

Review of Green Shipping Policy and Technology Development Research

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Abstract

This paper summarizes the emergence of green shipping and the progress of green shipping research at home and abroad through the study of literature, including the proposal and development of green shipping concept, green shipping management policy and green shipping technical methods, and lays the foundation for the subsequent research on green shipping planning.

Keywords

Green Shipping; Management Policy; Technical Methods.

1. Introduction

Shipping is one of the important modes of transportation for international trade. And while shipping facilitates economic trade, it also generates many environmental problems. Many forward-looking efforts to encourage better environmental management of the shipping industry emerged around 2004. Together, these various efforts are known as the Green Shipping Initiative. The concept of green shipping was thus gradually refined to include not only the various policies and regulations that resulted from it but also many shipping technologies that promote green emissions reduction. The main contribution of this paper is that, based on the analysis of the existing literature, the paper further proposes future research directions for the future development of green shipping. These proposals will not only help scholars to expand the theoretical research in this field and improve the emission control scheme of the shipping industry, but also motivate shipping companies and governments to integrate the emission reduction goals into specific shipping activities.

2. Overview of the Definition of Green Shipping

"The concept of "green shipping" originated from the Green Shipping Initiative. Originally, green shipping refers to the practice of shipping companies to reduce the environmental damage caused by the transportation of goods by sea by calculating the carbon emissions of shipping routes and using alternative ship facilities.

Since 2004, "sustainable shipping initiatives" (SSI) have been proposed internationally. In 2010, Singapore launched the Green Shipping Initiative[1]. 2011, WWF conducted a review of the Sustainable Shipping Initiative. 2013, the International Maritime Organization elaborated the objectives and actions for a sustainable maritime transport system[2]. In 2013, the 136th working group meeting of the International Chamber of Shipping discussed "sustainable maritime navigation", formulated the goals of sustainable shipping, and analyzed the related measures [3]. In 2013, the world's leading companies and non-profit organizations in the shipping industry established the Sustainable Shipping Initiative (SSI) as an independent public interest organization to promote the sustainable development of the shipping industry[4]. Wan

et al [5] proposed to achieve green shipping through clean shipbreaking, emission control and improved port management.

In summary, green shipping planning is mainly originated from the "Sustainable Shipping Initiative", which is still in the stage of conceptualization and content discussion, and there is no clear definition yet. It is generally agreed that the strategic goal of green shipping planning is to meet the requirements of sustainable development. The main achievements of the current green shipping plan are to put forward concepts and objectives, carry out practical actions and propose some index systems, etc. No clear distinction is made between sustainable shipping plan and green shipping plan. And IMO, European Commission and related shipping organizations or associations have played a prominent role in promoting green shipping.

3. Green Shipping Management Policy Overview

The shipping industry has developed rapidly in recent years, and the large amount of ship exhaust emissions has attracted widespread attention from the international community, maritime authorities, industry associations and academia. A series of policies have been introduced internationally, such as carbon tax, general emission trading system and government regulation to control the increase of carbon emissions, among which carbon tax policy is most widely applied. At the same time, the International Maritime Organization (IMO) has introduced MARPOL Convention Annex VI, which has established four major emission control areas around the world to limit sulfide and nitrogen emissions from ship exhaust. Between 2011 and 2014, IMO added several amendments to MARPOL Annex VI regarding technical and operational measures for ship emissions. The three main measures used to address emissions from shipping are: technical measures, operational measures and market-based measures. Ships consume fuel oil and produce a large amount of exhaust gas. In order to improve the fuel consumption efficiency of ships and reduce emissions, the shipbuilding industry must take a number of technical measures. Therefore, IMO has introduced EEDI for new ships, which can provide a reference for the comparison of different types and sizes of new ships to encourage the development of more efficient ships and the active establishment of new ships with the lowest energy efficiency.

