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TIANJIN PORT EMISSIONS CONTROL AREA

Area

By

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Declaration

I certify that all the materials in this research paper that are not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Introduction

At present, the atmospheric pollution of our country is very serious, which seriously restricts the sustainable development of social economy, and threatens the people's health. The environmental air quality is not up to standard in most of the port cities in China. The problem of the ship's discharge is more and more obvious. It is helpful to improve the air quality of the environment to control the ships emissions. The practice of developed countries and regions shows that establishing emissions control area is an effective way to control air pollution from ships dye emissions; according to the process of China's air pollution, at present, it is the right time to set up emission control area to control ship for the discharge of atmospheric pollutants. Tianjin port is the largest port in northern China, and the annual throughput of the port ranked third in the world, Tianjin port is listed the heart of the port as the first batch of emission control area by Ministry of transport, and the ship and port for the contribution of air pollution in Tianjin reached a high proportion, to reduce the air pollution by caused ship and port, and it is imminent that the Tianjin port implement emission control area.

1. The main components and hazards of the marine diesel engine exhaust emissions

Emissions from marine diesel engines can be divided into two categories, one is the gaseous pollutants, and the other is particulate matter. Gaseous pollutants including Sox, Cox, NOx gas and particulate matter including soot, dust and other substances, these pollutants are also known as the "primary pollutant, and they are not processed and directly discharged into the environment, and they lead to the more serious environmental pollution. A pollutant is the most important and the most direct sources to environmental pollution(Huang, 2013. Pp. 36-37). Waste gas pollutants

Sox is produced by the oxidation of sulfur in fuel oil, and with the operation of the ship diesel engine, the Sox emissions is produced more and more. After the Sox is discharged into the air, which will cause some pollution to the air, and will go to the soil with the rainfall, which affect soil acid. It is often said that the acid rain is coming. Because the great amount of Sox gases contained in the rain, acid water will greatly affect plant growth, and cause serious damage to the ecological environment of nature. In addition, SOX gas plays the bad role to the human eye and respiratory system, without caution a large number of inhalation with SOX gas will cause acute poisoning, affecting the health of the human body. Carbon monoxide (CO) is another kind of toxic gases, because the fuel and air can not be fully mixed, the incomplete combustion phenomenon will occur in the combustion process, and carbon monoxide (CO) is produced in the incomplete combustion(Yang, 2013, pp. 76-77). Marine diesel engine in operation with high coefficient of the air, and combustion process is also relatively complete, so that carbon monoxide (CO) is produced less, but still exist, and with the marine diesel engine combustion process being more and more perfect, the carbon monoxide emissions will be less and less, which requires that as far as possible containing carbon relatively low fuel. In diesel engine emissions in the exhaust gas, the NOx is produced due to the combustion of the fuel spray formed in the combustion process, and the temperature and oxygen content will influence the NOx formation volume. Under normal circumstances, combustion temperature for each additional 100 degree, NOx content will increases 3 times(Zhai & Guo, 2013, pp. 23-24). But in the case of high temperature, oxygen and nitrogen will produce a chemical reaction, and the formation of nitric oxide (NO) will be produced, after the expansion and exhaust process, part of nitric oxide (NO) will be directly converted into nitrogen dioxide (NO2) and two (N2O), nitrogen oxide in exhaust to the atmosphere, nitric oxide (NO) combines with oxygen to produce chemical reaction, which will be converted into

nitrogen dioxide (NO2). Nitrogen dioxide (NO2) is a toxic gas. If nitrogen dioxide (NO2) is absorbed to the body accidentally, it will cause emphysema, and like SOX gas, nitrogen dioxide (NO2) will be accompanied by rain water into the soil, affecting soil the acidity of the normal growth of the plant. In the operation of the ship diesel engine, the incomplete combustion of fuel and the formation of some metal oxide and sulfate particles are main part of diesel engine exhaust particulate emissions. Emissions of these particles not only damage the environment, and contain a large number of carcinogens, which damage the respiratory system of the human body. Emissions of polluting gases produced by marine diesel engine under normal circumstances is a pollutant, the primary pollutants in the role of sunlight and air, and after some chemical reactions will be transformed into a secondary pollutants. Secondary pollutants on the human body damage and destruction to the environment is more serious than a sewage pollution, and even will produce a series of irreparable environmental impact, so that effective control of ship diesel engine exhaust gases is very important, but also promote an important part of the steady development of the ship(Zhang, 2014, p. 191).

2. The global emission control area

2.1 Historical evolution and current situation of emission control area

Air pollution from ships, especially in the sea area with a large harbors, Straits, and on some routes, ship traffic, has become the main pollution source in these regions and lead to common concern of international society. In recent decades, with the continuous development of the shipping economy, the number and tonnage of ships in the main propulsion power of the diesel engine has been greatly increased. However, due to the long-term use of high sulfur content cheap heavy residue oil (HFO) as fuel, the ship emissions containing large amounts of sulfur oxides, resulting in a serious pollution of the atmospheric environment, causing the attention

of the international community. According to The 2014 International Maritime Organization (IMO) statistics show that the annual emissions of marine SOx, NOx of the total global emissions, respectively, account for 13% and 15%(International Maritime Organization, 2014,). Worldwide, the air pollution caused by the ship waste gas is about 5% ~ 10% of the whole air pollution. In some developed port cities (such as Shanghai, Hongkong, etc.), this proportion is even as high as 30% ~ 40%(The ministry of transport water transportation research institute, 2013), and ship exhaust become the main local air pollution source, serious harm human health. In order to solve the problem of air pollution caused by ships, since 1980s, the International Maritime Organization (IMO) Marine Environmental Protection Committee (MEPC) has improved air pollution caused by ships. From 1985 who signed to reduce sulfur emissions of MARPOL convention, 1997, the air pollution preventing international conference by the protocol of 1997 MARPOL Convention and eight resolution protocol included in the "prevent ship caused air pollution rules and makes it the Annex VI of the Convention. MARPOL Annex VI for ship exhaust the Sox emission content were limited, and provides global upper limit of sulfur content in fuel oil, and set the sulfur emissions control area. China's accession to annex VI in March 15, 2006, the annex has entered into force in China on August 23, 2006. Requirements of Annex VI of the Convention of the MARPOL 73 / 78, worldwide ship using any fuel sulfur content shall not exceed 4.5% m / M (mass fraction); revised since January 1, 2012, in emission control area, and ship fuel sulfur content from the original is not more than 3.5% and then adjusted not more than 3.0%. Within an emissions control area, ship using of fuel sulfur content by less than 1.5% adjusted for not more than 1.0%. Now some countries and regions further enhance the emission control standards, have submitted to the IMO regional implementation of more stringent emission standards requirements to set up an emissions control area.

