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Dilemma and Solutions of Greenhouse Gas Emission Reduction of International Shipping

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Abstract: How to build an international maritime GHG (greenhouse gas) emission reduction cooperation mechanism is an important international issue at present. Firstly, we describe the current situation of maritime transport GHG emission reduction and analyze the problems that still exist in international maritime transport emission reduction from four aspects: political, economic, legal and technical. For example, geopolitical aggravation hinders the solution of the FOC (Flag of Convenience) issue; maritime emissions are not included in the carbon emission trading system; the synergy of maritime emission reduction principles under the IMO (International Maritime Organization) framework and the technical level of maritime emission reduction needs to be improved. The motivation and essence of the divergent international actions on maritime emission reduction are discussed. Finally, it is proposed to implement the "true linkage principle" to solve the problem of FOCs; to promote the development of regional carbon markets and link them to the international maritime carbon emission trading market economically; to implement the CBDR (the common but differentiated responsibilities) principle legally to promote the international emission reduction work in an orderly manner; and the technical innovation of ships and increase the technical support.

Key words: Climate change, shipping, GHG reduction, international cooperation.

1. Introduction

The Paris Agreement states that "Holding the increase in the global average temperature to well below 2 ℃ above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 ℃ above pre-industrial levels..." To achieve this temperature control goal, more than 20 countries around the world have announced their intention to become carbon neutral. Following China's proposal to achieve carbon peak by 2030 and carbon neutrality by 2060, Japan, South Korea, Canada and other countries have followed suit, announcing their own carbon neutrality timetables one after another. In the context of globalization, if any country does not follow the development trend of carbon neutrality, it will become an island in the wave of world development.

With the development of global economy and trade, the amount of GHGs (greenhouse gases) emitted by international maritime transport is increasing as a proportion of the total global GHG emissions, and the international maritime transport industry has become one of the industries with the highest GHG emissions. Therefore, the international call for net-zero emissions from maritime transport is also increasing.

Compared with other industries, the international maritime industry is unique in that it is difficult to determine where its GHG emissions occur. During a ship's voyage, GHG emissions are emitted in areas that pass through flag states, port states or coastal states, as well as in areas that are not controlled by any competent authority. Because international maritime and air transport is characterized by high mobility and uncertainty, there are currently no specific mandatory regulations in international law for the maritime industry to reduce GHG emissions. The IMO (International Maritime Organization) is mandated in the Kyoto Protocol to have jurisdiction over GHG emissions from international maritime transport, while

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IMO is primarily responsible for maritime transport emission reductions by the MEPC (Marine Environment Protection Committee). According to the internationally agreed temperature targets under the Paris Agreement, the first is to reduce total annual GHG emissions from shipping by at least 50% by 2050 compared to 2008 levels; and the second is to eliminate maritime GHG emissions as soon as possible in this century in an effort to do so. Within the framework of the long-term goals of the Paris Agreement, the shipping industry has stepped up the pace of target-setting.

2. Status of International Maritime Emission Reduction

In order to reduce atmospheric pollution caused by maritime emissions, IMO has been committed to promoting the reduction of emissions from shipping. In 2018, it adopted the Preliminary Strategy for Reducing Greenhouse Gas Emissions from Ships, which makes a general deployment of the international shipping industry's actions to address climate change from a total of seven aspects, including visionary goals, reduction efforts, guiding principles, short/medium/long-term candidate reduction measures and their impacts, barriers and supporting measures [1]. In addition, IMO issued a global sulphur limit in the 70th session, that is, from January 1, 2021, the global implementation of marine fuel sulfur content of 0.5% m/m. With the full implementation of this limit, global shipping will usher in the era of low-sulfur fuel.

In June 2021, IMO issued the "International Shipping Carbon Intensity Code", forming a series of short-term measures to reduce GHG emissions, including the ship energy efficiency management plan, which aims to improve the energy efficiency of ships from both technical and operational aspects, and the measures will be formally implemented from January 1, 2023. Some countries have also made initial achievements in reducing emissions from maritime transport. The EU, which has long been a leader in global carbon emission reduction, proposed the "FuelEU Maritime Initiative" to include GHG emissions generated by the shipping industry in the EU ETS. It set greenhouse gas intensity targets and fuel standards for ships, and the "Energy Tax Directive" to remove fuel tax exemption for the shipping industry. China is also vigorously promoting the development of maritime emission reduction, establishing ship emission control zones in coastal waters in 2015, releasing the "Emission Limits and Measurement Methods for Ship Engine Exhaust Pollutants (China Phase I and II)" in 2016 to control GHG emissions from ships with stricter standards, and continuously increasing the range of waters that limit the sulfur content control requirements for fuel oil used by ships from 2017 onwards.

