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Analysis on the issue of ship sewage in terms of pollution, discharge and reception in the Minjiang Inland Port with countermeasures

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Analysis on the Issue of Ship Sewage in terms of Pollution, Discharge and Reception in the MinJiang Inland Port with Countermeasures

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is 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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ABSTRACT

Title of Research Paper: **Analysis on the Issue of Ship Sewage in terms of Pollution, Discharge and Reception in the MinJiang Inland Port with Countermeasures**

Degree: **Msc**

The research paper is a research on how to tackle several issues pertaining to ship sewage in the Minjiang inland port. Nowadays, with the increase of environment awareness, the water quality and local ecological protection have drawn increasingly attentions from the general public. Although the Annex IV to International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto (hereinafter referred to as MARPOL 73/78) has been ratified by China in 2 November 2006, then entered into effect in 2 February 2007, it is no easy job to get rid of the long-developed bad habits with respect to discharging sewage without any treatment by vessels which are engaged in domestic trade.

The lack of adequate port reception facilities leads to the inconvenience of vessels at the Minjiang inland port delivery sewage to shore treatment plants. Furthermore, regardless a better performance of international vessels in compliance with the requirements of international convention regarding the prevention of sewage pollution, a certain number of inland ships running business only within the port area results in serious issues of sewage pollution. In addition, the lack of effective measures for Maritime Safety Administration (MSA) officers gives rise to their failure to evaluate whether or not the sewage discharged by vessels cater for relevant effluent standards. The research collects the basic information about the quantity of sewage transfer to reception facilities, available reception facilities, the traffic flows, then analyzes the applicability of different laws and regulations, identifies the root causes and then provides some countermeasures.

Keywords: Ship Sewage, Pollution, Reception Facilities, Effluent Standard, Countermeasures.

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LIST OF ABBREVIATIONS

BOD	Biology Oxygen Demand
COD	Chemical Oxygen Demand
GB3552-83	Effluent Standard for Pollutants from Ship-GB3552-83
GB10833-1989	Marine Sewage Treatment System Specification-GB10833-1989
HELCOM	Baltic Marine Environment Protection Commission-Helsinki Commission

Helsinki1992	Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992
IMO	International Marine Organization
MARPOL73/78	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto
MSA	Maritime Safety Administration
MEPC	Maritime Environment Protection Committee
MWWT	Municipal Waste Water Treatment Systems
PDSWFZ	Programme of Designating the Environmental Function Zone for Surface Water of the Fuzhou City
SS	Suspended Solids
SRB	Sewage Record Book
TRDCS	Technical Rules of Statutory Survey for Domestic Coastal Ships
TRIS2011	Technical Rules of Statutory Survey for Inland Ships 2011

Chapter 1 Introduction

1.1 Research Background

Over the last decades, the number of vessels engaging in shipping which contributes to the economic growth is increasing; however, other consequences of this trend concerning water pollution can not be ignored. With the development of shipping, the increasing quantity of sewage water produced by people on board entering water environment has reached at a threshold level and then attracted more and more public attention to the negative impacts. The issue of ship sewage pollution not only concerns a single coastal country, but has become a major international problem as well. Then, with the cooperation and effort of International Marine Organization (IMO) and many States, the Annex IV of MARPOL 73/78 entered into force with the purpose of preventing the pollution by sewage from ships. Moreover, some countries or local governments have worked together to promulgate national laws or regional conventions according to their actual situations. In order to prevent and control the pollution by human beings in the Baltic Sea, the Baltic Marine Environment Protection Commission-Helsinki Commission (HELCOM) had adopted the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992, which entered into forced on 17 2000 (hereinafter referred to Helsinki 1992). The provisions of Annex IV to Helsinki 1992 established specific requirements referring to the prevention of sewage pollution from ships （HELCOM,2000).

Furthermore, in 2013, the document, entitled the HELCOM Interim Guidance on Technical and Operational Aspects of Delivery of Sewage by Passenger Ships to Port Reception Facilities, which is part of the 2013 HELCOM Ministerial Declaration, was endorsed by the 2013 HELCOM Ministerial Meeting on 3 October 2013, with the purpose of facilitating the work concerning upgrading reception facilities for sewage in ports and terminals used by passenger ships in the Baltic Sea. (HECOM, 2013)

In China, the central government has promulgated specific national laws and regulations to prevent the pollution produced by vessels. On the other hand, some local governments also note the still ongoing pollution by sewage from ships and identify the harm of ship sewage discharged into waters without treatment. That is the main reason why the Shanghai local government has unveiled a regional regulation, Regulations of the Shanghai Port on the Prevention of Vessel-Induced water Pollution, in 28 May 1996, which was meant to control the sewage pollution in the Huangpu River located in the vicinity of Shanghai(Dong, L.F,2007).

According to reports of State Oceanic Administration of People's Republic of China, harmful algal blooms or red tides occurred with increasingly frequency and longer lasting duration in the last decade. Besides, ship sewage discharged into waters directly may lead to the surplus of nutrients in waters which is one of the key preconditions and the material bases of algal blooms. Furthermore, it is widely recognized that red tides can exert huge adverse effects on the local ecological balance, especially on some sensitive targets, such as coral-reef communities (Robert A,P,& Gordon R, B, 1985, pp.175-189).

Therefore, it is necessary for the Administration to take a priority to the issue of ship sewage in the Minjiang inland port.

1.2 Basic Information about Minjiang Inland Port.

1.2.1 The Geography of Minjiang Inland Port

The Minjiang inland port, which is located along with sides of the estuary of Minjiang River, is a part of the Fuzhou port. Fuzhou is the capital of Fujian province, which lies in the southeastern coastal areas of China, in the opposite of north of Taiwan, is shown in figure 1-1.

Figure1-1: The Geographic Location of the Fuzhou Port

Source: http://www.vacationstogo.com/cruise_port/Fuzhou__China.cfm

1.2.2 Brief Introduction of the Estuary of Minjiang River

Minjiang River, which is the longest river in Fujian province, flows for 541 kilometers, originating from Nanping city and then cross southeastern area of Fujian before entering the Taiwan Strait, as is shown in figure 1-2. The Minjiang shipping mainly focuses on the Fuzhou Basin since the development of hydropower.

Figure1-2. Map of the Minjiang River

Source: http://www.huangshantour.com/english/map/minjiangmap.asp

Figure 1-3 provides some basic information about the Minjiang inland port in the estuary of Minjiang. Minjiang River flows into the downtown of the Fuzhou city, and

meanwhile is divided into two branches by the Nantai island: Beigang and Wulong. After that, Beigang and Wulong converge in Mawei districts. Port facilities of the Minjiang inland port were mainly distributed in the estuary of Minjiang River.