2.2 Europe and the United States set up emission control areas

Because of the harm to the ship's pollution, the developed countries in Europe and North America put forward the corresponding control measures earlier, and set up the emission control area (ECA). ECA's idea is to designate the water range around the port, after the ship entering into the area of the peripheral ports mustusing low levels of sulfur fuel, thereby reducing sulfide by the port city, respirable particulate matter etc,pollutants harm. Once there is excessive amounts of sulfur content of the ship, ECA countries will implement severe punishment, and may deduct the ship. Emission control areas are mainly distributed in Europe, North America and other developed countries, since January 1, 2013, The California Air Resources Board issued marine notice and provides access to the coastline of California 24 nautical miles of ocean going vessels, in addition to the need to refer to the MARPOL Annex VI emission control requirements of the region, with reference to the state of California, namely: since August 1, 2012, if the ship uses marine light diesel oil (DMA) that the sulfur content should be less than 1%, or if the use of marine diesel (DMB), sulfur content should not to 0.5%. If the ship to California coastal port, ship used on marine diesel engine (DMB), should ensure that the sulfur content is not more than 0.5%. (directive 2005/33/EC article 4b) according to provisions of the revised Law: since January 1, 2010, at EU ports berth (including anchoring, mooring buoys and berthing) more than 2 hours of the ship shall not use sulfur content of more than 0.1%m/m fuel (the requirement does not apply to shut down all the machines and the using of ship shore power), after the ship berthing should as soon as possible convert to meet the requirements of low sulfur fuel or shore connection. If ship want to EU ports, it is necessary to advance the understanding of the requirements of the relevant and ready to install conforming to the requirements of not more than 0.1% of low sulphur fuel, or application connected to shore power. If

the ship go into the emission control area, still need to install fuel with the requirements of not more than 1.0%. From January 1, 2012 on with Turkey's accession to the European Union Law, ships to the Turkish port must refere to the EU directive, using low sulfur fuel (Li & Li, 2016, P. 22). Up to now, sulfur oxides emissions control area, including the Baltic Sea waters (May 19, 2006 onwards), the waters of the North Sea, containing the English Channel (August 11, 2007 from the Executive), American waters (August 1, 2012 onwards), the United States Caribbean (January 1, 2014 onwards). Currently the only nitrogen emission control area is the North American emission control area, including the United States and Canada's coastal area of 200 miles(Zhang & Qiang, 2016,p 44)

2.3 the establishment of emission control area in Hongkong

Hongkong environmental protection agency released the 2011 air pollutant emission inventory pointing out that water transport has become the major sources of air pollutants of atmospheric sulfur dioxide (SO2), nitrogen oxide (NOx) and fine particles (PM2.5) and they accounted for 54%, 33% and 37% (Yang, 2014, p. 10). 2015 in April 15th, the Hongkong Legislative Council passed "the air pollution control (ogvs) (fuel used during berthing rules)", from July 1, 2015 on, all ships must use the specifications of the fuel in accordance with berth in Hongkong, fuel oil, liquefied natural gas including sulphur content not more than 0.5% of the sulfur ship, and the environmental protection department approved other clean fuel the ship. In order to reduce pollutant emissions and improve air quality. The rules will take effect after, in Hong Kong berthing if the ocean ship captain and owner did not implement the rules that they will face up to a maximum of $20 million and 6 months imprisonment punishment, for example if the oil record book did not record or recordsare not standardized, they will also face a $5 million, 3 months prison forbidden punishment (Wang, 2016. P 20).

2.4 Setting up emission control areas of Mainland China

On 2 December 2015, China's Ministry of transport issued the Pearl River Delta, Yangtze River Delta and ring Bohai Sea (Tianjin) waters ships emission control area of the implementation of the programme, through the establishment of three of the ship air pollutants emission control area, to control our country marine sulfur oxides, nitrogen oxides and particulate emissions. Program requirements in 2016 to 2019 emission control area of fuel sulfur content should be controlled to less than 0.5%, with 2016 and 2017 as transition year, 2016 is the sulfur content of less than 0.5% of the fuel (not mandatory) for the implementation of the conditions of port, 2017 requirements core port shore berthing using sulfur content less than 0.5% of the fuel (mandatory). In 2018 the policy transition to all ports in the control region, the transition to the entire control area in 2019 (Li & Li, 2016, p. 23). Ministry of transport and maritime bureau ship inspection department director Zhang Jiuxinjie introduces the principle measures to reduce emissions measure and the establishing of emission control area. He shows that "according to the prevention of pollution from ships convention, we take coercive measures, to reduce and control the sulfur oxides, particulate matter and nitrogen oxides emissions. Mainly through the upgrading of the ship' engine and the using of clean energy or tail gas treatment and other ways to achieve emission reduction. Zhang Jiu said the establishment of emission control area has four aspects: the first is the principle of outstanding national joint prevention and control of air pollution in key areas. Circular of the general office of the State Council in the forwarding the Ministry of environmental protection and other departments on promoting air pollution prevention and control work to improve regional air quality guidance notice proposed: to carry out air pollution prevention and control key areas of work is the Beijing Tianjin Hebei region, the Yangtze River Delta and the Pearl River Delta area. Three delimitation

of emission control area highlights the national joint prevention and control of air pollution in key areas of this requirement. The second is to maintain regional port fair competition, encourage core harbor pilot. The ship emissions control area chose the certain contiguous area, the level of economic development, similar types of goods port included. While taking into account the nuclear heart regional port shipping activity density, ship air pollution reduction row urgent demand, economic foundation good factors and ship emissions control system select a part of the port as the core region of port took the lead in the implementation of berthing oil conversion, for getting work experience emission control in ship air pollution prevention and control. The third is to give attention to both regional and economic development level and the intensity of the activities of the ship. The better reduction effect, ship emission control area contains our main ship intensive waters, at the same time, and taking into account the shipping companies operating and regional logistics costs are rising, the ship emissions control area delineation of taking into account the regional economic development level. The forth is to comply with international law and domestic laws and regulations. The ship emission control area is also applicable to foreign ships, and the implementation plan of emission control area strictly comply with international law and domestic laws and regulations (Chen, 2016, pp. 36-37).