3. The Problems of International Maritime Transport Emission Reduction

3.1 Geopolitical Intensification and Flag of Convenience Vessels Hinder the Timely Regulation of the Flag State

In the 16th century, early FOC ships emerged with the purpose of facilitating international trade interactions. After World War II, as the U.S. and Soviet wars divided the world into different political and economic camps, FOC ships rapidly developed globally in the face of political restrictions between countries and commercial restrictions such as mutual tariff barriers.

The difficulty of maritime emission reduction has only increased due to the existence of the flag of convenience ship system. Most of the countries that offer open registries do not have well-developed regulatory mechanisms or complete inspection and identification mechanisms, and even would have relied on such loose mechanisms to attract more countries to register with that country. These ships rarely, if ever, visit the waters of their flag state after registration [2]. This also results in the flag state and the country that actually enjoys the benefits of the ship's operation not exactly coinciding, and the effect of the transaction

cannot be determined specifically for which country, hindering the implementation of the recent levy scheme. It is extremely unfair to calculate the total amount of carbon in the same subject's emission reduction credits. Therefore, if the FOC system is solved, the specific amount of maritime GHG for each country can be calculated more fairly, which is conducive to the orderly promotion of maritime GHG emission reduction work.

3.2 Maritime Emissions Are Not Included in the Carbon Emissions Trading System

Carbon credits are provided for in the Kyoto Protocol. Carbon trading refers to the trading of carbon dioxide as a commodity in international and domestic markets. The first is the international market. The Kyoto Protocol provides for the IET (International Emissions Trading) Mechanism, which gives developed countries the right to trade and transfer their own emission credits among themselves, and helps countries that emit more than they should by buying excess credits from other countries to meet their emission reduction targets. Article 6 of the Paris Agreement provides for two types of international carbon trading mechanisms, namely Article 6.2 "Cooperative Approach" and Article 6.4 "Sustainable Development Mechanisms", which parties can voluntarily choose to transfer carbon emission reduction targets across borders. Carbon trading is a kind of "cost-based thinking" that allows countries to consider emission credits as assets and thus take the initiative to reduce energy consumption and strike a balance between environmental protection and economy.

For the international maritime carbon trading mechanism, the IMO sets the total amount of carbon dioxide emissions from the maritime industry and establishes an international carbon trading market, where shipowners complete the trading of carbon allowances with other shipowners based on all their carbon allowances and actual demand. The profit curve of carbon allowances and trading in Fig. 1 [3] shows that if the price of carbon trading exceeds USD 50 per ton, the profit will always be on an upward trend. Therefore, in carbon trading, relying on market mechanisms to solve problems and motivate shipowners to actively implement emission reductions is a strong incentive. This mechanism makes carbon emission reduction no longer just a cost, but at the same time creates the opportunity to gain revenue. As you can see from Fig. 1, in the case of a mature carbon trading market, profits increase rather than decrease. For shipowners, this will give them more incentive to actively reduce emissions [4].

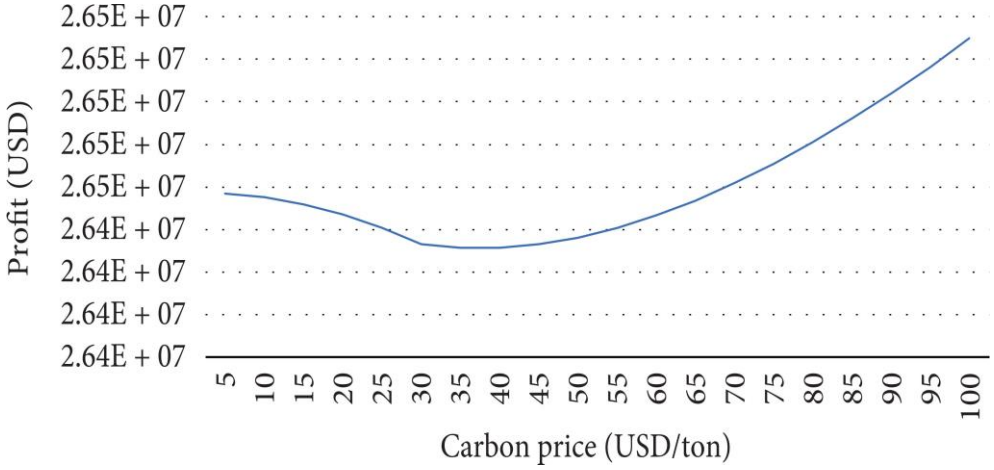

Fig. 1 The profit curve of carbon cap and trade.

