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The Study on Transport Characteristic and Impact Factors of Spilled Oil on Open Channel of Water Transfer Project

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Abstract: In order to quickly respond to oily pollution incidents in water transfer projects, the author has adopted the two-dimensional hydrodynamic model, oil spill numerical model, combined with physical model test, to carry out quick prediction on the characteristic parameters of oil spill transport and impact factors. The research results show that: in the case of sudden outbreak of oil spill pollution on the open channels of water transfer projects, the oil slick transports about 1.15 times as fast as the central flow velocity; the change rate of the longitudinal length of the oil slick is 0.5 times of the central flow velocity at the cross section; in the case of sudden pollution, neither the transport distance of the oil slick nor its longitudinal length change rate is affected by oil spill quantity; the wind field has a greater influence on the transport distance of oil slick: when the wind direction is parallel with the flow, the wind field has little influence on the change rate of the longitudinal length of the oil slick; when the wind direction is perpendicular to the flow, the oil slick will be banked under the action of the wind field; According to the physical model test, different oil spill types will lead to different the change rate of the longitudinal length of the oil film. The research results of this paper can be used to realize quick prediction of the pollution range in the case of oil spill on open channel of water transfer project, and provide support for decision making in emergency treatment pollution control.

1 Introduction

The spatial and temporal distribution of water resources in China is extremely uneven. Cross-basin water transfer projects are an important strategic approach to improve the existing pattern of China's water resource distribution, realize the rational allocation of water resources, and ensure the sustainable social, economic and environmental development of China. The water transfer projects function as the inland waterways that supply water to the intake area, and therefore the safety of their water quality is a primary concern. However, water transfer projects are often built upon open waters, with great regional population density, high level of industrial development, and numerous river-crossing buildings, subjecting the water transfer projects to high risk of emergent water pollution incidents. With the continued development of oil transportation industry, oil spill has become one of the major causes of water pollution these days. Compared with oil spill in marine waters, oil spill incidents on water transfer projects will, at best, affect the water quality along the river; at worst, the oil spill will burn and form a ribbon fire zone that moves with the flow, causing great danger to the safety of the buildings and residents along the river.

At present, the classic theories of oil spill models at home and abroad include the early Blokker's Spreading Model, Fay's Oil Spill Spreading Model, Yuan Lang's Spreading Model, the Oil Particle Model, and the Three-dimensional Oil Spill Model (Blokker, 1964; Fay, 1969; Lou, et al., 2008; Zhang, et al., 2008; Jiang, et al., 2017). However, most of the studies are focused on the spread of spilled oil in marine environment or estuary region and few are targeted at inland waterways and water transfer projects. Chinese scholars used the Oil Particles Model and the Three-dimensional Oil Spill Model to simulate accidents in different scenarios for inland waterways including the Huangpu River, the Yangtze River's Hanjiang-Wuhan section, the Yangtze River Three Gorges Reservoir section, and the Songhua River, etc. (Chen, et al., 2012; Jiang, 2007; Liu, et al., 2006; Chen, 2006; Wu, 2006; Qi, et al., 2010); Aside from numerical simulation, physical model test is also an important means to carry out research on oil spill pollution in inland waters. Wu (Wu, et al., 2010; Wu, 2009) studied the track of oil slick under tidal influence in tidal reach through glass water tank test. Guo (Guo, et al., 2008) studied the effect of wind on oil slick spreading and drift characteristics for instant and continuous oil spills through wind-water tank test. Targeted at oil spill accidents in water transfer project, Liu (Liu, 2014) combined the oil particle model with physical model test to study the oil pollution transport and separate characteristics in water transfer project and the conditions

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of oil submergence in front of check sluice and inversed siphon import, which laid the foundation for the research on oil spill's transport rules and impact factors in the open channel of water transfer project.

However, it is usually time-consuming to obtain the oil pollution scope through numerical simulation. The existing research does not meet the requirements for decision making in sudden outbreak of oil pollution accidents on open channel of water transfer project. Therefore, this paper uses numerical simulation and physical model test to propose a fast quantification approach based on characteristic parameters, and analyzes potential influencing factors on the characteristic parameters, in order to provide support for decision making for timely control and treatment of oil pollution on open channel of water transfer project.

2 Research Method

In order to quickly predict the position and affecting scope of the oil slick, this paper proposes two characteristic parameters for quick prediction of oil spills on river channels, i.e. oil slick transport distance and oil slick longitudinal length. Based on the actual needs of oil slick control and emergency treatment, the author uses depth-averaged two-dimensional numerical simulation model and physical model test to construct a typical canal segment, and simulates oil slick transport under different hydrodynamic conditions, and thus to ascertain the migration rules of the two characteristic parameters in water transfer channel, as well as to ascertain the influence of oil spill amountand wind field on the transport rules of oil slick.