2.5 Tianjin urgent need to set up emission control areas

Tianjin the third largest city of China, the central government of the people's Republic of China, the country's central city of the people's Republic of China, the second largest city in the north of China. On March 22, 2006, State Council executive meeting of the Tianjin complete positioning for " Bohai Sea economic belt, international port city and economic center in the north, ecosystem city", and will promote the development and opening of Binhai New Area "included in the Eleventh Five Year Plan and the national strategy, the establishment of a comprehensive

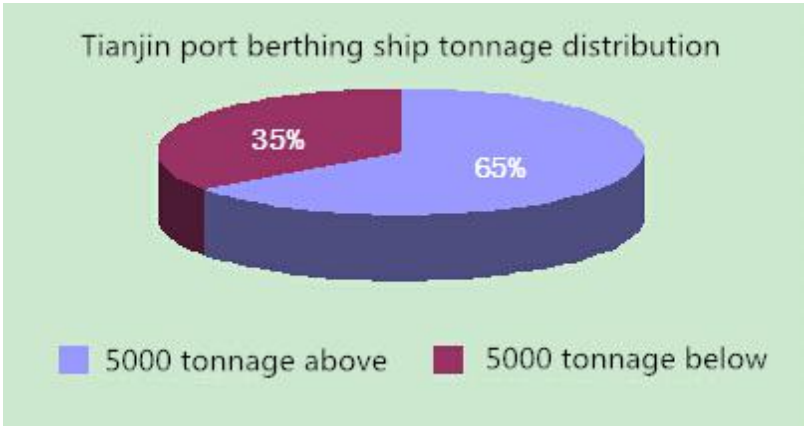
reform pilot area that is a national comprehensive, on November 10, 2009, and the State Council approved Tianjin Binhai New Area administrative division adjustment, and the economy has entered the era of rapid development and growth for many years in the national leading position, Tianjin has formed the only" a tale of two cities Shuanggang "urban form. Signed by Premier Li Keqiang in 2016, the State Council issued the approval to “carry out the pilot of service trade innovation and development”, and agreed to carry out the pilot development of service trade in Tianjin pilot. Tianjin port is the largest comprehensive port in North China, and is the world's highest level of artificial deep-water port. The existing water land area is 336 square kilometers, and land area is 131 square kilometers. Currently the main channel depth has reached -21.0 meters, 3.27 million meters of shoreline length, with various berths in total 159, including 102 million ton berths, public berths with a total coastline of 21.5 kilometers, and 25 million ton ship can be free access to port, 30 million ton ship a mere wave out of port. From a international perspective, in 2013, the ten world port cargo throughput port according to the order of ranking in turn for Shang hai port, Singapore port, Tianjin port, Guangzhou, Suzhou, Qingdao, Tangshan, the port of Rotterdam, Dalian port, Tianjin Port Throughput row in third place in the world and remarkable achievements, but behind a decent amount of throughput is huge ship exhaust pollution problems. International environmental organizations for the Natural Resources Defense Council (NRDC) published the “white paper on air pollution control ship port data” show that a ship 3.5% sulfur content of fuel oil used in large container ships, with 70% of the maximum power load driving, PM2.5 emissions equivalent to 50 million vehicles using the four oil truck (Zhang, 2016). Public opinion has a great disturbance. Originally, ship main emissions of sulfur oxides, NOx and PM2.5 variety of atmospheric pollutants, is a major source of atmospheric pollution in the water area of urban waterfront. The

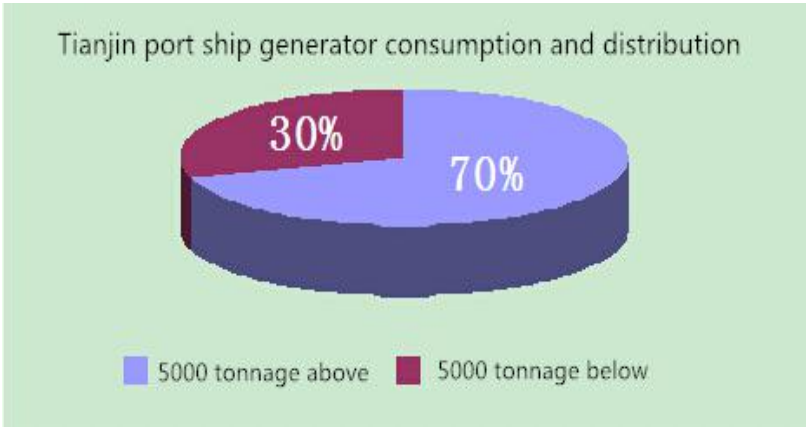
Tianjin local university and research institutions statistics show that the contribution of the ship and the port for Tianjin air pollution reached 30%.

After a preliminary investigation: Tianjin port 13, 14 for two years, outbound ship more than 47900 ships, cargo throughput of about 8.6 tons, including more than 5000 gross tonnage of ship berthing operation 31100 times, the average berthing time of 1.5 days, the generator fuel consumption is about more than 46600 tons, according to the calculation of sulphur content of 3.5%/ tons of fuel, about emissions CO2 more than 147722 tons, SO2 tons of waste gas 7100 tons, NOx 7700 tons, containing PM10\PM2.5 of 74560 million cubic meters; a total of 5000 tons and below the ship more than 16700 ships, the average berthing time of about 1 days, the generator fuel consumption more than 20000 tons, CO2 emissions more than 63400 tons, about SO2 tons of waste gas 3500 tons, NOx 3332 tons, containing PM10\PM2.5 of 32000 million cubic meters; one of the main components of haze particles (PM10/PM2.5) emissions accounted for the city's total emissions 3.2%.

Tonnage of ship	Berthing ships (time)	Fuel consumption (tonnage)	Emission CO2 (tonnage)	Emission SO2 (tonnage)	Emission Nox (tonnage)	Emission of waste gas(including PM10/PM2.5,Ten thousand cubic meters)
Tianjin port berthing ship	47800	66600	211100	10600	11030	106560
5000 tonnage above	31100	46600	147700	7100	7700	74560

5000 tonnage below	16700 (35%)	20000 (30%)	63400 (30%)	3500 (30%)	3330 (30%)	32000 (30%)





According to preliminary estimates, after the implementation of the ship emissions control areas, by 2020, the Bohai (Beijing, Tianjin) belt waters ship emissions of sulfur oxides and particulate matter will be decreased by 30% and 65% than 2015, ship emission reduction effect will be very obvious (Wang, 2016, p. 21).

Tianjin Port waters of ship emissions workspace control can be implemented in two stages: the first stage, the ship moored at the dock of Tianjin port using sulfur content of no more than 0.5%m/m during the mooring, to encourage the ship moored in the dock using of sulfur content not higher than 0.1%m/m fuel during the mooring.