Since 2012, IMO's work on the maritime market mechanism for emission reduction has been carried out, but the establishment of an international carbon emission reduction trading mechanism is not an easy task. First, due to the huge gap in emission reduction technology, developed countries have more emission reduction advantages than developing countries, making it difficult to evenly distribute the share of maritime emission reduction between developed and developing countries, thus leading to the establishment of maritime carbon emission reduction trading market to aggravate the inequity between developing and developed countries. Secondly, the shipping economy and energy efficiency are also important factors affecting the emission credits, and the instability of shipping will also make it difficult to maintain the credits at a relatively stable level. Emission allowances are a crucial part of the establishment of an international maritime carbon emissions trading system. Therefore, although the carbon emissions trading market is currently the most consistent with the development trend of international maritime emission reduction, it is still necessary to face a lot of difficulties if we want to vigorously promote the establishment of the carbon emissions trading market.

3.3 IMO Framework under the Maritime Transport Emission Reduction Principle Synergy Issues

In 2011, the 62nd MEPC meeting adopted the amendment to the "Ship Energy Efficiency Code", the CBDR (common but differentiated responsibilities) principle between developed and developing countries on the principle of application of maritime emission reduction.

Developed countries believe that the principle of "common" should be supported. Firstly, IMO, as a specialized agency of the United Nations, has the right to independently adopt documents in specific areas without the permission of the United Nations Framework Convention on Climate Change. Secondly, the view that the principle of CBDR has always been implemented in all actions to address climate change in international law is inaccurate; the principle can only provide direction for the discussion of the issue, but not determine the outcome of the solution. At the same time, CBDR has been controversial since its inception and cannot be a strong support for the application of all climate change actions.

The developing countries believe that the principle of CBDR should still be applied to maritime transport emission reduction. First, the principle of equal application established by the IMO is contrary to the CBDR principle, and the complexity of maritime transport makes compliance with the CBDR principle very important for developing countries with poor technology and financial resources. Second, the adoption of the principle of equal application in international maritime transport would lead to the opening of a precedent for sectoral emission reductions in a non-discriminatory mode, as well as imposing mandatory emission reduction obligations on developing countries [5].

3.4 The Level of Maritime Emission Reduction Technology Needs to Be Improved

In the "Study on Greenhouse Gas Emissions from Ships" published by IMO in 2000, it is clearly stated that if the speed of a ship is reduced by 4%, the energy consumption of GHG emissions from ships will be reduced by 13%. Thus, the benefits of reducing ship speed and technological innovation are obvious for controlling GHG emissions. However, there are many problems associated with the reduction of ship speed. First, through cost-benefit comparison, if the ship speed is reduced, the time cost will be increased and shippers may choose other modes of transportation instead of sea transportation. Secondly, the reduction of ship speed will lead to the increase of cargo transit time, resulting in a large amount of cargo accumulation on the sea surface, which will also cause the transportation of the same amount of cargo requires more ships to transport, which will produce more GHGs. With the

strong advocacy of new energy, 98% of civil transport vessels over 2,000 t are still using diesel power units, despite the new breakthroughs in technology in the use of new energy [6]. Part of the reason for the low utilization of new ships is that ship owners are uncertain about future technological developments and the most cost-effective fuels. In order to profit from the current high tariffs and charter rates, they choose to continue operating older vessels [7].

4. The Motivation and Substance of the Dispute over International Action to Reduce Emissions from Maritime Transport

4.1 Divergence between Developed and Developing Countries on the Right to Development and Emission Rights

Although countries have reached a certain consensus on reducing GHG emissions, when climate governance is combined with domestic economy and other areas, the pace of addressing climate change is no longer neat and tidy. At the root of this is the question of which is more conducive to fairness and justice, operability and feasibility for developed and developing countries to choose between their obligations to reduce emissions and their rights to development. In the view of developed countries, developing countries should share the mandatory emission reduction obligations with developed countries, while in the view of developing countries, the historical responsibility of developed countries and the difference in their capacity to deal with climate change justify developing countries to take a small reduction responsibility and focus more on domestic development issues.

