Analysis, treatment and countermeasures on oil spills at sea

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Abstract. In recent years, the related oil spill accidents have occurred from time to time because of various reasons (human caused such as negligence or collision, sinking, pipeline rupture, and so on.), which has given rise to lots of impacts on the economy, water environment, and human health. In order to solve this problem, it's necessary for us to reduce and control the impact caused by oil spill accidents by means of the characteristics of different ship oil spill pollution incidents, considering what to use, and how to take advantage of actual and effective methods and try to adopt these methods to derive out accident management solutions with feasible aspects in technology and economy and making the impact on economy and ecology, etc caused by oil spill accidents minimize. In this article, it introduces the situation oil spill accidents at sea first, and then analyzes the impact of oil spill accidents at sea, in the end; it put forward countermeasures and suggestions.

1. Introduction

In recent years, with the increasing demand for energy between countries, the volume of imports and exports of petroleum products has also been increasing, however, while the demand is increasing, what is coming is the oil spill accidents over again and again. It's showed in terms of the relevant data that there were nearly 500 major accidents with oil spills exceeding 700 tons in the world from the 1974 to the 2016, and the total oil spilled weight exceeded 10 million tons, which caused huge losses in economy and had extremely bad impact on ecology. For example, there was a collision occurred between the GL KAIHOU oil tanker “Sanchi” and the Hong Kong bulk carrier “Changfeng Crystal” in the east of the mouth of Yangtze River on January 6th, 2018,. The collision accident between the two ships caused a large number of gas condensate leaking and caused a relatively serious impact on the water ecosystem of the entire East China Sea. The following table shows several typical cases on oil spill accidents from 2002 to 2018 [1]. It's known in terms of this table that oil spill accidents have occurred in many parts of the world, and most of them have been caused by collisions and striking a reef in the course of crude oil transport by sea. In addition, some oil spill accidents have a large amount of oil spilled and have a particularly large area of pollution, which not only has wasted of resources, but also has unpredictable and uncontrollable hazards to the environment. As a consequence, it's essential for us to take measures to prevent crude oil from being transported by sea, mainly by the
methods, such as improving the safety of oil tankers, strengthening legislative oversight, enhancing enforcement efforts, and improving the response to oil spills and processing ability in the course of complicated environments. Besides, it's supposed to develop and research the new energy and attempt to reduce the use of oil, and in the end to strengthen international cooperation and do a decent job on monitoring and early warning.

Table 1. Status on major oil spill accidents at home and abroad

| category          | Ship or location involved | date         | cause                        | data leakage         |
|-------------------|--------------------------|--------------|------------------------------|----------------------|
| overseas          | “Prestige”               | 2002.11.13   | storm                        | 25,000 tons          |
|                   | United States Gulf of Mexico | 2010.4.20 | Drilling facility breakdown underwater | 7950-9350 barrels of crude oil |
|                   | “Sanchi”                 | 2018.1.6     | collision                    | 11.13 million tons   |
|                   | Panama “modern promotion” | 2004.12.7   | collision                    | More than 1,200 tons |
|                   | Panama “Saint Di”         | 2009.9.15    | striking s reef              | 30 tons              |
| inland            | Qingdao                  | 2013.11.22   | Oil depot explosion          | 600 tons             |
|                   | Penglai 19-3              | 2011.6.11    | Too much pressure on water injection | re are 6200 square kilometers which are polluted |
|                   | Dalian's Xingang Harbor    | 2010.7.16   | Firing due to explosion      | 1,500 tons           |
|                   | Hong Kong                | 2018.1.6     | collision                    | 9,000 tons           |

2. Analysis on The Reasons of Oil Spill Accidents

2.1. Accident Ship Types

It's showed on the basis of relevant data that there were 71 cases with the oil spillage of over 50 tons in the oil spill accidents in the coastal ports of China from 1974 to 2016, and these oil spilled ships include cargo ships, oil tankers, chemical ships, passenger ships, and passenger and cargo roll-off ship. Based on this point, the following takes the frequency of ship-type accidents and oil spillage as the analysis to continue the study in this article. It can be seen the statistical analysis in Table