After assessment the first phase of the implementation of measures and appropriate started the second phase of the control measures, the ship entrying into the controlled area and should be using sulfur content of no more than 0.5%m/m fuel, in the dock during berthing shall use sulfur content of no more than 0.1%m/m, to encourage ships entering the emission control of using sulfur content of no more than 0.1%m/m fuel. At the same time, the emission of the second phase of the control range can be extended to the Tianjin Port seaway. Ship sulfur oxide emissions control methods are mainly examined in three ways: the use of low sulfur content fuel, liquefied natural gas (LNG) as alternative fuels, or the approval of the marine exhaust gas desulfurization technology; after berthing the ship can be connected by a shore power meeting the emission control requirements.

3. Ship emission control method of sulfur oxidation

3.1 Low sulfur fuel oil

Low sulphur fuel technology refers to the oil refinery by a fuel processing technology for refining fuel oil sulfur removal. As the most direct way of SOx emission reduction, it used to be considered to be the mainstream technology to solve the SOx emissions from ships.and is the most direct way to reduce emissions of sulfur oxides for ship. Some studies have indicated that the sulfur content of marine fuel from 2.7% to 0.5%, SO2 emissions will be reduced by 80%, and can effectively reduce the emission of PM. But its price difference of about 90 euros per tonnage, if it fell to 0.1% of the sulfur fuel, the price difference is about 150 euros per tonnage. Many ships, sailing in Europe Beihai, the Baltic Sea SECA ,by modifying the fuel system and combining with selective catalytic reduction (SCR) technology, realize the simultaneous desulfurization and denitrification of (Nikopoulou Z, 2008). However, the marine diesel engine, boiler and other fuel power equipment, are mainly to apply the high sulfur content of the low cost of heavy fuel oil. Not after

the transformation directly to use low sulfur fuel oil is bound to have adverse effects, especially on the injection (Li & Hao, 2010, pp. 48-50) EC system and lubrication system, assessment of the feasibility of IMO on low sulphur fuel availability has not yet been completed, to the main ports in the world can supply sufficient refining fuel oil, is still inconclusive. In addition, low sulphur fuel refining will not only consume more energy to produce large amounts of carbon emissions, also increased the cost of refining and lead to a decline in oil flash point and lubrication properties that can not be met when the former IMO for marine fuel oil minimum flash point limit (60 DEG C). Therefore, low sulphur fuel technology will increase the ship operating costs and affect the safety of navigation, marine diesel engine and shorten service life. However, for the existing ship, due to the modification of low sulfur fuel equipment investment is small, so when high and low sulfur fuel price gap is less than 250 euros and ship in the SecA sailing time is less, part of the existing ship will still choose to increase the fuel cost, and low sulfur fuel to meet ship Sox emission regulations requirements.

3.2 Alternative fuels

LNG is recognized as a green fuel, and alternative fuel technology refers to the use of liquefied natural gas (LNG), methanol, bio fuels and other new clean energy as the representative of the fuel, instead of traditional marine fuel oil burning technology. This kind of fuel has a more prominent environmental performance, can effectively reduce emissions in ship exhaust Sox, NOx, particulate matter (PM) etc., the LNG can be almost 100% reduction of SO2 and no particulate matter (PM) emissions and reduce 85% ~ 90% NOx and 15% ~ 20% of CO2 emissions, fully meet the requirements of the Convention and the law of Sox and NOx and fuel prices are relatively cheap, help to reduce operating costs. So this technology is gradually beginning to be applied to the ship power plant. However, the pure gas fuel engine

and dual fuel engine cylinder lubrication, methane leakage, security and other aspects still exist some unsolved key technical problems (Brynolf S & Magnusson M & Fridll E, 2014) and ship LNG storage fuel pressure tank space required is about 3 ~ 4 times of that of equivalent diesel oil tank, the construction cost increased by about 8% ~ 20% (Panasiuk Irina & Lebedevas Sergejus & Transbaltica, 2013, pp. 153-158). In addition to the northern Europe area, in most of the world's port fuel supply port infrastructure is still not perfect, installing fuel, storage and lighter are more difficult. In addition, the study shows that the LNG economy depends on the price difference between LNG and HFO, as well as the proportion of SECA in the course. Therefore, alternative fuel technology is still only in the Nordic region within the short distance shipping and shipping on the line of passenger and freight shipping on the application of the promotion, but in large ocean shipping on the actual application of the case is less.

3.3 Marine Gas Desulfurization Technology

In the long run, the flue gas desulfurization technology is the best choice for performance, currently at home and abroad in the pilot scale, or have real ship in ship exhaust gas desulphurization technology mainly include: seawater, freshwater + sodium hydroxide method, hybrid system, CSNOx, of magnesium base - water method and dry method. And some of the technology is still in model study and laboratory research stage, such as alkaline discharge water jet screen method, ozone + hydrogen peroxide + sodium chloride spray absorption, plasma and ozone oxidation and water absorption, filtration + ozone and hydrogen peroxide oxidation, electrolytic pressure load and water absorption, (Huang, 2008, ppp. 5-9).

3.3.1 Sea water method

The natural alkalinity of seawater is as the active material of desulfurization. In the absorption tower, the exhausted SOx dissolve in seawater and neutralized. Due to

the limited capacity of SOx, in order to ensure the desulfurization efficiency, it needs to update the sea water. A large number of desulfurization wastewater is discharged after handling, so the seawater method is also called "open loop" (Loop Open) (Ma & Xu,2011, pp.190-193). Currently working in sea water ship sulphur oxide emission control technology's companies have Hamworthy Krystallon, Ecospec, marine exhaust solutions, and Belco. The main advantage of seawater method is that the sea water is easy to get, and the operating cost is low. But, due to the update of a lot of water, this method need to consume an additional 3% to 2% of the fuel, and a large number of desulfurization waste water needs to be treated as a drawback of the technology. At the same time, the main reason is that the sea water is in the buffer system, the system balance is destroyed, and the SOx emission is reduced while the CO2 emission is increased.

3.3.2 Fresh water + sodium hydroxide method

Fresh water + sodium hydroxide method is based on the fresh water as the carrier, adding sodium hydroxide as the desulfurization agent. When the pH value of the absorption liquid only needs to continue adding sodium hydroxide, the discharge of the desulfurization waste water can be reduced even to no discharge, so the method is also called "closed loop" (Loop Closed). Fresh water + sodium hydroxide method has the advantages of high desulfurization efficiency, low energy consumption (1% additional fuel), less waste water and no CO2 emission. But relative to seawater method, it needs dosing system, at the same time in order to reduce light water evaporation, the need to install a washing liquid cooling device. Therefore the purchase cost is higher than the sea water, and using expensive sodium hydroxide is used as a sweetening agent, resulting in the substantial increase in operating costs. The sodium hydroxide as the alkali material, needs to consider the safe storage of chemicals. At the same time, the continuous operation will make the washing liquid in the salt increased, and bring the problem such as salt corrosion.