According to the report by Fuzhou Research Academy of Environmental Sciences, entitled The Environmental Impact Reports about the Construction of High-grade Waterways, there are some sensitive areas involved in Minjiang inland port: the Minjiangkou wetland reserve, some drinking water sources, sea clams breeding area and the area of the germ plasm resources with some special aquatic species.

Figure 1-3 The Minjiang inland port
Source: The google map

All of them have a close relationship with human beings. This is true especially when we recognized the indispensable values of the water environment of the estuary of the Minjiang in terms of the historical and present economic, social and cultural values which have a close bearing on the development and the well-being of the local residents. Take the wetland for instance, the Minjiangkou wetland reserve, which normally reaches more than 2,100 hectares and is approved by the State Council as one of the 21 national natural conservations, is widely considered as a winter habitat

for many types of migratory birds as well as an ideal habitat for some rare endangered birds since its unique climate, special geography and distinctively ecological environment. Yuxi, director of Fujian Wildlife and Wetland Resource Monitoring Center, said that the Minjiangkou wetland reserve is a unique area that can bird the Chinese Crested Tern, the Eurynorhynchus pygmeus, the Black-faced Spoonbills and other endangered breeds at the same time. Every year, more than 50,000 water birds, in 265 categories from East Asia and Australia would rest here on their way of migration in winter.

Chapter 2 The Adverse Impacts Caused by Ship Sewage

It is necessary to comprehend the clear definition and characteristics of ship sewage with the purpose of grasping the adverse effects of sewage, which entering the water environment without treatment, on Minjiang river ecosystems.

2.1 The Definition of Ship Sewage Water

A broad definition of ship sewage includes the “Black water” and the “Grey water”. The Blackwater is used to describe waste water which usually comes from toilets, medical premises, and spaces containing living animals. On the other hand, the Greywater is mainly drainage from laundry, shower, bath dishwater and washbasin drains. According to the annex IV to MARPOL73/78 the sewage generated by ships refers to not only all waste water from urinals and toilers, but also mixed water drainage from spaces containing living animals or waste water when mixed with drainages through wash tubs, wash basins and scuppers installed in these spaces or medical premises. Therefore, sewage water from ships usually comprises black water, mixtures of black water and grey water, and sometimes food stuff. Then, sewage is obviously comprised of a certain amount of dissolved and suspended impurities, organic materials and minerals. Besides that, sewage also contains disease-causing microbes, parasites, and sometimes with certain kinds of virus contributing to

potential threats to the health of human and aquatic lives. If ship sewage water is discharged into water directly without any treatment, it will cause the deterioration of the local water environment, and may make coastal aquaculture at real risk (Jing W., 2010).

2.2 The Negative Influences of Sewage Pollution from Vessels

(1)The ship sewage is usually with the extremely high load of pollutant due to complex components, so an enormous amount of organic material and nutrients will enter the water with untreated sewage discharged directly. However, the high concentrations nutrients present in water can lead to the bloom of algal and other microorganisms, then causing the lack of dissolved oxygen to support other aquatic lives such as fish and shrimps. Because the decomposition of organic matters contained in sewage will consume excessive dissolved oxygen, this results in the oxygen available for aquatic creatures and plants possibly become insufficient， which contributes to the demise of them. Moreover, a certain algae blooms usually company with the releasing of some toxins that may kill other aquatic creatures, such as, in recent years, the frequent occurrence of red tides in Fuzhou adjacent sea waters, which has a special link with eutrophicated water in estuary of the Minjiang. Some research work illustrated that biological, physical and chemical factors played significant roles in the formation of red tides. However, the root factor which can exert effects on the occurrence of red tides was water eutrophication. In other words, it means there are excessive nutrients such as nitrogen, phosphorus. When we traced back to the source of these nutrients, we will find that the nitrogen and phosphorus were always contained in sewage, waste water and waste generated by human production and living activities. There were a large amount of organic materials, nutrient salts and phosphorus from waste water, which was produced by industrial,

farming and domestic sewage, continuously along with the waste water into the rivers, and finally, they become merged in the sea. It is inevitable to make the ocean transform into a big rubbish dump. Over the past 20 years, with the rapid development of market-oriented economy and the fast pace of urbanization in our country, a significant increase of quantity of waste water and sewage produced by industry and agriculture in coastal regions, contributing to the exacerbating of eutrophication in near coast waters. Meanwhile, a lot of vessels required to engage on trade also brought about the issue of sewage pollution. The process of eutrophication has provided the necessary material conditions for the outbreak of red tides.

Therefore, to some extent, it is a useful way of reducing the frequency of red tides occurrence by enhancing control of the ship sewage discharge. It is true especially when we consider the fact that the effective control over illegal discharge of sewage can considerable alleviate the pressure on the purification ability of marine pollution which exactly has some limits.

(2)In view of the fact that Minjiang harbor has more than one drinking water source protection area, the safety of the Minjiang water has a profound influence on local residents' health. Although the waterworks will take some necessary steps to make water subject to appropriate disinfection, untreated ship sewage discharged wantonly would augment the processing cost without doubt and increase the residents' health risk. According to some research, there are more than one millions of bacteria per ml, most of which are pathogenic bacteria with abilities of spreading a variety of intestinal infectious diseases. In addition, it will increase the risk of infection for swimmers in the Minjiang and bathing beach. Besides that, harmful microbes caming from the sea area, which was polluted by ship sewage, will possibly be parasitic or symbiotic in shellfish that can pose threats to those people or animals who consume them (Han, X.B., 2008).

(3) Minjiang has played a key role in the protection of birds in the world since its unique geographical conditions and ecological conditions. However, the Bulletin about the Water Environment of Main River Estuaries in Fujian Province, which was regularly publicized by Fujian provincial Department of Ocean and Fisheries, demonstrates that the quality of water in the Minjiang estuary can be considered as the fourth-class worst for a certain long certain, which means in a state of serious pollution. Nutrient pollution is already identified as one of the main environment issues of the Minjiang estuary. Even the wetland, which was located in the Minjiang estuary, possesses the certain capacity of self-purification in terms of sewage, the further development of the Minjiang shipping brought a large amount of sewage together with the other domestic sewage and industrial waste water from the surrounding area, which have already created an enormous destruction to the quality of wetland water.

(4)The deterioration of local waters caused by sewage will pose a considerable threat to the local aquatic resources protection and aquaculture. There are some sensitive ecological protection targets alongside the Minjiang estuary such as Sea clams breeding area, the plan of the germ plasm resources of scylla serrata which is expected to be built at the Minjiang estuary in 2017 and other sensitive ecological protection targets.

