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Research on the Assessment Method of Oil Spill Environmental Risks of Offshore Oil Facilities

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Abstract

The oil spill in the offshore oil facilities environmental risk assessment methods are explored, and the risk evaluation method is a comprehensive consideration of spill pollution range, degree and environmentally sensitive resources influence, which graded and situational combination drift diffusion trajectory simulation for each of the leak, quantitative measure of environmental risk. Thereby improving offshore oil facilities the major environmental risk management level, prevent accidents, reduce pollution, and solves the calculation method and ship pollution risk traditional risk calculation method is not suitable for offshore oil facilities oil spill environmental risk assessment.

Keywords:Oil spill; environmental risk; environmental risk assessment method

1. Introduction

With the boom of offshore oil and gas exploration and development, offshore operation moves into an era of deepwater or ultra-deepwater. Engineering equipment is also progressing toward large-scale, intensive, complicated, automatic and subsea production systems (Liao Mosheng, 2010; Zhou Shouwei, et al, 2010). But the resulting oil spill risks grow with more oil spill accidents, and the damage of oil spill pollution to marine environments is highly influential. For example, the oil spill happened in a production platform in Gulf of Mexico (in which the daily oil leakage is about 20,000-40,000 barrels) in April 2010; and the oil spill of ConocoPhillips happened in China's Bohai Bay--namely there was an oil spill in PL19-3 wells due to over-exploitation (in which the officially announced

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leakage is 3,400 barrels) in June 2011 both lead to disastrous consequences. This is because a large amount of flammable and explosive oil & gas products exist in all links of oil & gas field development; besides, the development is very strict in process and equipment, and once a small operational failure occurs, this will directly lead to such accidents as blowout, flowline break and leakage, and slop tank.

In order to prevent and control offshore oil spills, the governments around the world have taken measures in response to reduce the economic loss and ecological damage caused by environmental pollution accidents resulting from offshore oil spills, improve their abilities of marine environmental risk precaution and oil spill pollution emergency disposal, and to establish and perfect marine pollution emergency mechanisms(An Wei et al, 2011). In addition to the establishment of an offshore oil spill accident emergency system, an environmental risk assessment must be performed for oil spills to assess the possible scope and extent of pollution arising from any oil spills existing in oil facilities as well as the adequacy and effectiveness of environmental risk prevention measures. Currently, international and domestic academics have made many researches (Sun Xuejing et al 2009; Mou Shanjun et al, 2006) about the environmental risk assessment for oil spills from ships. China has published the Technical Specifications for Marine Environmental Risk Evaluation on Pollution from Ships (trial), but the research about the environmental risk assessment for oil spills from offshore oil & gas exploration, development and production operation facilities is at an initial stage in China. Traditional environmental risk evaluation methods include probability analysis and ZOI (zone of influence) calculation; the former is not so feasible, and the formula for the latter is based on such issues as inaccuracy under the hypothesis of seamless conditions. So researches about environmental risk evaluation methods suitable for any oil spills in offshore oilfields are beneficial to make relevant emergency material configuration standards, providing evidence for establishment of contingency plans.

2. Researches on Calculation of Environmental Risks from Offshore Oil Spills

A traditional risk calculation method is $C = P \times S$, where P means accident probability and S means consequence. However, this traditional method is not suitable to the risk assessment for oil spills in offshore oilfields because the oil spill happens not very often to offshore oil facilities, which is non-compliant with statistical requirements for probability statistics, so that the oil spill accident probability is not available.

In the Technical Specifications for Marine Environmental Risk Evaluation on Pollution from Ships (trial), the calculation method for marine environmental risks due to the pollution from ships is $C=\sum Pi \times Si$, where Pi means the probability of sensitive target i to be affected and Si means the sensitivity coefficient of protected sensitive target i. Whereas any traditional risk calculation methods are not suitable to the calculation of oil spill risks in offshore oilfields, we used the calculation method for marine environmental risks due to the pollution from ships, and also considered both the impact on environmental sensitive resources and the range and extent of oil-spilled waters and coat. The sensitive resources include natural reserves, ecological reserves, aquiculture areas and beaches, etc.; the impacts on such sensitive resources include the arrival probability and fastest time of sensitive resources; the arrival probability and fastest arrival time of entrained oil; the arrival probability, fastest arrival time and concentration of aromatic hydrocarbons; the probability and fastest time of migration to sediments, and hydrocarbon concentration; the coastline arrival probability, fastest time and oil slick mass. The pollution scope includes the sweeping area of surface floating oil and entrained oil. The pollution degree includes the thickness and mass of surface oil slick and the maximum concentration of aromatic hydrocarbons.

Based on the above factors, the calculation method for oil spill risks in offshore oilfields was proposed; see Formula (1):

$$C = w_1\left(S_i + S_{ji}\right) + w_2 \sum \delta_i \times \rho_i + w_3 \left(\sum (P_{\mathrm{mgi}} \times M_i \times \mathrm{T}_{mgi} + P_{jdi} \times M_i \times T_{jdi} + P_{fti} \times M_i \times \left(T_{fti} + C_{fti}\right)) + \sum P_{\mathrm{cji}} \times \left(T_{fti} + C_{fti}\right) + \sum P_{\mathrm{axi}} \times M_{axi}\left(T_{fti} + C_{fti}\right)\right) \quad (1)$$