption and consequently increased air pollution (Tribou and Swain 2010). Hence hull fouling removal can reduce the fuel consumption thus reducing the pollution. In this article various methods followed for hull fouling removal is discussed.

Hull fouling and its impact on ships dynamics

Vessels or structures that partially reside below the surface of seawater or freshwater are subjected to various levels of fouling by marine or fresh water from lakes and rivers organisms, respectively. Hull and propeller performance may deteriorate over time because of biofouling and mechanical damage; thus, poor hull conditions may decrease the energy efficiency. Moreover, biofilms on the hull can affect the ship's dynamics by increasing drag and the required propulsion. Various cleaning methods and devices applied to dry-dock cleaning and underwater cleaning are introduced in detail, including rotary brushes, high-pressure and cavitation water jet technology, ultrasonic technology, and laser cleaning technology.

Methods of removing of hull fouling

In summary, the most common methods used for biofouling removal are dry-docking cleaning, antifouling paint, and periodic underwater cleaning. Chambers et al. (2006) pointed out that a good method of removing biofouling is the use of high-pressure abrasives in dry docks. Hull fouling removal can be done by using machineries also

Antifouling Paint

In the antifouling paint method, the ship hulls are sprayed with soft antifouling paint, which can effectively kill or slow the growth of organisms by gradually releasing biocides. The antifouling effect is greatly reduced as the paint ages. Therefore, the antifouling paint needs to be reapplied. However, many jurisdictions have

considered dockside cleaning illegal because the hazardous substances of antifouling paint particles that may spread into contaminate the water during cleaning (Smith and Colvin 2014).

Types of machineries used in hull cleaning

Cleaning methods and tools can be divided into three categories:

- Manual hull cleaning
- Powered rotary brush cleaning systems
- Non-contact cleaning technology

Manual Hull Cleaning

Manual cleaning of biofouling surfaces is commonly performed on small ships, e.g., recreational yachts and small fishing boats. Tools like cloths, brushes, or scraping devices are used to remove biofouling organisms. When a diver performs manual cleaning, removing all the marine creatures on the hull is impossible it is reported that improper manual cleaning results that about 40% fouling is left unremoved.

Powered Rotary Brush Cleaning Systems

Underwater cleaning methods have gradually evolved from manual operation to mechatronics equipment, especially for large vessels. Large brush devices can usually be used when quickly cleaning flat or slightly curved areas of the hull, and small brushes can be used for better results when cleaning the propeller. A single brush, double brushes, or multiple brushes that are powered by hydraulic motors could be installed in large rotary brush devices (Hopkins et al. 2009).

Figure: Rotary Brush hull Cleaning

Contactless Underwater Cleaning Method

The use of brushes, scrapers, and other abrasive means to clean the hull can damage the welds, rivets, and protrusions of the underwater structures, thereby compromising their mechanical integrity. Hence contactless cleaning methods and apparatuses, including the high-pressure water jet method, the cavitation water jet method, and the ultrasonic cleaning method are introduced. When these cleaning techniques are used to remove the biofouling from the hull, the damage to the coating can be better when compared with rotating brushes (Morrisey and Woods 2015).

High-pressure Water Cleaning Jets

The high-pressure water cleaning method relies on its own impact force to remove biofouling on the hull. A high working pressure corresponds to a good cleaning effect. If the appropriate water pressure is used to safely remove the slime layer, then the effect on the hull coating is minimal. The Hull Wiper cleans the hull and simultaneously collects biofouling removed from the ship rather than directly discharging them into the water and uses local water for it

Cavitating Water Cleaning Jets

Cavitating water jet technology is an improved version of high-pressure water cleaning technology that uses specially designed nozzles, which convert high-pressure water into cavitation water. The cavitation jet

introduces cavitation into the high-pressure clean water, which is highly aggressive and enhances the cleaning of the hull. The number of bubbles in the cavitation water can be increased by improving the nozzle design. The bubbles rupture as they approach the hull, resulting in very high local stresses, which can result in greater cleaning power.

Figure: Cavitating Water Cleaning Jets

Ultrasonic Cleaning Technology

The application of ultrasonic cleaning technology to underwater ship cleaning has become possible due to the rapid development of digital electronics and transducer technology over the past two decades. The method relies on simultaneously generating ultrasound energy pulses over a plurality of frequency ranges. This energy produces a pattern of alternating positive and negative pressures. This alternating pattern then produces tiny bubbles during negative pressure and implodes the bubbles during positive pressure. The destructive energy of the implosion not only provides a cleaning effect on the hull but could also eliminate the marine creatures removed from the hull to some extent

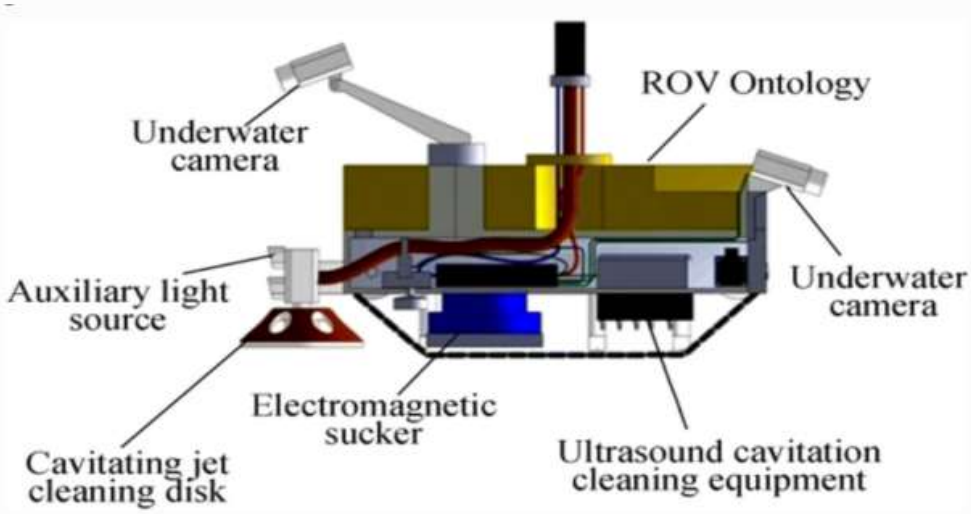

Figure: Ultrasonic Cleaning Apparatus

Laser Cleaning Technology

Laser cleaning technology, which uses the laser radiation scanning the treated hull, has the advantages of faster surface cleaning capability, precise selective processing capability, and better cleaning process

Other Cleaning Technologies

Heating methods are widely used to eliminate marine organisms in power station cooling systems and marine creatures entering the vessel's ballast tanks. It is suitable for the vessels with light and moderate biofouling. Ultraviolet radiation technology is increasingly used for water sterilization and can be used to kill marine creatures at the early growing stage at which they attach to the hull

CONCLUSION

With continued exposure to rising fuel prices, the fishing industry will continue to suffer a loss in profitability. The fishing sector should strive to lower its fuel consumption, reduce its carbon footprint, and decrease ecosystem impacts. To achieve significant and permanent reductions, dry docking of fishing vessels can be an alternative step to reduce the emissions. Among which hull fouling reduction results in less fuel consumption. Frictional resistance due to buildup of biofilms, sea grass, barnacles, and other marine creatures on the hull as a vessel goes through water will increase its fuel consumption. Hence the prime goal is to remove hull fouling which results in reduction of carbon emissions.

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