3.3.3 hybrid system

Hybrid system is method of Aalborg industries according to the seawater and freshwater + sodium hydroxide method respective characteristics of the development of a ship exhaust gas desulfurization technology, the hybrid system named incredible is two ways combined into a set of desulfurization system. In order to achieve a high desulfurization efficiency by switching to the fresh water + sodium hydroxide method, the discharge control area is switched to the seawater method in order to reduce the operating cost. The system is well used in the technical advantages of seawater and fresh water + sodium hydroxide method. But because containing both of the two methods, the acquisition cost is high. The advantages of the two methods must have the disadvantages of the two methods.

3.3.4 CSNOx system

CSNOx system is developed by Ecospec ship exhaust gas comprehensive treatment technology, both high efficient desulfurization (99%), denitrification (66%) and the effect of the decarburization(77%). The system is divided into two stages: the first stage is the same as the typical "open loop" seawater FGD system; the second stage is treated by ultra low frequency electrolysis system, which is used to remove NOx, CO2 and the remaining SOx. NOx is converted to CO2, and N2 is converted to carbonate. If Ecospec's report is true, the system has broad application prospects. Because there is no comprehensive validation, it is considered that the system is not mature enough.

3.3.5 Magnesium based seawater method

Magnesium base of seawater (M & S) is from Dalian Maritime University research team in the mature land-based magnesium method desulfurization based on seawater combination from creative new ship exhaust gas desulfurization technology (Tang & Li & Hao, 2012, pp. 1081-1087). Through the real ship experiment: in the waste gas flow for 5 000 m3 / h, the pilot device repeatedly continue operation, at

after discharge gas SO2 concentrations remained below 57 mg / m3 (equivalent to fuel sulfur content of 0. 1%), and confirmed the device of persistence. In principle, it overcomes the shortcomings of seawater and fresh water + sodium hydroxide method.

3.3.6 dry method

Dry is the use of calcium oxide, calcium carbonate or calcium hydroxide desulfurizer, due to exhaust gas and the sorbent packed bed direct contact and reaction, the reaction process without intervening liquid, therefore it is called dry (Tower Paul, 2003). Systems DryEGCS is developed by the Couple system, and which is currently the only dry process of ship exhaust gas desulfurization technology. Compared with the wet method, dry method has the most obvious advantages, not to consume water and waste water, and the energy consumption is lower than that of wet method. However, the gas solid reaction rate is low, so it takes longer to stay, which also leads to a larger volume of dry process, which is about 2 times of the wet process. The by-product of dry desulfurization is calcium sulfite and calcium sulfate, and the by-product of accumulation also needs to occupy larger space. But for the limited space on the ship, these problems are the bottleneck of the application of the technology. Ship exhaust gas desulfurization technology is an effective means to control the emissions of sulfur oxides. Magnesium resource is abundant in our country, the development of local characteristics of magnesium based seawater sulfur ship exhaust gas desulfurization technology will break the technical barriers of developed countries, from passive compliance performance to take the initiative to change to ensure the economic interests of the new ship our manufacturing, and to protect the ship transportation safety operation.

4 the use of ship shore power in berthing

4.1 the use of shore power is an effective way to reduce the discharge of air pollutants in the port

The use of shore power is an effective way to reduce the discharge of air pollutants in the port. The effect of energy saving and emission reduction by using shore power is greatly related to the power generation level and the power source. China's power, mostly from the thermal power plant, which mostly come from coal-fired power, usually under the condition of coal-fired power generation air pollutant emission intensity is larger, berthing of ships using shore power instead of the marine auxiliary power that the overall emission reduction effect has been questioned(Yang, 2013, pp. 30-34). China is committed to reducing power share, but in 2014 China power of 74.9% still comes from thermal power, which most of spontaneous combustion of coal power generation, and coal-fired power generation is generally considered to be "dirty electricity", however, under the background of building a resource conserving and environment friendly society in fire power plant energy-saving emission reduction work progress is huge. According to the data provided by the China Electric Power Enterprise Association, in 2014, 6000 kilowatts of the country and power over the factory power supply standard coal consumption 318gce/kWh (expressed as a 1gce 1 grams of standard coal); according to China's national development and Reform Commission issued the “2014 China Grid domains baseline emission factor "report, from 2010 to 2012 in China north, northeast, East China, central China, Northwest China and South Regional Power Grid power carbon dioxide emissions intensity is respectively 1058.0g/kWh, 1128.1g/kWh, 809.5g/kWh, 972.4g/kWh, 957.8g/kWh and 918.3g/kWh; 2010 China thermal power accounted for the national power generation capacity 80.76%, thermal power plant sulfur dioxide, nitrogen oxides and fine particulate matter (PM2.5) emission intensity are respectively 2.883g/kWh, 2.795g/kWh and 0.295g/kWh (Mo

& Zhu & Wang, 2013, pp. 1-6). According to IMO released the 2012 ship energy efficiency design index calculation guidelines (Marine Environment Protection Committee, 2012), marine auxiliary power generation of the fuel consumption rate 215g/kWh, consuming 1kg fuel emissions of carbon dioxide 3.114kg and berthing of ships making with auxiliary fuel power generation of carbon dioxide emissions intensity 670g/kWh Root according to California's ocean going ships emission estimation methods and ship berthing using sulfur content of 2.5% residual fuel oil power, the unit consumption of sulfur oxides, nitrogen oxides and fine particulate emissions were 11.10g/kWh, 14.70g/kWh and 1.46g/kWh, the vast majority of the sulfur oxides of sulfur dioxide, a few for sulfur trioxide, can be regarded as sulfur dioxide treatment. Therefore, theoretically, in East China, ships use shore power instead of auxiliary power, if all of their electricity from burning coal power generation, in energy conservation, control of greenhouse gas emissions and reduce air pollution emissions results as shown in Table 1, table "+" and "-" were shown to increase or decrease; marine auxiliary power fuel consumption rate 215g/kWh, reduced energy consumption rate is 307.1gce/kWh. The analysis results show that in our country ship by using shore power instead of auxiliary power, even if all of their electricity from coal-fired are only a small increase in energy consumption and carbon dioxide emissions, which can effectively reduce air pollutant emissions. Taking into account the coal-fired electricity generation accounted for the share of the total power 3/4, and other fuel for power generation is relatively more energy-saving, emission reduction and low carbon can conclude, currently in China ship by using shore power instead of auxiliary power may help to save energy and reduce greenhouse gas emissions, but also effectively reduce the emission of air pollutants. Therefore, in the current grim situation of China's atmospheric environment , to promote the use of offshore vessels have a special practical and important significance.