4.2 High Cost of Implementing Maritime Emission Reduction Policies

Whether it is to improve the design of a ship or to apply environmentally friendly fuels, significant retrofitting capital and technology is required. It means the obligation of countries to reduce emissions from maritime transport needs to incure significant retrofitting costs for ships. For example, the difference in production costs between HSFO (high sulfur fuel oil) and the ideal formulation with 0.5% sulfur highlights the significant impact that future regulations will have on marine fuel prices, which are expected to fluctuate dramatically when 0.5% sulfur marine fuel oil is used in large quantities under the guidance of emission reduction policies. It is a heavy challenge especially for developing countries in the current downturn of the international maritime industry. This has also led to the inability of developing countries to meet their emission reduction obligations.

4.3 The Competition among Countries for the International Discourse of Maritime Technical Rules

Under the influence of the epidemic, global shipping is in a deep depression. A country that can seize the opportunity, rush to layout, accelerate development and implementation of green shipping development strategy, and promote the construction of maritime emission reduction capacity, can grasp international dominance and discourse in the formulation of international maritime emission reduction rules. International discourse is crucial. For example, developed countries discriminate against developing countries in the process of building rules and regulations for environmental protection, and selectively ignore the demands of developing countries for maritime environmental protection. As the major international shipping countries, China, the United States and the European Union are under particularly difficult pressure to reduce emissions, and are also important players in the maritime emissions reduction game. In order to obtain the discourse behind the regulation of maritime emission reduction, the discourse of countries around the construction of emission reduction regulation has become more and more fierce, which also makes the IMO comprehensive promotion of maritime “desulfurization” and “decarbonization” synergistic action, broken under the competition between countries.

5. International Maritime Emission Reduction Pathway

5.1 The Effective Implementation of the "True Link Principle", to Solve the Problem of Flag Ship Convenience

The "genuine link principle" allows for a more realistic and equitable approach to the issue of determining liability for abatement. Although Article 5 of the 1985 Geneva Convention on the High Seas, Article 91 of the 1982 UN Convention on the Law of the Sea, and the preamble and Article 1 of the 1986 UN Convention on Conditions of Registration of Ships all provide for a "genuine link" between a ship and its flag, the principle of genuine link is vaguely defined [8]. If the "genuine link principle" is to be thoroughly implemented, it should be done both internationally and domestically.

On the international front, international treaties should be introduced to clarify the concept of "genuine link" to facilitate the resolution of flag of convenience issues. At the same time, an international convention to test the principle of genuine link should be developed to ensure that the ship is partly or wholly owned by a country, the crew on board is partly or wholly citizens of the said country, and the management of the ship's company is partly of the said country's nationality and the relevant components are quantified, so as to solve the problem of flag ships of convenience.

On the domestic side, countries that encourage ships to be registered mostly overseas have additional punitive laws to restrict overseas registration of ships with a real connection to their country. Developing countries can be broadly divided into three categories: flag states, flag of convenience states, and other developing countries, which have very different attitudes toward maritime emissions reductions. The flag of convenience countries profit a lot from the registration of foreign ships, and are happy to see the registration of foreign ships, so they can be negative to the implementation of the "genuine link principle". In this way, it is easier to promote the "genuine link principle" from developed countries and developing countries that are not FOC countries.

5.2 Promote the Development of Regional Carbon Markets and Connect into an International Maritime Carbon Emissions Trading Market

Extending the carbon emissions trading system to maritime transport, thereby limiting maritime carbon emissions to part of the overall carbon emissions market cap, creates a carbon price signal that can contribute to GHG emissions reductions in a flexible and cost-effective manner and provides a portion of the economic support for the maritime industry to develop more energy efficient and technologically advanced ships and to adopt more efficient operating practices [9]. Through such financial incentives, countries can be promoted to become more energy efficient in their navigation patterns.

