Retrospective and Prospective Research on Petroleum Pollution Incident in Qinhuangdao Sea Area

Lihui Zheng [a], Lei Li, Changjin Wang

Northeast Petroleum University, Qinhuangdao 066004, China

[a]tuke126@126.com

Abstract

The petroleum pollution incidents in Qinghuangdao sea area, especially the oil spill incidents had been studied in this study. The petroleum spilling risk assessment theory was applied to evaluate the petroleum spilling risk to prevent the accidents and reduce the petroleum spilling incidence, and minimize the economic losses and the damage to environment.

Keywords

Petroleum spilling incident; spilling risk analysis; incident probability calculation.

1. Introduction

Qinhuangdao is a predominantly export energy comprehensive harbor. In recent years, Qinhuangdao port developed so fast. The annual throughput reached 44.19 million ton in the end of Sixth Five-year plan, which was in the second place in all coastal ports, followed by Shanghai [1]. In 1990, Qinhuangdao port designed to establish to reach more than 90 million tonnes. The rapid growth of Qinhuangdao port brought a huge social and economic benefits. With the development of economy, China had become a net oil importing country, and 90% of the oil imports was by sea. According to the incomplete statistics, there were a total of 2, 353 cases of petroleum spilling incidents during 1979 to 1999 [2]. The average was 1 cases of incidents in each 3.5 days. The incident with hugest spilling volume was 8,000 tonnes.

Bohai Sea was China's most important maritime transport channel. Bohai Sea was a semi-closed sea, which the circulation of sea water could only be formed in the bay. The water self-purification ability was weak, and some small area of sea water even could exchange [3]. Therefore, if the the petroleum spilling incidents happened in Bohai sea area, it could damage the sea and surrounding environment irreparably. Qinhuangdao port was the vital energy output port of the Bohai sea, the throughput of 250.53 million tonnes, which increased by 16.7%, compared with the previous year.

Along with China energy transportation market booming, the economic and transportation industry of Qinhuangdao had a rocketing speed, along with petroleum and its related product volume. Qinhuangdao Port located in the center of the bottom of the Bohai Sea. Once the petroleum spilling incidents happened in this sea area, it could not only affect the water environment of the whole Bohai Sea, but also directly seriously polluted the scenic areas near Qinhuangdao coast, nature reserves and tourist resorts [5]. Therefore, it was urgent to start the assessment research of sea petroleum spilling simulation and Oil spilling risk, in order to improve the ability to facilitate early warning of petroleum spilling incidence and oil spilling emergency.

2. Qinhuangdao Sea Area Petroleum Spilling Risk Analysis

2.1 Factors from Offshore Oil Field and Petroleum Platform

For the offshore oil platform, oil well and its auxiliary facilities, the natural conditions, operating erors, and other reasons all could lead to the petroleum spilling incidence. Many Petroleum Pollution Incidents had happened, such as the overturned accident of vessel of Bohai No.1 in 1979, super accident of Piper Alpha platform of British in 1987, the overturned accident of Brazilian P-36 platform, sank accident of Mexico drilling platform of the U.S.A.[6]. All these accidents was with mass huge volume of petroleum going into the sea, and caused large areas of Marine pollution.

Nowadays, there were many petroleum fields in Bohai Sea. Oil field exploitation activities involved in all kinds of platforms, facilities and large numbers of auxiliary vessels, which complicate the Bohai sea vessel traffic environment, and brought many maritime pollution hazard and hindered safety and prevention and marine environment. In recent years, the pollution accidents usually happened, along with the oil spilled drift to Qinhuangdao sea area, which broght the coastal pollution of Qinhuangdao.

Qinhuangdao port had closely relation with its hinterland of Beijing Yanshan Petrochemical, Cangzhou Petrochemical, Shijiazhuang Perochemical Refinery, Dalian West Pacific Petrochemical Refinery, Jinzhou Petrochemical Company, etc. The above enterprises was with oil processing capacity of 5.45 million tonnes. According to the petrochemical department planning, the processing capacity should reach 5.56 million tonnes, which put forwarder higher requirements to the Qinhuangdao port for the throughput oil capacity [8]. In addition, the oil reservoir of Qinhuangdao port already had a larger scale, and formed a complete set of pipeline facilities, which had the good conditions for oil transit trade. Therefore, Qinhuangdao port gradually would increase oil throughput gradually, it could reach 10 million tonnes three years later. In addition, the large scale oil reserve base in shanhaiguan could further increase Qinhuangdao port oil volume, at the same time, the incidents of petroleum spilling incidents may increase in Qinhuangdao port and its surrounding waters area.

