Numerical Simulation of Accidental Oil Spill Diffusion in Xiamen Sea Area

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ABSTRACT

The two dimension oil spill model of Xiamen Bay will be built up by using Mike 21SA module. The “oil particles” model was used to simulate transport movement, weathering and heat transfer process of spilled oil. And the impact of typical oil spill accidents in different weather conditions and different spill sites was predicted for eight typical scenarios. The results show that the sweep range and migration path of the spilled oil is closely related to the spilling position, time, and wind. In different conditions, the sweep range and migration path has great differences.

KEY WORDS: Xiamen Sea Area; MIKE21; spilled oil; impact on the sensitive areas.

INTRODUCTION

There are some sensitive areas in east lateral of Xiamen Island, includes the Sousa Chinesis reserve, Xiamen amphioxus natural reserve, vacation resort in eastern coastal of Xiamen, and the southeast coastal beach reserve etc. So once the oil spill accident occurs, it will give a great impact on the marine environment around. Thus, if oil spill accident occurs, the research on the oil film drift-diffusion will make great significances not only in theory, but also in practical. This article makes a research simulation in the tidal current field of Xiamen Bay and a simulation on the oil spill diffusion accident by using MIKE 21 HD module and SA module. It not only solves practical problems but also provide references for the technique people who engage in the research in this area: Yaneko N(1971); Casulli V(1988); Casulli V(1990); Leendertse Jt(1970); Grotkop G(1973); Chung T.J(1978); Thompson J.F(1974); WangJia He(1994); WeiWen(1995).

OIL SPILL PREDICTION MODEL

The oil spill prediction module is developed by the water environment research institution of Denmark and this module is based on the ALE System. By simulating the process which the oil particles does extension, transmission (flow and wind field effect), turbulent diffusion, dispersion (entrainment), evaporation, emulsification, and dissolution in water, it can provide oil particles’ attribute change in drift position, thickness, the viscosity during drifting, the surface temperature of oil particles and pour point. And this change is made along the time. Besides, the module can make an accurate simulation on complex water’s (such as various hydraulic structures) hydrodynamic. The powerful pre and post processing function can be available for the development of the decision system. The system is the most advanced simulation tool among the similar software in the world. Now, many successful applied cases can be found all over the world(Jiang Weixing,2007a).

TRANSFERRING PROCESSES

The transferring process of the oil particles includes extension, drift and diffusion. These processes are caused by the position change of oil particles. But the components are not changed during the process (DHI,2003a).

(1) Extension movement

We can calculate oil film extension by using the modified formula Fay gravity-viscous force:

\[
\frac{dA_o}{dt} = K_e \cdot A_o \cdot \frac{\sqrt{V_{oi}}}{A_{oi}} \cdot \gamma^2
\]

In this formula, \(A_o\) is the area of oil film, \(A_{oi} = \pi R_{oi}^2\); \(R_{oi}\) is the diameter of oil film; \(K_e\) is coefficient; \(t\) is time; and the volume of oil film is:

\[
V_{oi} = R_{oi}^2 \cdot \pi \cdot h_i \]

In the formula, the initial oil film thickness is \(h_i=10\) cm.

(2) Drift movement

The force for oil particle drift is water flow and wind draft force, the total drift speed can be calculated by the following weight formula:

\[
U_{oi} = c_w (z) \cdot U_s + U_w
\]

In this formula, \(U_w\) is the wind speed above water surface for about 10 m; \(U_s\) is surface velocity; \(c_w\) is coefficient of wind drift, it is usually between 0.03 and 0.04. The data of wind field is provided by