2.1 Numerical Simulation

After a sudden oil spill incident, the oil slick would be affected by wind, waves, light, temperature and biological activity, and the size, physical and chemical properties of the oil slick would change with time. This research is aimed at the quick prediction of oil slick characteristic parameters in sudden oil spill incident, so as to obtain an accurate oil slick position and affecting scope within a short time and provide technical support for emergency treatment. Therefore, this paper only considers the transport process of oil slick in water, including its spreading and drift process. The weathering process of the oil slick is therefore ignored in this paper.

（1）Oil Slick Spreading

After the spilled oil enters the water, the spread area of oil slick with the change of time can be calculated with modified Fay's gravity-viscous formula：

$$\frac{dA_{oil}}{dt} = K_\alpha A_{oil}^{1/3}\left(\frac{V_{oil}}{A_{oil}}\right)^{4/3} \tag{1}$$

in which： $A_{oil} = \pi R_{oil}^2$， is the spread area of oil slick，m^2；R_{oil} is the radius of oil slick，m； K_α is the coefficient，s^{-1}。

（2）Advection Transport and Turbulent Diffusion

Oil slick transport refers to the translatory movement of oil particles under the influence of wind, surface current, and waves in the surrounding waters. The formula for calculating the drifting velocity of the oil slick is:

$$\vec{U} = \vec{U}_a + \vec{U}' \tag{2}$$

in which， $\vec{U}_a$ is the translatory velocity of the surface current and wind， m/s； $\vec{U}'$ is the horizontal turbulent diffusion velocity， m/s.

The translatory velocity is calculated by the following weight formula:

$$\vec{U}_a = K_s\vec{U}_s + K_w\vec{U}_w \tag{3}$$

$$\vec{U}_s = (1-j)(1-k)u_1 + j(1-k)u_2 + (1-j)k\cdot u_3 + j\cdot k\cdot u_4 \tag{4}$$

in which，$\vec{U}_s$ is the surface velocity of the canal segment， m/s ； K_s is water-driven drift impact factor， set at 1.15(Zhao, et al., 2012)； $\vec{U}_w$ is the wind velocity 10m above the water surface, m/s ； K_w is wind-driven drift impact factor， generally set at 0.02~0.03； u_1， u_2， u_3， u_4 are velocity components.

The turbulent diffusion rate of the oil slick is calculated using random step. The formula for calculating the diffusion rate is：

$$\Delta S = [R]_0^1\sqrt{12D_h\Delta t} \tag{5}$$

in which： $[R]_0^1$ is a random number from 0 to 1， D_h is the horizontal diffusion coefficient.

Distributed formula of oil slick displacement：

$$L_{x(\Delta t)} = U_{ax}\Delta t + \Delta S\cos\theta$$
$$L_{y(\Delta t)} = U_{ay}\Delta t + \Delta S\sin\theta \tag{6}$$

in which， $L_{x(\Delta t)}$ and $L_{y(\Delta t)}$ are displacement in the direction of x and y, respectively; U_{ax} and U_{ay} are advection velocity components in the direction of x and y; $\theta = 2\pi[R]_0^1$.

The new position of the i^th oil particle moving from moment n to moment n+1 is:

$$X_i^{n+1} = X_i^n + L_{x(\Delta t)}$$
$$Y_i^{n+1} = Y_i^n + L_{y(\Delta t)} \tag{7}$$

in which, X and Y are the coordinates of oil particles.

2.2 Physical Model Test

In order to verify the transport and spread rules of oil slick on open channel of water transfer project, the physical model test is carried out using the glass water tank shown in Fig. 1. The tested canal segment consists of two types of tank sections: rectangular water tanks and trapezoidal water tanks. The total length of the rectangular tank is 26.0m, the width being 1.0m; the total length of the trapezoidal tank is 34.5m, with the bottom width being 1.0m, the slope coefficient being 1.0. By adjusting the upstream inlet flow velocity and the downstream outlet water level, the transport rules of oil slick under different

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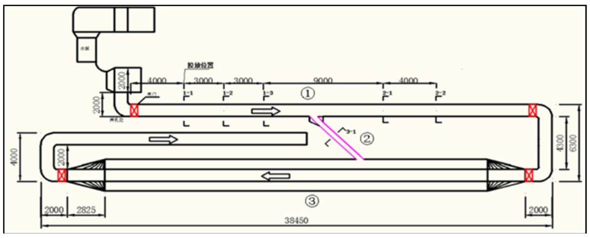
hydrodynamic conditions can be studied.