2.2 Marine Traffic Risk Analysis

With energy demand constantly increasing, the throughput capacity of Qinhuangdao port increased continuously, especially after the breakthrough of 100million tonnes in 2001. The average annual growth was 15 million tonnes, and reached 249 million tonnes in 2008. The rapidly increase of throughput made the marine traffic become heavy in Qinhuangdao waters area, details as seen in below table 1. The traffic flow had been doubled in the near 5 years.

Table 1. Traffic flow, cargo throughput statistics of Qinhuangdao port vessels

Item \ Year	2003	2004	2005	2006	2007	2008
Traffic flow/vessel-times	20 208	25 371	26 706	29 074	33 919	30 393
Port throughput/10 Thousand tons	12 562	15 036	16 900	20 356	24 972	25 150
Tanker traffic/vessel-times	1 559	1 341	1 290	1 288	653	809
Petroleum throughput/ 10 thousand	423	402	340	564	703.4	840.7
Large vessel/vessel-times	12 428	16 537	19 316	23 260	28 051	26 965
Proportion of large ships/%	61.50	65.18	72.32	80.00	82.70	88.72

From above table 1, the large vessels occupied a large rate in all ships, which objectively increased the possibility of petroleum spilling incidents, while, the small vessels still toke a considerable proportion. The frequently in and out of port of small vessels would not change the heavy marine traffic in a short time. Moreover, most of these small ships with poor technical conditions and low qualified crew, which was a big security hidden danger.

From the region, Qinhuangdao harbor and its surrounding water area had become the vessel traffic concentration areas of Bohai Sea. The traffic flow would become continuously heavier, the petroleum spilling risk increased accordingly.

2.3 Vessel Traffic Accident of Petroleum Spilling Risk Analysis

There were so many reasons why the marine water traffic accidents happened. And the causes of petroleum spilling incidents mainly included: collision, stranding, touch, explosion, etc.

According to maritime department statistics, there was 116 cases of maritime traffic accidents in Qinhuangdao sea area from 2001 to 2008, among which there was a 7 cases of large accidents. There was a big accident happened in the gold coast tourist resort. According to the type of accident statistics, stranded accidents percentage was 19.8%, 29.3% for collision accidents, 18.1% for touch accidents, 2.5% for fire accidents. From the accident site, there were 85.7% for the accidents happened in traffic channel, basin and anchorage and 15% for all maritime accidents.

The accidental petroleum spilling accidents could be divided into vessel accidental oil spilling accidents and operational oil spilling accidents. The accidental oil spilling accidents usually happened port area, high accident rate area and heavy traffic areas, the operational petroleum spilling accidents mainly happened in port marine area. According to Hebei maritime sector statistics, there were 20 great cases of vessel petroleum spilling accidents in Qinhuangdao port area, including 12 cases happened in east part district which was near the oil terminal, accounting for 60%. During 2003 to 2008, there were a total of 38 cases of ship petroleum spilling pollution accidents, including 33 cases occurred in Qinhuangdao port area, 2 cases happened in Shanhaiguan sea area and 3 cases happened in marine ares outer of Qinhuangdao port. More details was shown in table 2 and table 3.

Table 2. Vessel maritime traffic accident statistics in Qinhuangdao water area from 2001 to 2008

Year / Accident reason	2001	2002	2003	2004	2005	2006	2007	2008
Collision	1	4	3	8	3	6	4	5
Stranding	1	4	5	4	3	0	4	2
Touching	6	4	3	3	1	1	2	1
Fire	1	0	0	0	1	0	0	1
Other	8	4	0	3	4	6	1	9
Total	17	16	11	18	12	13	11	18

Table 3. Petroleum pollution incidents statistics of Qinhuangdao sea area from 2003 to 2008

Year	Accidents / Cases
2003	3
2004	4
2005	2
2006	12
2007	8
2008	9
Average	6.3

3. Calculation of Vessel Petroleum Accident Probability in Qinhuangdao Port Area

Supposed the ship collision and stranding incidents were coincidence with the binomial probability distribution. Then when 'n' ships reached in the sea area, the number of accidents was marked as $\chi=\kappa(\kappa=1,2,\ldots,n)$, the ship accident probability function $p(\chi=\kappa)$ obey the normal distribution, which expressed as $p=(x=k)=C_n^k p^k(1-p)^{n-k}$ formula 1.

In the above function: C_n^k was the combination formula; p was the accident probability; if $k=0$, the formula was: $p(k=0)=C_n^0(1-p)^n=(1-p)$ formula 2.

Assume the specific waters was with 95% of confidence level without vast ship accident, the formula was: $p(k\geq 1)=\sum_{k=1}^{n} C_n^k p^k(1-p)^{n-k}\leq 0.95$ formula 3.