Minjiang shipping plays a special role in inland water transport for its favorable geographical location combined with economic and efficient features, that can be considered as a link in the regional integrated transport system. With the proliferation of river and ocean combined transportation, the raw material and products coming from hinterlands could acquire an effective new outbound channel. Moreover, the Minjiang through the downtown of Fuzhou city also carries out the important task of offering the city with adequate safe water in order to keep the citizen’s daily life and daily production activities in good order. Therefore, the safety of water quality

together with the maintenance of water will engender great social, ecological and economic benefits. This is evidenced by the development of several projects, such as the Minjiang water sightseeing, birding in wetland, yachting industry and so on in recent years. All this needs the enhancement of the protection of the Minjiang eco-environment construction and safety. Fuzhou MSA, which is in a position of responsibility for supervising and controlling the sewage discharged by merchant vessels, shall try their best to prevent ship sewage from contaminating local residents' drinking water and deteriorating the local ecosystem.

Chapter 3 The Main Parameters of Sewage in respect of Biological Index and Physicochemical Index Focused by Both Domestic and International Rules

3.1 Biology Oxygen Demand

BOD5: The value of Biology Oxygen Demand (BOD) means how much oxygen is required by microorganisms for decomposing organics. Furthermore, BOD5 was used for representing the quantity of organics in water since oxygen is usually depleted remarkably in the first five days. The higher value of BOD5 of sewage discharged by vessels signified the more dissolved oxygen will be consumed. In addition to that, as a consequence of the excessive dissolved oxygen consumed, it will make the dissolved oxygen available for fish, shrimps and other aquatic lives inadequate, thus resulting in their death. Therefore, BOD5 is considered as one of the most important indicators referring to organic pollution, and the unit is mg /L.

3.2 Suspended Solids

SS: SS stands for Suspended Solids, usually involves the dissolved matters in terms of organics, inorganic substance, sediments, microorganisms and so on, which contribute to the reduction in water clarity, the growth in cost of domestic drinking water treatment as well as the adverse effect on respiration and metabolism of

aquatic organisms. It was also applied to indicate the degree of water pollution, and the unit is mg/L.

3.3 Chemical Oxygen Demand

COD: COD is short for Chemical Oxygen Demand the value of which is usually measured by calculating the quantity of strong oxidizers used to deal with the water sample in order to calculate the quantity of reducing agent which mainly refers to organic pollutants. The value of COD is also another indication of water pollution, the higher value means the organic pollution of water is more serious, and the unit is mg/L.

3.4 Coliform

Coliform: The coliforms is one of the most common types of colonized bacteria living in the intestinal canals of humans and animals, generally flush into waters with excrement and usually serves as one key gauge of water pollution, the unit is coliforms per 100 mL. However, according to the requirement of the resolution MEPC.159(55) adopted by IMO, the required data is the geometric mean of the thermotolerant coliforms count of the samples of effluent in 48 hours at 44.5℃ instead of testing all categories of coliforms since the thermotolerant coliforms is now more widely accepted(IMO, 2006).

Chapter 4 Overview of the Current Situation of Sewage in terms of Discharge and Reception

4.1 Analysis on the Vessels in the Minjiang Basin

Minjiang shipping transport mainly occurs from Yanfu wharf in Nanping city to Minjiang port in Fuzhou city. However, due to the failure to balance the relationship between the pursuit of generating electricity and the development of shipping, some navigation facilities in significant waterway were delayed to construct or even not in plan. Other key factors contributing to shipping constriction is the decline of water level at downstream of Shuikou dam as well as Shaxi dam. In nearly 20 years, Minjiang shipping is mainly built within the Minjiang inland port in Fuzhou; therefore the problem of ship sewage also focuses on Fuzhou sector of the Minjiang.

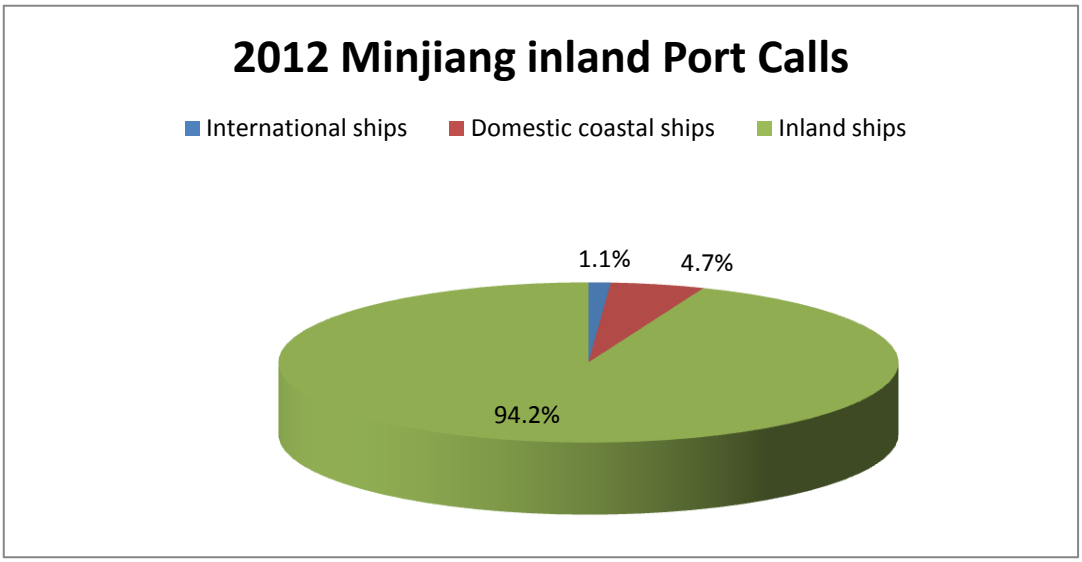
4.2 A Brief Introduction of the Applicability of Effluent Standards for Different Vessels

According to the investigation, there are three standards about sewage discharge available for vessels, which is classified in the light of ship's nationality as well as navigable areas, due to the development of seaward channel: a) Inland ships, which

are registered in the Fuzhou area, need to meet not only our country's general standard for sewage discharged by inland ships, but the local standards as well in theory , b) Domestic coastal ships, which are entitled to fly the flag of China and engaged in coastal transportation. When this type of vessel is sailed into the Minjiang inland port for the companies' operation with the purpose of loading or unloading cargos, both national and local standards applied to costal ships should be complied with. C) International ships, at least shall abide by the related International conventions such as the Annex IV to MARPOL 73/78, then satisfactory with the Chinese law as well as the local standards since Minjiang is under China's jurisdiction.

4.3 The Basic Information about Reception Facilities and Sewage Delivery in the Minjiang Inland Port.

According to the Fuzhou MSA statistics, the total number of port callings at the Minjiang inland port has reached more than 155.54 thousand calls in 2012. And then, the number has declined obviously by 21.3 %, about 122.24 thousand calls in 2013 due to the global economic recession. In general, the international vessels account for less than 1.1% in 2012 and around 13 % of total port calls in 2013; the domestic costal ships is next with 4.7 % in 2012 and 6.2 % in 2013; finally, the inland ships compose the remained part, as shown in figure 4-1.