Table 2. Statistical analysis on ship type and oil spill accidents

| Ship type       | statistics on accident frequency | (%) Proportion on accidents (%) | (t) statistics on accident oil spillage (t) | (%) proportion on accidental oil spillage (%) |
|-----------------|----------------------------------|---------------------------------|---------------------------------------------|-----------------------------------------------|
| oil tanker      | 32                               | 46                              | 12649                                       | 58                                           |
| cargo ship      | 23                               | 32                              | 9386                                        | 42                                           |
| Other ships     | 16                               | 22                              |                                             |                                               |
| total           | 71                               | 100                             | 22035                                       | 100                                          |
It can make a conclusion based on the Table2 that oil tanker and cargo ship are the types of ships that are most easy to break out the oil spill accidents, accounting for 78% of the total proportion among which the total oil spillage by oil tanker is the largest, accounting for 58% of the total. As a consequence, when monitoring the oil spill for preventing the oil spill accidents, it's necessary to attach significance to the inspection and prevention of oil tanker and cargo ship.

2.2. Causes of Oil Spill Accident

It's known in terms of the relevant statistics from 1974 to 2016, that there were more than 11,000 accidents of crude oil spills occurred in the world within the statistical scope in the 32 years, among which oil spill accidents with more than 700 tons of crude oil leakage nearly 500 times. The author here selects the relevant data of the coastal city of Rizhao in China from 1997 to May 2014 to set up examples and illustrate. The specific data of statistics of oil tanker on oil spill accident is seen in Table3 [5-9].

Table 3. Statistics date of Oil Tanker on Oil Spill Accidents in Rizhao Sea Areas from 1997 to May 2014

| Statistical data cause | Equipment breakdown | operational errors | Ship collision | other reasons |
|------------------------|---------------------|--------------------|----------------|--------------|
| Number of accidents (from) | 28 | 22 | 6 | 12 |
| proportion | 41.18% | 32.35% | 8.82% | 17.65% |

It can be known from the above table that there were 68 oil spill accidents in Rizhao sea area, with an average of 3.9 occurrences per year from 1997 to May 2014, among which equipment breakdown and operational errors are the main causes of oil spill accidents. In the subsequent supervision, it's essential to pay attention to these two aspects. [2] Most of the oil spillage in oil spill accidents broken out in Rizhao sea area is not more than 5 tons; therefore, it should be classified as general pollution accidents.

2.3. Analysis on the Location of Oil Spill Accidents

Upon most occasions, serious oil spill accidents have been caused because it broke out marine perils on the oil tanker (such as ship collisions and striking a reef, etc). However, in addition to these reasons, the oil spill accidents caused by oilfield development (mainly offshore oil fields) also have the same huge impacts. The following will analyze the types of oil spill accidents that may occur in the oil field. Oil spill incidents on oil fields are mainly divided into two aspects: one is the collision between oil drilling rigs, transport pipelines (including oil wells) and ships on oil fields (ships here are not only ships associated with oil fields, but also include other ships that pass the oil fields due to various reasons). Once oil tankers collides with oil drilling rigs in the oil field or other facilities, it would be particularly prone to cause the fire accident in the oil field and oil spill accident in the oil field, in addition, their oil spillage should not be underestimated, especially the oil tanker with slow speed but carrying a large number of petroleum products should pay special attention, once it breaks out violent
collisions with the oil field facilities, it will inevitably cause devastating damage to the oil tanker itself and the shallow waters near the oil fields; the other is that the drilling towers of offshore oil fields. Wells and oil wells have been lost. In the course of oil exploration in offshore oil fields, the spilled oil data caused by their own losses is also relatively large. It's in terms of the relevant statistics and known that the average number of oil spillage caused by the loss of facilities is more than 10 tons per year.

3. The Impact of Oil Spill Accidents

The oil spill accidents has great impact, and involves a wide range of fields and areas, as a consequence, after the accident, it's necessary to fully consider and analyze its impact in order to find a method to minimize the impact. Then, the author will analyze the impact of the oil spill accident on the economy, human health and the environment.