(a) Overall layout of the glass water tank

(b) Rectangular section (c) Trapezoidal section

Fig. 1 Water tank for physical model test

3 Study on the Transport Rules of Oil Slick in Water Transfer Channel

3.1 Characteristic Parameters in the Transport of Oil Slick

In order to characterize the position and scope of the oil slick, two characteristic parameters are proposed: oil slick transport distance L_{oil} and oil slick longitudinal length D_{oil}, as shown in Fig. 2. The transport distance of oil slick is the distance from the initial oil spill point to the central point of the oil slick after a period of time following a sudden oil pollution incident. It is a characteristic parameter reflecting the velocity of oil slick transport with the water flow. The longitudinal length of the oil slick is the length of oil slick flowing along the river during the transport process. It is a characteristic parameter that reflects the extension of oil slick itself and its enlarged scope under the influence of water surface tension. It is an important decision parameter for determining the pollution scope in the case of sudden oil spill incident. By quantifying the transport distance and longitudinal length of the oil slick, the position and scope of oil slick in water transfer project can be quickly predicted, which offers essential guidance for incident regulation and control, determining the treatment scope, layout of the treatment facility, and arrangement of treatment personnel.

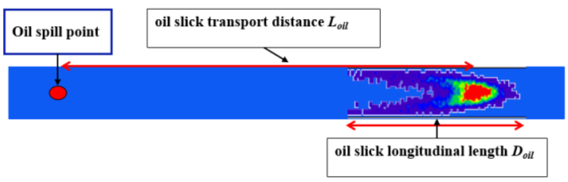


Fig. 2 Shape of oil slick spread on channel and characteristic parameters

3.2 Physical Model Test

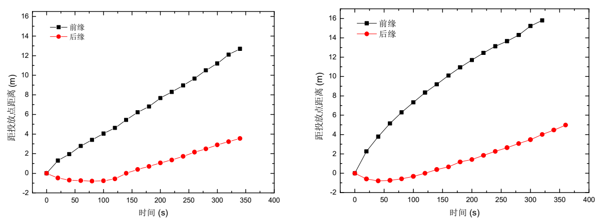
The conditions of physical model test are set according to Table 1. Considering the environmental characteristics of water transfer project, diesel oil is selected as the test oil for the experimental study on the transport and spreading rules of oil slick on both trapezoidal and rectangular cross-section canals. The same working conditions are set to eliminate the influence of subjective behavior differences in single oil spill physical model test such as oil input amount and method as well as manual observation.

Table 1 Condition-setting for physical model test of oil slick transport rules on water transfer channel

Conditions	Cross Section	Input Amount /ml	Downstream Water Level/cm	Flow /m³/s	Central Flow Velocity /m/s
1-1	Rectangle	20	20	0.006	0.026
1-2	Rectangle	20	20	0.006	0.026
2-1	Trapezoid	20	20	0.0128	0.042
2-2	Trapezoid	20	20	0.0128	0.042

Through observation and photo-taking of the test results, the transport and spreading characteristics of oil slicks in the test process of sudden oil spill are obtained. Due to the different cross-section velocity distribution in rectangular and trapezoidal water tanks, the ultimate shapes of the oil slick after transport and spread are different. In the rectangular water tank, since the cross-section velocity distribution is even and the drag force of the side walls to the oil slick is small, the oil slick would form an elliptical shape with its long axis in the direction of the river. In contrast, the cross-section velocity distribution in trapezoidal tank is quite uneven, with high flow velocity near the center and low flow velocity near both sides of the tank. Therefore, the drifting velocity of the oil slick along the center line of the tank is faster than that near the side walls, thus the oil slick would be continuously elongated and ultimately form a shape of swallow-tail.

According to the measured values obtained from the physical model test, the curves for the change of position of the oil slick's front and rear edges over time in two types of tanks are created, as shown in Fig. 3.



(a) Rectangle

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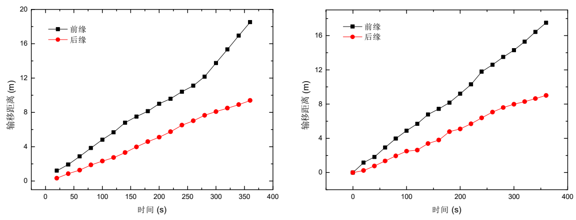


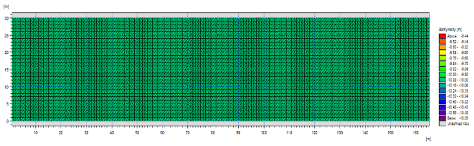
(b) Trapezoid

Fig. 3 Results of physical model test on the transport and spreading characteristics of oil slick

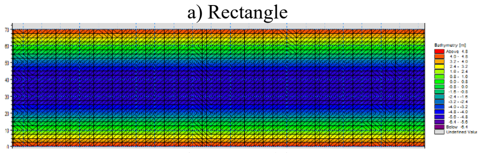
It can be seen from Fig. 3 that in a short-lived oil spill, the horizontal spread of oil slick on the open channel is discontinued due to limits of the river banks, but its longitudinal spread is not limited and its ultimate length can be estimated based on the minimum thickness possible of the oil slick. The oil slick will continue to spread along the river and drift with the water flow. Therefore, the length of the oil slick would increase over time.