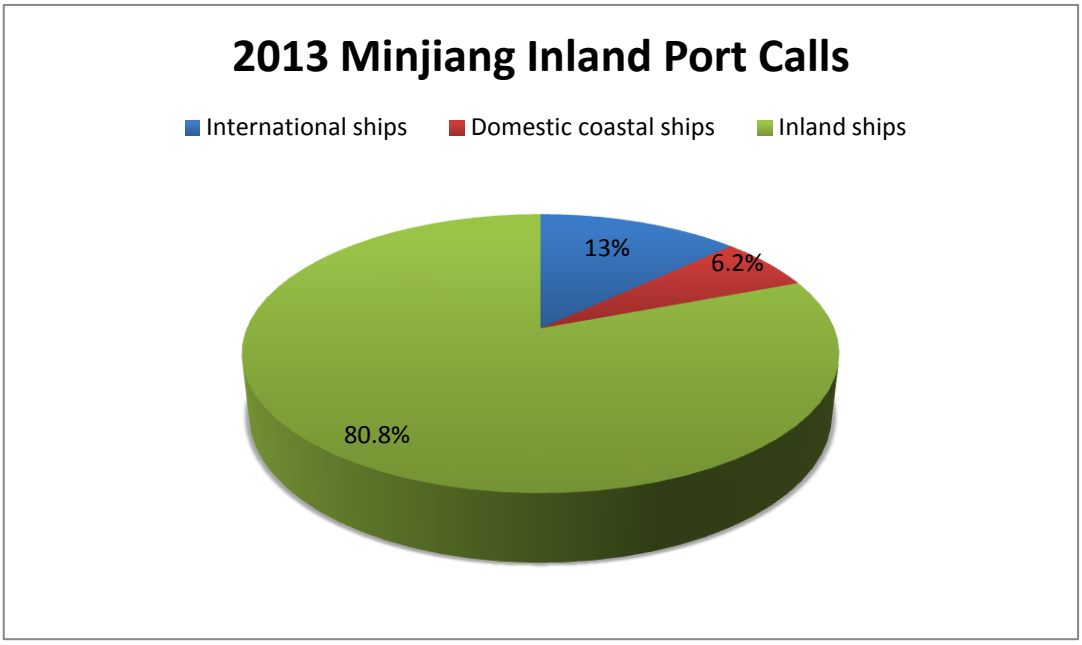


Figure 4-1: Minjiang Inland Port Calls in 2013 and 2014 respectively
Source: Compiled by the Author

It is worth to notice that the total number of inland ships registered in the Fuzhou reached to 371 vessels in 2013. Then, this number experience a slightly increase to 386 vessels in 2013. According to figure 4-2, in 2013, the bulk ships, which is 61.39 %, comprises the largest part of the total number, then next is the passenger

ferries with 16.06 %, followed by the engineering ships, making up 4.14 %; and finally comes sightseeing passenger ships, oil tankers, liquid cargo vessels, container ships and so on. It is significant for us to bear in mind that all of these vessels which are registered in the Fuzhou can only navigate in the Minjiang due to the related mandatory requirements of our country's law. Further, many document researches have demonstrated that the quantity of sewage is proportional to the port calls and the quantity of harbour craft and inland waterway vessels in port. The preliminary estimation of sewage produced by vessels in port is huge based on the fact that each person onboard produced 140 liters per day.

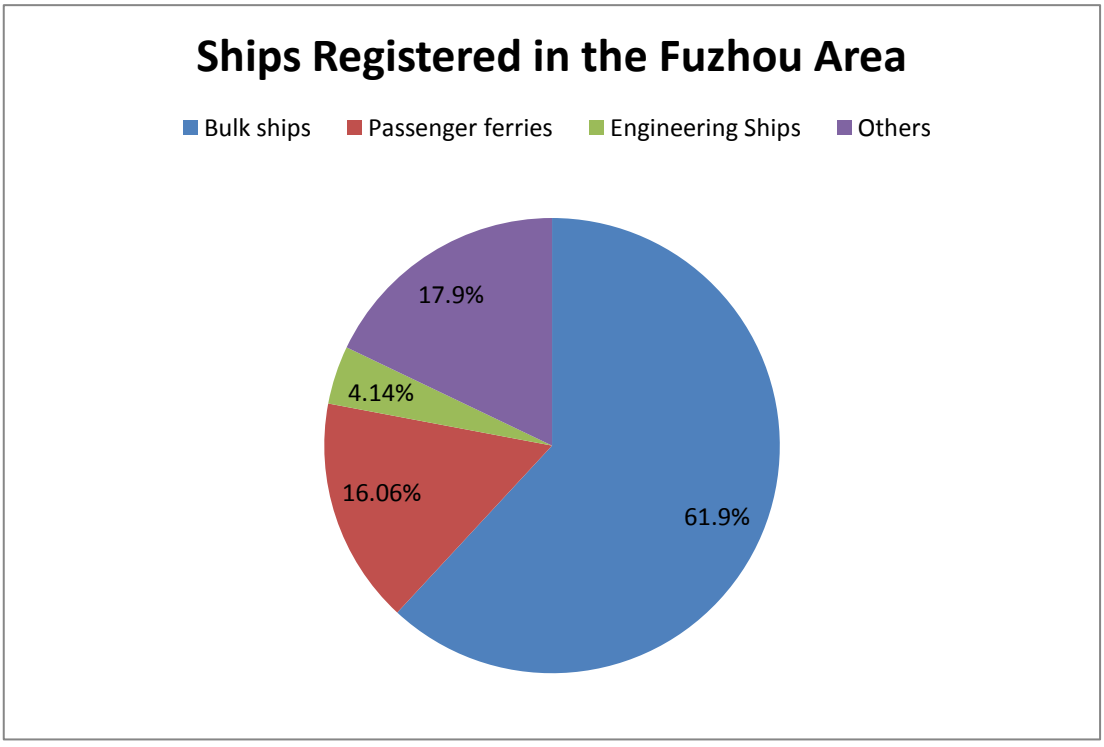


Figure 4-2: Ships Registered in the Fuzhou Area

Source: Compiled by the Author

Chapter 5 In-depth Analysis on the Related Requirements of Sewage Pollution in terms of International Conventions and Domestic Laws