Source of electricity for marine vessels in China	energy consumption	Greenhouse gas emission	Air pollutant emission		
	Standard coal(gce/kWh)	Carbon dioxide(g/kWh)	sulfur dioxid (g/kWh)	nitrogen oxide(g/kWh)	Fine particulate matter (g/kWh)
Auxiliary power	307.1	670	11.1	14.7	1.46
Shore power	318	809.5	2.883	2.795	0.295
The effect of using of shore power to replace the power auxiliary	+10.9	+139.5	-8.217	-11.905	-1.165

4.2 Port construction power supply equipment and facilities are the key to the using of shore power

In promoting the berthing of ships using shore power in the process, the port thinks that the ship is a little wiht the ability by using shore power, and construction of shore power equipment utilization rate is very low, and there is no much practical significance. Shipping companies think that the port is has little shore power supply capacity, and the implementation of the transformation of the ship, with shore power to accept ability has not much practical significance, the problem of "the egg, or the first chicken" plagued the ship in port using shore power technology popularization and application(Wu & Xu, 2015, pp. 51-55). In fact, port with shore power supply ability is the key to promote the berthing of ships using shore power, for the following reasons: (1)It is because of the existence of port which leads to a large increase in the density in the waters around the port ship activity , and marine

air pollutant emit port area and its surrounding air pollutants which is one of the main sources, controlling ship air pollution emissions become the important ways to the port to fulfill social responsibility or get public recognition, and the port has the obligation to as active, to create the conditions to reduce ship air pollutant emission(Song & Zhou & Tian, 2015, pp. 21-22). (2)The berthing of ships using auxiliary power meeting the ship power demand is normal, and it is the changing that ship using shore power which meet the requirement of port improving air quality of the environment, and the port should first have a shore power supply capacity to propose the requirement that ships should use the shore power(Li & Sun, 2006, pp. 10-14). (3)In view of the port construction of shore power supply equipment and facilities investment costs, usually higher than the cost of power equipment and facilities which the ship take, preparing the shore power supply ability involves including power supply, all levels of government, the port the battalion and many other interest related parties, coordinate the interests of relatively complexed, and the ship with accepting shore power capacity relates only to the shipping company, there is no problem of interest coordination. Therefore, the realization of port with shore power capacity is relatively difficult. Since the port with the shore power supply capacity is the key to promote the using of shore power by the port of the ship, to promote the using of shore power by the port, it is required to focus on solving the problem of port with shore power supply capacity(Zheng, 2010, pp. 15-20). California by ship rules in the proposed mandatory berthing ship to shore power requirements, and at the same time, corresponding special requirements, these ports which are required to use the ship shore power services must in a specified time provided respectively in July 2013 July 1, 2016 1, and 2019 July 1, complete berth with the renovation plan for the shore power supply ability. EU alternative fuel infrastructure directive, the port must be required before December 31, 2014 have the ability to supply shore power for the port on the port(Wang, 2008).

4.3 The government needs to provide financial support to make up for the port construction of the power supply equipment and facilities

In order to improve the regional air quality, the port investment construction of shore power facilities, port needs to fulfill their social responsibilities, ports can increase the public recognition, to enhance the capacity for sustainable development, but as the port enterprises in pursuit of economic benefit maximization as the goal, input return or interest who made the balance of interests also behoove, and improve the air quality of the environment effect on the port region for people to share, if the state or local government did not have policy of mandatory standards or requirements of port enterprises construction of shore power facilities, it should provide financial support to make up for the port construction of shore power facilities investment(Yu, 2013). Actually, in the developed countries and regions in the promotion of berthing ship to shore power but also to do so, the government and public interest organizations always share port construction of shore power equipment and facilities as part of the cost of that (Peng, 2012, pp. 11-14). Recently built into the port of Hamburg Altona cruise terminal shore power system, using liquefied natural gas (LNG) power boat for Cruise Port provide up to 12 MW of electricity, with a total investment of 885 million euros, as a demonstration project won the Federal Environment, nature conservation and nuclear safety all 370 million euros in funding, the European Union funded 350 million euros, government funding accounted for 81.4% of the total investment of the project. Since 2011, China's Ministry of transport use the transportation special funds for energy-saving emission reduction winning "award on behalf of the ways to motivate shipping enterprises implementation of ship energy saving emission reduction projects(Tong, 2013). In 2011, 2012 and 2013 delivery through transport special funds for energy-saving emission reduction application guide, "the berthing of ships use shore power

technology" independent listed as bonus content, reward berthing of ships using shore power system construction or renovation cost 20%, but in 2014 will be relevant in volume into the theme of the regional pilot projects, because each year into thematic and regional pilot of the port and the city quantity are less, weakening the of berthing of ships using shore power technology "reward is also lower than the berthing of ships using shore power system construction or reconstruction cost 20%. Compared with the developed countries providing financial support to compensate for the investment in port construction of shore power equipment and facilities, if our country does not have the introduction of mandatory port construction of shore power facilities or berthing of ships using shore power of mandatory policies or standards, still in using of existing transportation section emission reduction special funds to "berthing of ships using shore power technology" incentives, may be very difficult to effectively promote port construction of shore power facilities or ship using shore power(Li & Wang & Jin, 2010, pp 12-15).

5 The problems and countermeasures of China's ship emission control area

5.1 Control requirements

The sulfur content of marine fuel is directly related to the content of sulfur oxides. In view of the application in ship desulfurization of exhaust after treatment technology, it is not only difficult to adapt to the high desulfurization requirements (equivalent to 0.1% sulfur containing the amount of fuel sulfur oxide emissions requirements), and ship arrangement desulfurization exhaust after treatment system needs to occupy a larger space. Therefore, the current controlling of the emission of sulfur oxides is mainly realized by controlling the sulfur content of the marine fuel. Our ecz currently only on the controlling of emissions of sulfur oxides, requirement for ships using sulfur content limit for 0.5% of the fuel, and China's Hong Kong Special Administrative Region in 2015 on July 1 implementation of the mandatory