Since EEDI is only for new ships, IMO has proposed the ship energy efficiency management plan (SEEMP) in order to limit the emissions of existing ships. The energy efficiency operating index (EEOI) reflects the energy efficiency management plan of the ship during operation. In the field of ship construction, MARPOL Annex VI sets out clear requirements for the ship energy efficiency design index (EEDI) and the ship energy efficiency management plan, and provides detailed classification for different ship types and corresponding deadweight tonnage. Taking bulk carriers and gas carriers with deadweight tonnage over 20,000t as an example, MARPOL Bylaw VI requires a discount factor of 0 in Phase 0 (2013-2014), 10% in Phase 1 (2015-2019), and 10% in Phase 2 (2020-2024). - The discount factor for Stage 0 (2013-2014) is 0, for Stage 1 (2015-2019) is 10%, for Stage 2 (2020-2024) is 20%, and for Stage 3 (2025 and beyond) is 30%. However, in practice, the promotion and implementation of the standard has faced many technical and regulatory obstacles. According to relevant statistics, as early as 2010, about 50% of domestic ships did not meet the standards set in Phase 1, and by 2013, the number of ships meeting Phase 1 was only 60%, and by 2020, the current status of ship design and manufacturing is far from the implementation target of Phase 3. However, IMO still considers to advance the implementation time of Phase 3 to 2023 and plans to set the target of Phase 4, which may increase the discount factor to 35% or more[6]. Zakaria and Rahman investigate the effect of the ship Energy Efficiency Design Index (EEDI) on ship draft, fuel type, engine power, fuel consumption rate, and displacement factor, and describe how to optimize the ship type of existing ships considering the EEDI[7].

The greener ship factor focuses on the prevention of air pollution [i.e., carbon dioxide (CO₂), sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulate matters (PM)] from ships, improving ships' ballast water management methods to tackle invasive species, the adoption of CFC-free (e.g., R134A or R404A) refrigerated containers so as not to damage the earth's environment, and the use of TBT-free antifouling paint in order to protect living organisms in the ocean, as well as designing new ships based on energy-saving and environmental protection concepts[8].

China has also made great progress in promoting the process of green shipping, and has established China's ECA in the "Implementation Plan for Ship Emission Control Areas in the Pearl River Delta, Yangtze River Delta and Bohai Sea Rim (Beijing-Tianjin-Hebei) Waters", which stipulates that from 2019, ships in the coastal ECA should use marine fuel with a sulfur content standard of no more than 0.5%, and then gradually improve the standard, which will be reduced to 0.1% by 2025. The program provides for the use of marine fuel with a sulfur content of no more than 0.5% in the coastal ECA starting in September, followed by a gradual increase in the standard to 0.1% by 2025, in line with the global ECA standard[9].

4. Green Shipping Technology Overview

After the 2020 Global Sulfur Cap, shipping emission reduction technologies are more focused on exhaust gas scrubbers and liquefied natural gas as two ways to reduce emissions. This is in addition to other clean energy sources: bioenergy, nuclear, etc. After the installation of scrubbers, ships can continue to use higher content of fuel oil in the emission control area (ECA), where the ECA mainly refers to the four areas specified by the IMO: the Baltic Sea region, the North Sea region, the North American region, the United States Caribbean waters. Since 2015 the sulfur content of ship fuel within the ECA cannot be higher than 0.1%. The main cost of installing scrubbers is the initial investment cost, which is a key consideration for many ship operators. The use of LNG is a cleaner source of energy. Nikopoulou et al. found that the cost of using distillate within the ECA is too high, scrubbers, SCR and air humidification are better abatement technologies, and LNG is the best abatement measure. Since ports around the world are not currently matched on a large scale to retrofit LNG[10]. The use of this technology in practice is not widespread because it has not yet been matched on a large scale in ports around the world with LNG retrofitting equipment.

At present, the specific application and development trend of China's green shipping technology in shipping field mainly focus on the following fields, such as the use of low sulfur oil, the installation of desulfurization tower, the operation of LNG-powered ships, the promotion of port shore power, etc. The application of some green energy-saving and emission reduction technologies in shipping field in China lacks the regulation and adjustment of system, which should be regulated in the legislation with the development and maturity of green shipping technologies, and the corresponding legal responsibility should be clarified. But even for some green shipping technology fields that have been regulated by laws and regulations and shipping policies, the relevant shipping policies and legal systems need to be further improved due to many reasons such as bottlenecks in technology research and development, institutional mechanism barriers and legislative concept bias[11].

5. Conclusion

Shipping is closely related to the marine environment, and the study of the development of green shipping is not only beneficial to the development of shipping economy but also to the protection of marine environment. This paper mainly composes the origin of the emergence of green shipping concept, analyzes various policies and technical methods provided by domestic and foreign for green shipping activities. On this basis, some shortcomings of green shipping

policies and technologies are found. In terms of policy, based on these ship emission regulations, each country can design more stringent ECAs to limit sulfur or nitrogen emissions within their own territorial waters, but how to balance the resulting reduction of moored ships will be a key research direction to be considered. Technically, the emission reduction technology within ECA is relatively mature, but after the 2020 global sulfur cap, the current global speed and route design within and outside ECA and the consideration of reselecting emission reduction measures should be an important research direction afterwards.

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