5.1 The Requirements of International Conventions

In order to prevent and control sewage pollution in worldwide, IMO had adopted the Annex IV to MARPOL73/78, which stipulated the specific requirements in respect to sewage pollution prevention and control, although the Annex IV was not entered into force at once on account of immature technology combined with the limitation of other objective conditions, such as it requires the member States to have adequate port reception facilities and sewage treatment facilities (IMO,1997). Moreover, the discharge criteria for sewage were considered as too strict by many flag states. So, it was still unable to gain enough ratification in 2000.The Maritime Environment Protection Committee (hereinafter referred to as MEPC) had adopted the resolution MEPC. 88(44) on 13, March 2000 to amend the Annex IV in terms of lowering the discharge standards and decreasing the scope of suitable objects, with the aim of acquiring wide acceptance from member States to accelerate the process of Convention come into effect. For instance, from the very beginning the Annex IV was intended to be mandatory for new ships for 200 tons of gross tonnage and above(now it is revised the scope to 400 tons of gross tonnage); the other is for ship certified to carry more than 10 persons, now it is 15(IMO,2000). Based on that, the Annex IV of MARPOL finally got enough ratifications from member States, and entered into force on 27 September 2003. According to the requirements of the

regulation 2 of the Annex IV，the following ships shall be satisfied the Annex IV:

(1) new ships of 400 gross tonnage and above

(2)new ships of less than 400 gross tonnage which are certified to carry more than 15 persons

(3) existing ships of 400 gross tonnage and above, five years after the date of entry into force

(4) existing ships of less than 400 gross tonnage which are certified to carry more than 15 persons, five years after the date of entry into force.

All ships mentioned above shall be equipped with one of the following sewage systems with the aim of complying with the provisions:

(1) A sewage treatment plant which shall be of a type approved by the Administration or recognized organizations, in light of the measures and test standards publicized by IMO or

(2) A sewage comminuting and disinfecting system shall be approved by the Administration. In addition, this system need to be arranged with necessary equipments, which shall gain the satisfaction of the Administration, with the purpose of storing sewage temporarily when the vessel is within 3 miles from the nearest land,or

(3) A holding tank with the enough capacity to the satisfaction of the Administration with the aim of retaining of all sewage generated onboard, taking the operation of the vessel into account, the total quantity of sewage be produced by all persons on board and the possible time be spent on sailing and other relevant factors. Furthermore, the construction of tank shall grasp adequate abilities in terms of strength, sealing and anti-corrosion. Last but not least, the tank shall be constructed with a measure to illustrate visually the amount of its contents(IMO,2000).

In order to discharge sewage to port reception facilities, vessels mentioned above shall be equipped with ship-shore sewage connections named Standard Discharge Connections. The Regulation 10 of MARPOL73/78 Annex IV has stipulated standard dimension of flanges in terms of discharge connections, in order to ensure pipes of port reception facilities to be connected exactly with ships' discharge

pipeline.(IMO,2000)

MEPC has adopted the resolution MEPC.2(VI) on 3 December 1976 at its sixth session, the Recommendation on International Effluent Standards and Guidelines for Performance Tests for Sewage Treatment Plants, to provide member States with guidelines in terms of the Effluent Standards and Sewage treatment plants approved(IMO,1976). After that, resolution MEPC8/WP.3 adopted in 1983 by MEPC, the Sewage Treatment Plant Type Testing and Accreditation Criteria, to further describe the specific requirements for a sewage treatment plant, a sewage comminuting and disinfecting system and a holding tank respectively(IMO,1983). MEPC had recognized the resolution MEPC.2(VI) did not keep pace with the current trend in the ship pollution prevention and the development of the new technology applied in sewage treatment plants with more efficient and cost effective properties. All of these contribute to the resolution MEPC.159(55) be adopted on 13 October 2006 by MEPC, at its fifty-fifth session, the Revised Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants and provided more specific and stricter requirements about sewage treatment plants. In order to find the trend in ship sewage pollution control, it is very useful to know what main differences between MEPC.2(VI) and MEPC.159(55) refers to effluent standards, as is shown in table 1.

Table1-Differences between the effluent standards for treatment plants of MEPC.2(VI) and that of MEPC.159(55)

	Total Suspended Solids(TSS)	Biochemical Oxygen Demand(BOD5)	Chemical Oxygen Demand(COD)	PH	Disinfectant residual or Residual chlorine	Coliforms (MPN)
MEPC.2(VI)	50 mg/l	50 mg/l	NO	6~9	As low as possible	250/100ml
MEPC.159(55)	35 mg/l	25 mg/l	125 mg/l	6~8.5	<0.5mg/L	100/100ml

Source: Compiled by the Author

(1) It was noted that MEPC.159(55) requires that the effluent discharged by sewage treatment plants contains less organic pollutants. Compare the concerned standards of MEPC.159(55) with that of MEPC.2(VI), both of them stipulated the related standards with respect to TTS, BOD5, PH, MPN, however, the former provided more strict requirements.

(2) In addition to that, MEPC.159(55) is required to test the Chemical Oxygen Demand of the samples of effluent taken during the test period which does not exceed 125 mg/l.

(3) Regarding disinfectant residual or residual chorine, MEPC.159(55) tended to quantify the standard of the sample of effluent less than 0.5mg/l

Therefore, all that sewage treatment plants arranged on board on or after 1 January 2010 shall meet MEPC.159(55), which means the more strict discharge standards.

Meanwhile, the regulation 11 of the Annex IV to MARPOL 73/78 stipulated clear provisions referred to discharge of sewage without using the sewage treatment plant onboard. It is required that the ship is forbidden to discharge sewage into sea except some preconditions were satisfied, as followed:

(1) The sewage was discharged by the vessel through a sewage comminuting and disinfecting system, which shall be approved by the Administration, at a distance of more than 3 nautical miles from the nearest land, or

(2) The ship is discharging sewage which is not comminuted or disinfected at a distance of over 12 nautical miles from the nearest land,

However, in any cases, the sewage that has been stored in holding tanks shall not be discharged into waters instantaneously but with a certain rate, and then meet the following requirements: a) proceeding at not less than 4 knots; b) the ship is en route; c) the certain rate shall be calculated in the light of standards publicized by IMO. Moreover, IMO has adopted the resolution MEPC.157(55) in February 2008, Recommendation on standards for the rate of discharge of untreated sewage from ships, in order to stipulate the max discharge speed rate from holding tank in different situations:

DRmax = 0.00926 ·V Ð Ƀ

where DRmax = max permissible discharge rate (m3/h)

V = average speed (knots) over the period

D = draft (m)

B = breadth (m)

Soon after, the resolution MEPC.164(56) adopted by MEPC to make the resolution MEPC.157(55) became mandatory for member States(IMO,2006).