berthing of ships using fuel sulfur content limit requirements are the same, but a ECA 2015 January 1 implementation of the ship fuel sulfur content limit control requirements, EU 2010 January 1 implementation of ship fuel sulfur content limit control requirements low. Shipping enterprises need not only to meet the shipping area and docking port fuel sulfur content requirements, and at the same time, but also to try to reduce the operating cost of ship, in different regions or docked port in different regions of the international sailing ship and satisfy the corresponding sulfur content of fuel. In order to meet the requirements of our country ecz control, when anchored in the European Union and the North American port, ships need to enter our country ecz, need additional storage in sulfur content limit for 0.5% fuel oil storage tank, increasing the cost of renovation; only at the expense of some ship operating costs of shipping companies to increase, the ship using sulfur content limit for 0.1% of the fuel before they can avoid additional storage for fuel oil storage tank transformation. But, no matter what kind of situation, it is not appropriate to increase the shipping enterprises to meet the requirements of the control of the ship's air pollutant emissions policy. The Baltic Sea comprehensive synthetic freight index has dropped to below 300 points, many shipping enterprises have closed down or restructuring. Under the shipping economy remains in the doldrums of the implementation of ECA, for the owner is undoubtedly worse. Whether it is the using of low sulfur fuel, clean energy source or exhaust after treatment device and will add to owner operating costs. Of container ship with ECA's strategy it is to use low sulfur fuel operating costs turn married to the owner of cargo, such as all ships bound for the ECA region, need shippers pay low sulfur fuel surcharge, for the owner of the shipping conditions it will cause greater impact. It is suggested that the government should take appropriate measures to encourage the owner to take the measures to actively adapt to the imperative of the ship ECA. In addition, because of our country ecz requires the using of sulfur content limit for 0.5% fuel, part of the

ship using such fuel to meet the control requirements, and another part of the ship use sulfur content limit for 0.1% of the fuel oil to meet the control requirements, our country need to ensure that the above two kinds of fuel supplies and additional increase the fuel supply security trouble.

5.2 Core port area

ECA international adopted more stringent than in the other areas of the ship emission control standards for special geographical area, in the region and implementation clear and consistent ship emissions control standards. Our country in the Pearl River Delta, Yangtze River Delta, the Bohai Sea (Tianjin) waters ecz set up core port in the area, to in the core region of port prior other port area of the implementation of control require or encourage core port pilot areas. At present, our country has not yet accept the concept of "core port". There is no port core area; setting emission control area aims to minimize ship discharge and core port area i.e. the using of strict ship emission control standards so it can be most effective in reducing air pollution emission of the port area, but currently our country lack enough data to support. In accordance with the requirements of the control of our country ecz, January 1, 2017, ship in the ecz core region of port shore parked during the period should be using a sulfur content of less than 0.5% of the fuel. From setting ecz to port in the core region enforce emission control requirements for only 1 year, the demonstration of core port area is extremely limited. The reason lies in: sailing ships of Europe and the United States in the core inside the port area of terminal anchored, if using control fuel requirements, port needs to satisfy the control requirements of the fuel supply capacity, which needs time; ships not sailing to Europe and the United States need to transform the increasing sulfur content limit storage for 0.5% fuel oil storage tank, which also requires time. A port with relatively stable competition within the region requires a number of ports "first try" may affect their own competition ability

measures, which is too idealistic. Although the core region of port started the implementation of mandatory ship strict emission control requirements after 1 year, emission control in all the ports in the region began to implement the same emission control requirements, but to some of the core region of port enterprises may still have reason to worry about its port operations they will be transferred to other ports, attention should be paid to the problem of port competition pressure. The establishment of the ship ECA will bring some influence to the port enterprises. At present our country coastal and inland port competition is intense, three emission control area of establishment can increase the ship's operating costs in this region, resulting in these emissions control areas within the core port to a certain extent reduce the competitive advantage. Such as Tianjin port to enforce sulfur emissions control, import and Tianjin port shipping port costs increase, many ships will turn anchored on sulphur emissions requires low standard of Qingdao port. In addition, the lack of a number of port shore power facilities or they do not match, the transformation of the need requires to invest huge sums of money. We suggest our government take some subsidies from the central finance and local finance and can even learn from international and Hong Kong SAR government practices, taking measures like reduction of port facilities and beacon fees, administrative fees, shared ports, aviation enterprises reduce emissions by adding? after the operation.

5.3 Covering the port range

The establishment of emission control area belong to the action of government, and should try to avoid competition for emission control policy implementation, affected area, different administrative jurisdiction within the scope of port and shipping industry and the development of related industries. There is a competition between Liaoning, Shandong and other coastal port groups, the development goals of Dalian Port, Tianjin port and Qingdao port are all built into the international shipping center

in the area. In September 2007, the former Ministry of Communications issued a "national coastal port layout planning"to strengthen the state of port planning and construction management, to ensure the national economic and social comprehensive, coordinated and sustainable development, Liaoning, Tianjin, Hebei and Shandong coastal ports group are classified as Bohai economic belt. China's Bohai sea (Beijing, Tianjin) waters ECZ does not cover the port of Qingdao, which will change the port groups in the Bohai area of different ports and related industries to develop competitive situation. Beijing, Tianjin and the atmospheric pollution is a very serious problem, controlling air pollution need joint efforts, not only regional internal defense linkage, different regions should also work together. On October 23, 2013, Beijing, Tianjin and surrounding areas started cooperation mechanism for prevention and controlling of atmospheric pollution, determining Beijing, Tianjin and the surrounding areas of air pollution prevention and controlling key industry and trade in 2015 ", proposed" governance of port and marine pollution, explore and study the Bohai belt regional governance measures ". Therefore, Tianjin clean air action plan increased the task of "Jin Ji Lu Jian ship source pollution list, the" Tianjin lead, and Hebei, Shandong jointly carry out port and ship pollution discharge research status, the establishment of port and ship pollution source inventory, carry out harbor boat, flow mechanical equipment, engineering ship, dock filling facilities construction port application of clean energy pilot demonstration, study and explore the berthing ship in port using shore power supply alternative owned fuel power generation policy, measures, reduce air pollution caused by ship combustion of heavy oil "(Peng, 2016, pp. 6-7).

5.4 Fuel quality

To solve the problem of qualified low sulfur fuel. and implement the above measures in ship emission control area, the core problem is qualified low sulfur fuel

supply, and use the sulfur content 0.5% fuel in our country at the present time. When we ,do so, technology is not a problem, and just refinery must increase the cost of production, and then desulfurization can produce high quality fuel, and desulfurization increases the cost of the proposed by the Chinese government for oil refining enterprises to tax breaks or give full compensation. In addition, the ship sailing into the ECA region needs to replace low sulphur fuel, must increase the storage of low sulfur fuel oil tank, carries on the transformation to the ship also need to spend time and cost, we suggest that the government takes certain incentive policy like tax breaks to encourage emission reduction.