However, it is not a quick fix to build an international carbon emissions trading market. Especially for developing countries with a large number of old ships, it is unfair to use a uniform standard to restrain the GHG emissions brought by maritime transport. It is possible to develop each regional carbon trading market first, the actual situation of each region is different, and the carbon trading rules market is also different. Let the experience of each regional carbon trading mechanism be brought into the negotiation of the international carbon trading mechanism, so as to bridge the serious differences between the parties in the negotiation and thus provide an opportunity to establish international carbon trading rules. In the negotiation process, regional carbon trading rules not only help enrich the experience of the parties in the negotiations, but also provide valuable reference objects for the international carbon trading mechanism. If parties, especially developing countries, lack relevant practices in establishing carbon markets, it is also difficult to put forward targeted proposals in the light of their own situations, which is detrimental to the ensuing

international cooperation. Therefore, the regional carbon trading market is an important foundation for establishing an international carbon trading market, which can be promoted from the point to the surface, so that the international carbon trading market can be established more quickly and effectively.

5.3 Implement the Principles of CBDR and Promote the Orderly Implementation of International Emission Reduction

On the issue of synergy of legal principles for maritime emission reduction, developed countries advocate the principle of equal emission reduction, while developing countries advocate the continued application of the CBDR principle. In fact, the global emission reduction principle in the Paris Agreement and the maritime emission reduction principle established by the IMO have similarities and differences, both emphasizing the need for parties to jointly fulfill their obligations in climate governance, and both requiring countries to assume equal responsibility for emission reduction. The new CBDR principle stipulates that all parties should bear the responsibility of emission reduction, but allows different emission reduction targets according to their own national conditions, while developed countries should give strong support to developing countries in terms of finance, technology and capacity building. While IMO insists on the basis of common emission reduction, it also tries to achieve "differentiated" treatment of developing countries through legislation, for example, stipulating that developing countries can have a grace period for compliance, requiring developed countries to provide financial and technical assistance related to maritime emission reduction for developing countries, etc. It is not difficult to find that the IMO's series of initiatives have not departed from the CBDR principle, which can be regarded as the specific application of the CBDR principle in the maritime emission reduction work. Therefore, continuing to adhere to the application of the CBDR principle in the field of maritime transport is more conducive to the international cooperation of countries in maritime transport emission reduction, and is also conducive to maintaining the integrity and effectiveness of the UN Framework Convention on Climate Change.

5.4 Pay Attention to the Technical Innovation of the Ship and Increase Technical Assistance

The reduction of GHG emissions from international maritime transport is first and foremost a matter of reducing the combustion of fossil fuels and technological innovation as a means of improving the energy efficiency of ships. Technological innovation can be divided into the following areas. Firstly, improve ship design. For example, ship fouling bottom management is a major innovation in shipping technology, and current research hotspots revolve around the development of anti-fouling coatings for ship bottoms. Ship bottom fouling will change the flow of fluid boundary layer, and the increased resistance due to bottom fouling is mainly related to the time after the ship is out of dock, and it is generally believed that the total resistance increased by bottom fouling can be more than 10% 6 months after the new ship is launched [10]. And good bottom antifouling coating can not only reduce the resistance, but also can effectively isolate the hull steel plate and reduce the erosion of seawater on the steel plate [11]. Secondly, actively develop new energy. In the process of ship design development, new energy has made great progress in the development technology. For example, the heat exchange and heat radiation of ship engine consume a lot of heat energy during the process of ship driving, and the waste heat is recovered through waste heat recovery technology, and then the waste heat is converted into kinetic energy, so as to provide mechanical energy to the ship [12]. Thirdly, it promotes developed countries to provide technical assistance and capacity building to developing countries. For example, the European Commission has provided 10 million euros in funding

for the EC-IMO Energy Efficiency Project, and as part of the four-year project, maritime technical cooperation centers have been established in five regions, including Asia and Africa [13]. Through technical assistance and capacity building, these centers will promote the adoption of low-carbon technologies and operations in maritime transport in less developed countries.

6. Conclusion

The ocean is an important geopolitical issue, from the initial setting of the issue to the subsequent design of the system, there has been an explicit or implicit international competition between developed and developing countries, not only in the maritime emission reduction, but also in the response to the whole issue of climate change, around the initiative of international emission reduction regulation, the right to formulate and dominate the fierce exchanges. Countries should take the initiative to actively participate in the international maritime emission reduction actions, and promote the maritime emission reduction program that effectively meets the interests of the industry, so as to achieve the emission reduction target as soon as possible.

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