5.2 Domestic Standards with respect to Ship Sewage Pollution Control

China was really late in getting started with decreeing laws, regulations and orders for the prevention of pollution by sewage from ships. However, with rapid development of shipping and shipbuilding industry, the related laws and decrees were promulgated one after another, such as Marine Environment Protection Law of the People's Republic of China, Law of the People's Republic of China on the Prevention and Control of Water Pollution, Regulations of the People's Republic of China on the Prevention of Vessel-Induced Sea Pollution, Statutory Survey of Ships and Offshore Facilities, and also unveiled a national standard, Effluent Standard for Pollutants from Ship-GB3552-83 which entered into force on 1 October 1983 (hereinafter referred to as the GB3552-83). According to the regulation 15 of the Regulations of the People's Republic of China on the Prevention of Vessel-Induced Sea Pollution, vessels that in the sea area under jurisdiction of the People' Republic of China shall comply with the laws, administrative regulations, the international conventions ratified by China and the related standards, when they need to conduct discharging garbage, sewage, oily water, noxious and harmful substances content water, exhaust gas and other pollutants as well as ballast water.

Therefore, the Chinese international ships which navigate in water area of the

Minjiang inland port, shall comply with not only the International conventions ratified by China, such as MARPOL73/78 and related mandatory resolutions, but also the national regulations and standards. The main requirements concerned with the standards of ship sewage discharge stipulated by the GB3552-83 can be illustrated as follows:

Table2-The Effluent standard for sewage discharged by vessels

	Inland river	Coastal sea	
The distance from the nearest land		No more than 4 n miles	Between 4n miles and 12 n miles
Biochemical Oxygen Demand(BOD5) mg/l	<50	<50	
Total Suspended Solids(TSS), mg/l	<150	<150	No visible suspended solids
Coliforms (MPN), per coloforrm/100ml	<250	<250	<1000

Source: Compiled by the Author

The related requirements of the GB3552-83 was established in 1983, taking into account the standards recommended by IMO at that time, and the standards performed by vessels discharge sewage in inland river is the same as those of ships discharge sewage at a distance of less than 4 n miles from the nearest land in coastal area. It is obvious that the international standard of sewage discharge is more stringent than that of the GB3552-83 in specific indicators about effluents.

In addition, our country also unveiled another national standard in 31 March 1989, Marine Sewage Treatment System Specification-GB10833-1989 (hereinafter referred

to as the GB10833-1989), which entered into force in 1 January 1990. The GB10833-1989 provides requirements about the sewage treatment plant, the sewage comminuting and disinfecting system and the holding tank in terms of technical requirements, test measures, inspection rules, marks, package and so on. In other words, all sewage treatment systems equipped with domestic vessels shall meet the requirements of the GB10833-1989 at least. Table 3 demonstrates major differences between MEPC.159(55) and GB10833-1989.

Table2-The main differences between the standards for treatment plants of MEPC.159(55) and that of GB10833-1989

	Total Suspended Solids(TSS) mg/l	Biochemical Oxygen Demand(BOD5) mg/l	Chemical Oxygen Demand(COD) mg/l	PH	Disinfectant residual or Residual chlorine	Coliforms (MPN)
MEPC.159(55)	35	25	125	6~8.5	<0.5mg/L	100 coliforms /100ml
GB10833-1989	100	50	No mandatory	No mandatory	As low as possible	250 coliforms /100mll

Source: Compiled by the Author

It is noted that MEPC.159(55) was the latest resolution adopted by IMO to enhance performance of sewage treatment plant, however, the related standards stipulated by GB10833-1989 is closer to that of MEPC.2(VI).

Furthermore, vessels entitled fly a Chinese flag, which is only be authorized to engage in domestic trading in the Minjiang inland river, can be divided into two

types in light of navigable area: a) coastal ships; b)inland ships. Both of them need to satisfy certain basic requirements of the GB3552-83 and GB10833-1989 with respect to effluent standards and sewage treatment systems. However, the former shall cater for the Technical Rules of Statutory Survey for Domestic Coastal Ships which is only applicable to coastal ships provides the more comprehensive requirements refers to the prevention of sewage pollution; the latter shall meet the corresponding rule named Technical Rules of Statutory Survey for Inland Ships which only applicable to inland ships. The following part will analyze on the related requirements for these two types of vessels.

5.2.1 The Specific Requirement for Coastal Ships

Chapter V-V of Technical Rules of Statutory Survey for Domestic Coastal Ships (hereinafter referred to as TRDCS2004) is mainly focused on the prevention of sewage pollution from ship, entered into force in 1 March 2004. In general, the contents of TRDCS2004 in terms of the definition of sewage, sewage discharge, standard discharge connections, etc, takes the requirements of IMO at that time into account. However, chapter V-V of TRDCS2004 was only available for domestic vessels with the entire length more than 20 meters and make applications for Sewage Pollution Prevention Certificate on a voluntary basis. In other words, it was not considered as a mandatory requirement. The TRDCS2004 was amended by the circular TRDCS 2006 which was publicized in 2006 in order to deal with the newest challenge in environment protection and keep pace with the development of world shipping. Therefore, the application of chapter V-V TRDCS 2006 was revised, such as take-off restriction in the length of vessels, increasing the distance from the nearest land for vessels to discharge through comminuting and disinfecting system from less than 4 n miles to less than 3 n miles. All of these changes are in obvious

connection to the Annex IV to MARPOL73/78. However, the significant change was brought by the circular TRDCS2008 which stipulated: a) vessels of 400 gross tonnage and above; b) vessels which are certified to carry more than 15 people shall meet the requirements since 1 January 2014. It means the revised chapter V-V of TRDCS has become mandatory. Therefore, domestic vessels, which navigate in the Minjiang inland port, of 400 gross tonnages and above, associated with vessels are certified to carry more than 15 people, shall comply with the requirements of chapter V-V.

Furthermore, China MSA has adopted the new version of TRDCS which entered into force in 1 September 2011, namely TRDCS 2011, with the purpose of integrating the TRDCS 2004 and all of its circulars. Meanwhile, the revised documents by IMO have a profound impact on the process of setting out TRDCS2011. Therefore, it is no wonder that the requirements of chapter V-V of TRDCS2011 is remarkably similar to these of the Annex IV of MARPOL73/78. However, vessels which are applied to the requirements of TRDCS2011 shall still perform the standards of GB3552-83 involving detailed parameters about effluent discharged by them.

5.2.2 The Specific Requirement for Inland Ships

According to provisions of chapter VII-V of the Technical Rules of Statutory Survey for Inland Ships 2011 (hereinafter referred to as TRIS2011), new inland ships of 400 gross tonnage and above together with new vessels of less than 400 gross tonnage are certified to carry more than 15 people and shall fit up one of sewage treatment systems as follows:

a) a holding tank of adequate capacity to store all sewage produced onboard, shall discharge sewage to reception facilities.

b) a sewage treatment plant, which shall tackle sewage generated onboard, and

ensure effluent shall meet the related requirement before being discharged.

c) a sewage collecting and packaging facility, which does not need flush, with functions of collecting and packaging sewage, and then send packaged sewage to reception facilities.