3.1. Impact on Economy

The occurrence of oil spill accidents will inevitably have effect on the economy due to the value of the oil itself and the value held by the polluted sea area, in addition to the use of currency for estimation and measurement the loss on economy on the petroleum industry, aquaculture, and aquatic product processing industries, the tourism industry and the shipping industry and so on, it should also attach significance to impact on economy for these industrial investment, planning, development and employment that are unpredictable and cannot be measured in terms of currency, for example, spilled oil pollution may block the ongoing trading activities at the surrounding environment, which will bring serious economic losses, and another example is that the oil spill accident pollutes the water surface, which is inevitably to lead to market losing the confidence for the quality of products in polluted waters, drastic drop in product prices, and making the entire fishery industry chain fall into a declining tendency.

3.2. The Impact on Human Health

It is understandable that crude oil contains a considerable proportion of carcinogens, while the animals and plants that live in contaminated waters are bound to absorb these carcinogens. Marine products will also contain certain carcinogens, but the carcinogens in sea products will also be subject to the impact of other pollution, such as seaweed toxins, pathogenic bacteria, and floating garbage on the sea, and because the number of carcinogenic items that the human beings can touch is numerous, the number of carcinogens in the human body cannot be directly and accurately explained because of the effects of oil spill accidents. However, after polluted by the oil spill, what it mainly brings is polycyclic aromatic hydrocarbons, and the harmful effects of polycyclic aromatic hydrocarbons on the human body are not too severe. Therefore, the current impact of oil spill accident on human health remains to be studied and discussed.

3.3. The Impact on Environment

The environment is the foundation to control everything. The impact of oil spill accidents on the environment and ecology is the most important concern and attention in all impacts. Related experts have shown that the breaking out of oil spill accidents have a particularly wide range of impacts in the natural environment, which may directly or indirectly have an influence on five natural circle (such as water circle, biosphere, atmosphere, soil circle, and lithosphere). However, because it has little impact
on most of circles, there is no necessary to consider the impact during the process of reducing the impact of accidents. Generally speaking, what we need is to focus on the impact on the surrounding ecosystems, because there are mainly fish and birds in the main fauna in marine ecosystems. The author will analyze the impact of these two types of organisms. For birds, because birds do not live directly on water or in the water, they are generally ignored the effects of oil pollution on them. However, seabirds can use the water-air interface. If the interface suffers from serious oil pollution, which make the seabirds using it face the risk of death. There is one thing that is worthwhile to attract our attention is that, in addition to the birds with higher region, there has not yet been an authoritative research outcome to prove that oil spill accident can curb the growth and breeding of seabirds within a relatively long period of time. For fish, the pollutants caused by oil spill accident generally affect the survival rate of fish eggs and juvenile fish to a large extent, but because adult fishes have strong activity and a wide range of activities, there is not big impact on adult fish.

4. The prevention and treatment on offshore oil spill accident

4.1. Accident Prevention

For the occurrence of oil spill accidents, improper human operations are the main reason. As a result, it is of great importance to do preventive measures before the accident and strictly control the sources of pollution. First of all, it should perform strictly check, management and approval for the ships with large oil reserves and dangerous goods in order to make the containment boom operation possibly perform the periodic implementation of oil tankers in the harbor, and to formulate and take preventive measures to the oil spill of ships. Control measures. [3] In addition, it is necessary to actively and rigorously carry out supervision work and inspection work on the oil tanker. And it is essential to monitor and control that is without omissions for the violation behavior of the vessel, especially for serious oil pollution incidents that violate the law and regulations, which needs to investigate and deal with them in accordance with the law. The third is to conduct an emergency rehearsal on oil spill incidents so as to be able to cope with and solve various problems in the event of an oil spill accident. In the end, for sudden oil spill accidents, it is necessary to timely handle and minimizes the losses and pollution caused. [4]