If the result of formula 3 minus formula 2 combined with formula 3 minus formula1, then the results were: $p(k=0)=1-p(k\geq 1)\geq 0.05$, $p\leq 1-\sqrt[n]{0.05}$

Through the above formula and other comprehensive analysis, Qinhuangdao sea tanker petroleum pollution rank was: donggang district was the largest, then were, xinkai river, shanhaiguan, xigang district and Beidaihe area. Qinhuangdao tanker petroleum probability was not high, the donggang port was the main of Qinhuangdao, of which there were a lot of anchorage, waterway, garages and other important settings. There were many sensitive places in that, such as thermal power plant, industrial water inlet, fish culture zones, tourism landscape. Qinhuangdao district port cargo throughput ranked highly in history. Petroleum pollution had happened many times, and with highest degree of petroleum spilling risk.

Shanhaiguan port area was with a lot of anchorage, channels and multiple port facilities. Sensitive starting point of the Great Wall - laolongtou scenic sport resources, there was low probability of petroleum spilling in this area, with relatively low degree of pollution risk. Xinkaihe port area was with few port cargo throughput, the ship traffic volume was relatively small, oil spilling accidents probability was low. While, xigang district and Beidaihe area had the main channel, anchorage, multiply berth, port with underwater world culture zones, seaside bathing, many nursing institutes and other large amounts of sensitive resources. The two port risk was low, but in the event of petroleum spilling accident, the consequences would be vital serious [4].

4. Conclusion

The Marine petroleum spilling pollution in Qinhuangdao area was a long-term, complex and arduous work, this paper only completed the part of the research. There was still much work need to further improve and further study.

First of all, it should study the inner line monitoring system of petroleum spilling in Qinhuangdao Sea area, which would provide strong data support for the analysis of the petroleum spilling accidents. Secondly, it need to invent a set of applicable petroleum spilling emergency decision support software in Qinhuangdao port water area. When the petroleum spilling accidents happen, the emergency plan could started, and offered the guidance and reasonable decision of petroleum spilling accidents, and reduced the damage and losses brought by petroleum spilling accidents. Thirdly, It also need to strengthen the supervision and obligation sense of government and functional department, and practice the implementation of the petroleum spill emergency response plan and practice, the port should adopt corresponding measures to reduce the risk of petroleum spilling incidents. The higher risk of port should be intensified the efforts to monitor and equipped with enough emergency supplies based on the characteristics of jurisdiction, and improve the ability of emergency response measures; The implementation of dynamic monitoring, especially for dangerous goods in the ships going in and out of the harbor, it need to actively clean the dredge in the waterways and effectively ensured the channel unobstructed; it should protect the sensitive resources area, and equipped with a certain number of emergency equipment of petroleum spilling, in order to achieve the protection when petroleum spilling accidents happened in a short period of time.

Acknowledgements

Foundation: Project of Qinhuangdao Science and Technology Bureau Project No.: 201502A255, Project Name: Optimizing Rules Research on Petroleum Pollution Control, Method in Widespread Sea Area of Qinhuangdao

References

[1] Xinhuanet. The serious situation of marine petroleum pollution. [EB/OL]. (2007-06-01 [2011-10-16]. http://news.xinhuanet.com/video/2007-06/01/content_6182888.htm.

[2] J. Yang, D.L. Wang: Grey fuzzy comprehensive evaluation theory of vessels petroleum spilling risk method, Transportation Science and Technology, No.4, p. 118-118.

[3] SHCHERBAK, S. S, LAVROVA, O.Y, MITYAQINA, M.I. Multisensor satellite monitoring of seawater state and oil pollution in the northeastern coastal zone of the Black Sea [J]. International Journal of Remote Sensing, 2008, 29(21):6331-6345.
[4] J.J. Miao: Vessel Petroleum pollution risk research of Qinhuangdao sea area. Dalian: Dalian maritime university, 2008.
[5] J.K. Xiao, P.H. Yin, J.G Lin, et al: Artificial neural network identifying of ship section, Maritime Environmental Science, Vol.21 (2002) No.4, p. 42-45.
[6] Q.Z. Yin, X.N. Chu, X. Sun, et al: Application situation and development trend of vessel petroleum spilling monitoring method, Marine engineering, Vol. 39 (2010) No.5, p.246-250.
[7] S.F. Gao: Study on prevention of vessel pollution by establishing Bohai sea three-dimensional monitoring system research (Dalian: Dalian maritime university, 2005) p, 25-76. (In Chinese)
[8] P.F. Li, P.H. Yin: Petroleum spilling risk assessment in port area (the assay serious of the 90th anniversary of China's higher education of sailing and Dalian Maritime university: Engineering section, China 1999), p. 287-292. (In Chinese)