For the first two systems, vessels also need to fit up a standard discharge connection in order to get connected with the reception facilities.

Chapter 6 Analysis on Whether Vessels Can Discharge Sewage by a Sewage Treatment Plant in the Minjiang Inland Port

As analyzed above, our country's current effluent standard for sewage from ship is relatively lagging behind since maritime conventions have been revised more and more frequently in recent decades. GB3552-83 can be considered as a very typical example that has been established more than twenty years, and can not catch up with the new challenge in respect of environment pollution prevention. This is true especially when we consider the fact that the significant increase in the number of vessels in China brought a huge pressure from sewage pollution. Moreover, it is not wise to ignore the improvement in industry of manufactures' sewage treatment plants in recent decades that make continuous efforts to upgrade existing and produce sewage treatment plants with a higher performance in coping with effluent.

However, the real situation for vessels discharge sewage is more complicated since there are so many types of ships which may comply with different standards of effluent: some rules set forth by IMO, some stipulated by the States, others by the regional regulations. The other factors may make this problem even more serious. Some rules or regulations lacking in precisely stipulation may contribute to the confusion involving vessels sewage discharge through a sewage treatment plant in

the Minjiang inland port, then pose a threat to the protection of drinking water source, wetland and other sensitive water areas. In addition, it will also exert adverse impacts on practical work for MSA officers in control of sewage pollution. Therefore, it is necessary for us to give a priority to this issue.

6.1 International Ships

According to requirements of Annex IV of MARPOL73/78, vessels can discharge sewage by using a sewage comminuting and disinfecting system at a distance of more than 3 n miles from the nearest land. But, if this distance is less than 3n miles from the neatest land, the only way an international vessel can discharge sewage overboard is to operate a sewage treatment plant, approved and certified by the Administration to meet requirements of MEPC.159(55) or MEPC.2(VI), and the discharging rate shall obey the standards of MEPC.157(55).

However, Annex IV and other resolutions related to sewage pollution prevention adopted by MEPC did not refer to the issue of vessels discharging sewage through a sewage treatment plant under the condition of anchoring or berthing alongside the pier in something like inland ports, just require the effluent overboard should not produce any visible suspended solids nor lead to the surrounding water being discolored.

6.2 Domestic Coastal Vessels Registered in China

The content of TRDCS2011 with respect to the prevention of sewage pollution was following up the development of pertinent international conventions, with no specific requirement on whether or not domestic coastal vessel has the right to discharge treated sewage in the area of inland ports.

6.3 Inland Ships

TRIS2011 provides the relatively clear requirement which refers to inland ships discharge sewage within the area of inland port. The regulation 5.1.3.2 of TRIS2011 states that vessels shall avoid drinking water area to discharge sewage in the operation of a sewage treatment plant, and this operation is prohibited when vessels docked at a port. Moreover, the regulation 5.1.3.3 of TRIS2011 stipulates that the treated sewage shall not be discharged instantaneously when ship is en route. It is noted that the regulation 5.1.3.4 set forth in TRIS2011 even requires vessels, sailing in Beijing - Hangzhou Canal, shall store sewage onboard with the aim of delivering to reception facilities instead of discharging treated sewage overboard. The root cause for that is to prevent the local waters from ship sewage pollution.

We can get a comprehensive understanding about these three types of vessels with respect to sewage discharge in the Minjiang inland port and sum up the main points as follows:

a) From a legal point of view, sea ships, which comprise both international ships and coastal ships, have the right to discharge sewage in the operation of a sewage treatment plant since there are no regional laws and regulations which expressly stipulate this operation is illegal in the Minjiang inland port.

b) The precondition for inland ships discharge sewage in the Minjiang inland port through an approved sewage treatment plant is to comply with requirements of the regulation 5.1.3.2 as well as the regulation 5.1.3.3 of TRIS2011.

Chapter 7 The Existing Problems on Sewage Pollution Processing from Ships in the Minjiang Inland Port

7.1 The Basic Problem of Fairness

Under the current framework of laws and regulations which are applicable to vessels navigated in the Minjiang inland port, the sea ships have the right of discharge sewage through a sewage treatment plant without taking a responsibility for getting away from drinking waters area, wetland, the special aquatic species breeding area and other sensitive waters areas. Meanwhile, the inland ships shall at least be away from drinking waters and wharfs for discharging treated sewage. This has caused unfairness in enforcing inland ships to cater for more stringent requirements, sometimes resulting in breeding of resistance for inland ships' owners and seafarers. In other words, it is unreasonable for tolerating that sea ships to take less responsible for caring local water environment.

7.2 Necessity and Obligation refer to the Prevention of Drinking Waters from Sewage Pollution

The Fuzhou Municipal Government has publicized a programme in 23 February

2006, entitled The Programme of Designating the Environmental Function Zone for Surface Water of the Fuzhou City (hereinafter referred to as PDSWFZ). PDSWFZ states that environmental function areas of surface water in Fuzhou can be classified into five categories in the light of the standards set forth in the Environmental Quality Standard for Surface Water -GB3838-2002-a national standard unveiled by our country. And, there are six drinking water sources, which belong to the second category, first-grade protection area, distributed in the Minjiang inland port, and nine drinking water sources, which belong to the third category, second-grade protection area spread along sides of the Minjiang inland port. In the view of water sources protection, it is necessary to request all vessels that navigate in the Minjiang inland port to keep away from the mentioned area. Moreover, considering the regulation 5.1.3.2 of TRIS2011 fails to specify and quantify indications to evaluate what the degree of keeping away from the sources of the drinking water is enough, it would be confused for the vessel to conduct. At the same time, the uncertainty in work of the MAS officers would possibly augment since it is hard to carry out spot inspection with respect to deciding how far can be considered as far enough..

7.3 The Illegal Discharge of Sewage for Inland Ships Remains Serious

Nowadays, nearly all the sea ships which are en route in the Minjiang inland port well-equipped approved sewage treatment systems in accordance with the related international conventions or national laws. On the other hand, most inland ships, however, discharge untreated sewage directly into water due to several reasons: 1) The shipping market's recession results in shipowners' continuous suffer of losses, thus they can not bear the cost of providing their ships with an approved sewage treatment system; 2) The running of a sewage treatment system needs shipowners' persistent investment, however, they can not benefit directly from this.3) According

to an investigation carried out by the Fuzhou MSA, the average cost of per cubic meter of sewage being transferred into reception facilities in the Minjiang inland port has reached about 300 RMB. The cost of delivery sewage to either port reception facilities or specialized reception boat is relatively higher compared with direct discharge of sewage. 4) It is difficult for MSA officers find and investigate illegal discharge of sewage, especially when this action happened in night since effluent subject to be flushed by river flows without any traces. 5) The environmental awareness of inland crew members with respect to sewage pollution is still weak since they have already been accustomed to discharging sewage directly during the last decades. Therefore, it is no wonder that there are rare reports about illegal discharge of sewage compared with that of oily water.