The last point is also most important point, which is that in the process of prevention and emergency response of oil spill accident, all relevant departments need to be able to respond to the accident and make cooperation to do preventive and emergency work so that the accident can be quickly and effectively dealt with. Although there are equipped with professional facilities in the ports that are responsible for accident prevention and emergency response, facilities cannot be fully invested due to the impact of price and budget (most ports in China are equipped with emergency facilities such as oil containment booms used in ports or near shores, but there are no emergency facilities in open seas). Therefore, all relevant departments should take special consideration for this point and prepare effective and practical plans to deal with oil spill accidents that may occur at any time. [5]

4.2. The Procedures on Accident Handling

There are mainly three steps: the first step is that after the oil spill accident occurs, an optimal handling solution that is fast, effective, and convenient should be selected, which requires the relevant staff to track and monitor the oil spill situation by means of advanced means such as marine resources
satellites and GIS, etc. and implement a full range of analysis for the tracing and monitoring results, including the location of oil spill incidents, the size and scope of oil spills, the nature of oil spills, and the diffusion speed of oil spills, and then to formulate effective and correct treatment solution based on the current and timing conditions. [6] In the process of tracing and monitoring, it's possible for us not to be able to directly obtain data on oil spill accidents, but we can use the carrier-water of oil spills to collect useful information, for example, tide changes for the sea, flow velocity of sea water and flow direction, the depth of water area, temperature changes of seawater and color changes can be investigated and analyzed, and the temperature and speed of wind and the direction of wind can be also used to predict the direction of movement and the speed of movement of the spilled oil.

Besides, it's necessary to select the execution team that handles the oil spill accident, as well as the required devices and equipments. Because of the influence of the strength of wind and water flow, spilled oil are fluid and changeable, and the executors must guarantee the quality and quantity and rapidly implement the organization and efficiently select facilities and devices that can deal with various problems within the scope of ability to grasp the control technology ability, and it's not allowed to delay in the event of missing the best time for cleaning up. In this process, it's of great significance to the consideration of the professional quality of the team members for cleaning up the pollution. The cleaning team must be very familiar with the structure of the ship that is performing the task, the speed of the ship, and the location, type, and function of the equipped device and equipment and clearly know the processing methods for various oil goods in the oil spill accidents. [7]For example, if the spilled oil with light oil spillage is easy to be volatile, it is recommended to use oil absorbing material for recovery, while the spilled oils with heavy oil spillage is more suitable to use oil containment boom to use a recycling boat for recycling after stopping the spillage.

In the end, it is the implementation on the cleaning processing solution. In this process, what the first thing needs to pay attention to the first is that the removal technology needs to match with the removal object, different types of oil pollution selects different cleaning technologies and facilities, and to pay attention to the removal effect at any time and analyze the removal effect in order to make sure that the cleaning task can be completed on time. When the cleaning effect is not ideal, it is necessary to make timely adjustments to the cleaning plan. The second is to pay attention to the risks possibly brought by the prevention and dealt with the oil spill itself. For example, some oils are strongly volatile and toxic, which may have effect on the body of the decontamination personnel and cause harm, therefore, it is necessary to do a decent job for antivirus safety propaganda and prepare protective facilities for everyone, trying to minimize its impact on human body.

5. Conclusion
Off-shore oil spill accidents will cause a lot of losses on economy and energy and it will also cause a certain scale of environmental damage and ecological pollution, thus affecting the survival and breeding of living things. As a result, it is imperative to publicize and educate the public about marine protection, such as carrying out marine environmental awareness lectures, producing and releasing marine bio-protection propaganda films, so that the public can recognize the significance of marine environmental protection, at the same time, it's also necessary to take the publicity of environmental protection awareness and related technical training for the personnel engaged in port and shipping related work in order to enable them to recognize the dangers of petroleum pollution, establish the concept of marine ecological protection, and can take advantage of the correct and effective methods
and techniques to deal with the problem of leakage of oil pollution. All in all, the processing of oil spill accidents by sea still needs to take the prevention as the core, which also requires citizens of the entire society to commit themselves to the task and make efforts jointly.

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