6. Emission control area (ECA) port state in inspection

Operation of the ship and in the ECA region and inevitably to encounter the port state control inspection, the current conventional practice of major container ports in the memo is using shore power or changing low sulphur fuel during ship berthing. Port shore power supply technology for energy conservation and emission reduction, has very positive significance to the construction of green port, and solve the landing ship water pollution problem when the ship enters port mouth. But because of limited power supply time, destination port electric load factor, voltage, frequency, etc, for example, frequency and voltage of power grid in our country adopt 50 hz and 380 v respectively, and most of the ship's power supply frequency is 60 hz and 440 v voltage, large scale promotion need to design to the installation of frequency conversion and the corresponding equipment distribution. Thus operating in the ship with replacement of low sulfur oil and satisfy the practice of ECA area to seek more respected.

6.1 Port state inspection

On January 29, 2016, China maritime safety administration issued the notice on

strengthening the supervision and administration of ship emissions control area work , clear the ship emissions control area regulatory requirements. Relative to the domestic port state supervision and inspection, the Paris memorandum group woven inspection carried out earlier in the project, checking the program is more standard and strict. According to the European maritime bureau released the fuel inspection guide in emission control area, the emission control zone, prosecutors understanding on port state control in the initial inspection stage will check according to the following way:

(1) Low sulfur oil transmission pipeline is located in the position of the low temperature, heating facilities shall be installed. .

(2) Sample inspection, the fuel oil control area use shall comply with the requirements of MARPOL annex VI article 18.

(3) Fuel conversion program includes the related records. Ships shall carry a book program showing how to perform fuel switch, in its regulation enough time before entering the emission control area, the fuel oil supply system should conduct a comprehensive flushing, to remove all excess sulfur content of fuel. In fuel conversion operation into the emissions control area, after finishing or leaving the area at the beginning, each fuel oil tank shall be of low sulfur fuel oil volume and record date, time and position of ship in the main pipe organ in the log book.

If the vessel is to be inspected at low temperature, the prosecutor shall pay particular attention to the following items:

(1) the low sulfur oil transmission pipeline in the low temperature position, heating facilities should be installed.

(2) in the low temperature conditions, to enter the emission control area of the fuel conversion program.

(3) in the emission control area, any vessel which has a sulfur content of more than 0.1% is not acceptable due to environmental impact. .

If the inspection found that the ship does not conform to the standard, port state prosecutors will enter a detailed inspection, to use fuel not in conformity with the standard in the control area, the consequence is very serious, it will directly cause retention. If ship can't get low sulfur oil before entering emission control area, the captain needs to provide the following document:

(1) If the ship can't conform to the requirements of the low sulfur oil, before entering emissions control area, the master and the owner shall report the port of destination port state authorities and the flag state.

(2) Ship voyage plan includes shipping port, the port of destination and time to enter and leave the emissions control area.

(3) The time to enter and leave the emissions control area.

(4) Measures taken to obtain low sulfur oil and the compensation measures.

(5) Contact the oil supply business records and oil supply business cannot provide evidence of low sulfur oil.

6.2 Ships entering the ECA region using fuel matters attention

In order to pass the PSC inspection, ships must ensure that 100% low sulfur fuel burning. This requests the ships into the region of the ECA, fuel oil daily tank and its exports to the high-pressure pump pipeline, low sulphur fuel, and there is no longer a high sulfur fuel. According to the above analysis of the cause of the excessive amount of fuel sulfur content of the ship, there are several possibilities:

(1) Ships did not set up a special low sulfur oil tank of a ship, in the process of changing oil, they can not be high sulfur fuel completely split up and join the low sulfur oil sulfur content although lower than the required value but relatively close to the standard, resulting in low and high sulfur oil mixure after the actual amount of sulfur higher than the standard values.

(2) The oil products provided by the gas company may not meet the standards.

(3) Deviation may exist in the changing oil program. The crew in the procedure of oil preparation may work only by experience or imagination of preparation, not verified in practice, thus causing oil program itself may not meet the requirements.

(4) Deviation may exist in the changing oil operation. Crew did not strictly enforce the oil change procedures, causing the oil changing time being too short, part of high sulfur crude oil remains ing the dual-purpose oil tank or mixed oil tank and pipeline.

Based on the above analysis, to deal with PSC inspection, the ship into the ECA can be prepared from the following aspects:

(1) For ships not equipped with special low sulfur oil tank, when entering ECA region, it is recommended that dual-purpose fuel tanks are thoroughly cleaned. For ships into the repair factory, it is recommended a thorough cleaning for dual-purpose fuel oil tank of the main and auxiliary engines, fuel precipitation cabinets and daily tank or oil mixed cabinet, in order to reduce the sludge quantity for the crews on the subsequent operation of the self-cleaning and lay a good foundation. In the ship cabin with fuel and low sulfur oil, and will need to be repeated to confirm the empty cabin. If the specified oil change time is too short, we should revise the program, use low sulfur oil, changing oil ahead of time as far as possible.

(2) For the current plan to the ECA region, store in the ship some low sulfur oil, according to the documents, examine the sulfur content, to accomplish know fairly well.

(3) Two tanks and two vessels for daily use, shall be provided. When without ships into the sulfur content control region or port, conversion to low sulfur oil should be early, and the general principle is in the security situation, the remaining amount of high sulfur oil should be as little as possible.

(4) Crew should be aware of the division of the ECA region, the different requirements of the ECA regional sulfur content; familiar with oil operating procedures, and strictly carry out the program. Understanding fuel oil sulfur content

control of the importance and mastery of the corresponding operation skills.

(5) In EU ports staying (includes mooring) more than 2 hours, the ship must use fuel sulfur content within 0.1% m/m. Within the European Union countries, each port requirements sometimes are not the same, a captain needs to contact agents in advance to understand clear port host before oil change. Part of the port requirements in Anchorage should also be used before the host is not more than 0.1% of the sulfur content of fuel.

(6) as to the ECA region on the way to buy qualified fuel, MARPOL Annex VI article 779 covers the provisions, the ship shall be promptly notified its competent authorities and relevant to the port authorities, specific requirements, please contact the flag state and port of destination. According to 18.2.1.2, the port of destination will be required to provide " the fuel alternative resources, and in spite of the best efforts to obtain qualified fuel, still can not buy the fuel of the evidence". In conclusion, despite strict port state control, but the ship such as the preservation of good oil receipts, and fuel conversion time and then daily tank, stock and other important card and fully understand and familiar with the port state supervision and inspection and the main points of the procedure, the ship will be able to smoothly through the ECA region, full sail (Li & Li, 2016, pp. 23-24).

Conclusion

the date of the affiliated ports and refueling. Ship provides the above-mentioned material, and for good reason, port state authorities should fully consider the situation, if accepted, ships can not modify the navigation and will not be punished.

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