7.4 The Lack of Appropriate Measures for MSA Officers Applied to Judge whether or not A Sewage Treatment Plant is in Good Order

The fundamental objective of the convention or laws related to sewage pollution prevention is keep sewage pollution from ships under control by means of ensuring that effluent from ships complies with relevant standards. At present, China MSA officers which carry out on-site inspections always face a challenge as to how to ensure the effluent coming from an approved sewage treatment plant meet the related standards. Although they can check the validity of a certificate or documents pertaining to this system, combined with inspecting the running of the whole system and the operation of crew members, all these can just be considered as a qualitative judgment. Therefore, when they lack necessary equipment to detect the specific parameters of effluents, they can not know exactly whether or not effluent discharged by vessels meet the basic related requirements.

Chapter 8 The Countermeasures

8.1 Some Recommendations for the Local Government

The local government should pay more attention to the issue of sewage pollution, enhancing the research and investigation work about adverse effects from sewage produced by ships in the local aquatic environment. Besides, the drinking water sources, wetland and the special aquatic species breeding area and other sensitive waters should also be remarked with the aim of warning vessels in port to keep away from these targets. Finally the government should enact necessary regional rules, based on the practicability of laws and real situation of the port, with the purpose of further improving the framework of local laws concerning sewage pollution prevention.

8.2 Further Perfect Reception Facilities

In order to perfect reception facilities in port, the local government should integrate the public utilities and invest more money in perfecting reception facilities in port. According to the requirements of our national laws and regulations, as well as international conventions, the government shall take the responsibility for ensuring the provision of reception facilities at ports adequate to meet the needs of vessels without resulting in any unnecessary delay to ships. The first challenge for local

government is the lack of enough money to ensure that every current berth in the Minjiang inland port has adequate port reception facilities. In this case, the local government should give a priority to the existing municipal waste water treatment systems (hereinafter referred to as MWWT) since the current MWWT of Fuzhou city for tackling normal residential sewage flow is large enough compared with the average flows from ships. As we all know, although renewing of current MWWT especially with respect to the sewer networks and connections pipelines for ship-shore sewage delivery is a time-consuming and money-consuming process, both residents and the local government can benefit directly from this work after the improvement of water environment. In addition, regarding the planning berth, the government should take the needs of sewage processing into account(Wang,X.X,2010,PP23-26).

8.3 Enrich the Measures Available for Delivering Sewage.

Generally speaking, a responsible local government should enrich the measures available for delivering sewage by means of enhancing the efforts in support of existing companies, which carry out effluent reception work through specialized ships, in terms of establishing funds, financial aid, policy support, since the cost of sewage processing is relatively higher compared to the processing of oily water which may create added value. This is determined by the inherent features of sewage, especially when we consider that sewage reception work may refer to health and epidemic prevention if sewage drainage from the medicine room onboard as well as vessels comes from an epidemic area. In this case, the local government should take necessary steps to guide social capital to sewage reception work with the purpose of further broadening the channels for vessels and improving the competitiveness of the port. Meanwhile, in this way, the government can lower shipowners' costs with

respect to sewage delivery to reception facilities and then reduce the high incidence of illegal discharge.

8.4 The Work of MSA with respect to Inspecting Sewage Discharge

The MSA is undoubtedly responsible for performing the duty of supervising the implementation of relevant marine laws. They should set up an effective procedure in order to enhance the competence of inspecting illegal sewage discharge. The officers should grasp a deep and comprehensive understanding about the operating mechanism of vessels since the performance of a sewage treatment system was determined by several factors: the regular maintenance and repair work, the proper operation, the competence of crew members, the characteristics of sewage flow into the system, the quantity of sewage and so on. Therefore, the valid certificate and document related to the sewage treatment system can only be regard as a formal proof, and the real situation of the system still need the professional judgment of MSA officers. That is the root cause of why MSA officers need necessary equipments in order to analyze the effluents discharged by vessels to confirm whether the effluent is in compliance with the applicable standard by the way of quantitative analysis. Until now, some researchers have already done the feasibility research of an instrument for ship sewage rapid detection (Huang,W, 2012).

8.5 Perfect the Record of Sewage Discharge and Delivery to Reception Facilities

In response to the concerns about pollution of oily water from vessels, the Oily Record Book, which is as a mandatory requirement in the ANNEX I to MARPOL 73/78 for certain applicable vessels, is also one of the effective measures of monitoring operations with reference to oily water. It is a method which deserves

referencing as China MSA may decide whether or not it is necessary to generalize the use of the Sewage Record Book (hereinafter referred to as the SRB) after weighing the advantages and the disadvantages. From a technical point of view, the SRB can provide the MSA officers more specific information in terms of: a) details of repair and maintenance, b) whenever sewage is delivered to reception facilities, the entry shall comprise the time, location, quantity of each discharge and the name of crewmember in control of the discharge, c) the quantity of disinfector be used, d) the volume of sewage produced onboard, e) vessel's minimal speed during discharge or others valuable information. All of these would provide the MSA officers with an alternative way to grasp a general understanding of the working condition of a sewage treatment system within a short period of time.

Chapter 9 Conclusion

This research has explored the appropriate measures of tackling the issue of ship sewage in Minjiang inland port, since the sewage pollution has not only exerted increasing negative effects on the Minjiang estuary environment, but also increased the risk of safety in the residents' drinking water. In this case, it is not wise to ignore the pollution of sewage from vessels since a significant increase in the number of vessels due to the development of shipping during the last two decades. However, some complicated factors combined to lead to the high incidence of illegal sewage discharge in the Minjiang inland port: provisions about prohibited areas in the port not enacted for different ships, the national standards incompatible with the relative international conventions concerning the effluent standard for sewage discharged by vessels, a deficit of infrastructure on port reception facilities, a deficit of finance to upgrade the current waste water treatment plant in port area, inland crew members' lack of environmental awareness, the Fuzhou MSA's lack of adequate detection instruments, etc(Xu,H.E.,&He,J.M,2010,pp.47-50).

In order to find some effective measures of dealing with these problems, except the countermeasures discussed in this paper, a deep and comprehensive research remains to be carried out at the direction of local government since it involves the interest of several parties such as Administration of environment protection, Fuzhou MSA, inspection and quarantine bureau, port managers, crew members, shipowners, etc.

Then, the sewage pollution prevention still needs the cooperation of these parties, and the delivery of sewage to port reception facilities can be regarded as a fundamental solution, especially when we considered a certain amount of inland ships sailing in the port. However, the afore-mentioned necessary steps shall be taken into account before the port is equipped with adequate reception facilities.

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