3.3 Numerical Simulation Study

Based on the characteristics of the main channels of the South-to-North Water Diversion Project and the physical model test conditions, the numerical models for rectangular and trapezoidal river segments are constructed respectively according to the model scale in Table 2, and the corresponding hydrodynamic conditions are set to carry out the numerical simulation of oil slick transport and spread. The meshing is shown in Figure 4. The numerical simulation condition-setting and hydrodynamic simulation results are shown in Tables 3 and 4, respectively, and the oil slick transport and spread result comparison is shown in Table 5.



a) Rectangle



b) Trapezoid

Fig. 4 Local meshing of open-channel numerical simulation model

Table 2 Scale of physical and numerical model for oil spilled river segment (Gao,2006; Wang, et al., 2004)

Scale Type	Expression	Scale of Rectangular Water Tank Experiment	Scale of Trapezoidal Water Tank Experiment
Horizontal Scale	λ_l	30.0	20.0
Vertical Scale	λ_h	30.0	20.0
Flow Velocity Scale	$\lambda_v = \lambda_l^{0.5}$	5.477	4.472
Flow Scale	$\lambda_Q = \lambda_l^{2.5}$	4929.5	1789
Time Scale	$\lambda_t = \lambda_l / \lambda_v$	5.477	4.472
Roughness Scale	$\lambda_R = \lambda_l^{1/6}$	1.763	1.648
Input Amount	$\lambda_V = \lambda_l^3$	27000	8000

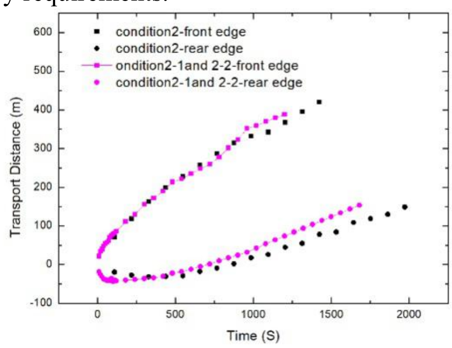
Tab 3 Condition-setting for numerical simulation on open channel

Condition	sm-1	sm-2
Segment	Rectangle	Trapezoid
Flow /m^3/s	29.5	22.9
Downstream Water Level/m	6.9	4.9
Roughness	0.014	0.013
Input Amount/m^3	0.54	0.16
D_Lm^2/s	0.25	0.25
D_Tm^2/s	0.1	0.1

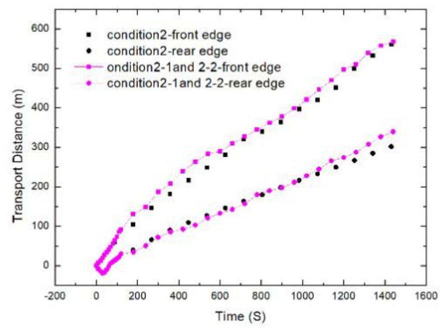
Table 4 Hydrodynamic result comparison between numerical simulation model and physical test model on open channel

Condition	Segment	Flow /m³/s		Flow Velocity/m/s		
		Physical Model	Numerical Model	Physical Model	Numerical Model	Relative Error
1	Rectangle	0.0060	29.50	0.026	0.163	12.0%
2	Trapezoid	0.0128	22.90	0.042	0.192	2.2%

It is shown in Table 4 that the scale-converted hydrodynamic simulation results of the numerical model for both rectangular and trapezoidal tanks are consistent with the physical model test results, and the relative error is less than or equal to 12%. Therefore, the numerical model simulation results are reasonable and can meet the accuracy requirements.



(a) Rectangle



(b) Trapezoid

Fig.5 Test result comparison between numerical and physical model test on the transport and spread of oil slick on water transfer channel

3.4 Analysis on the Transport Rules of Oil Slick

Based on the results of the physical model test and numerical simulation, the relationship between the time and transport distance of oil slick is fitted, and the formula for quick prediction of the transport distance is obtained; Linear fitting of the relationship between the time and the transport distance of the front and rear edge of the oil slick is conducted, and time derivative of the difference between the two is the change rate of the longitudinal length of the oil slick, as shown in Table 5.

Table 5 Numerical simulation and physical model test results on the characteristic parameters of oil slick on water transfer channel

Condition	Transport Distance /m	Change Rate of Longitudinal Length dD_{oil}/dt	Flow Velocity m/s
1-1	0.0310t	0.013	0.026
1-2	0.0302t	0.015	0.026
2-1	0.0474t	0.020	0.042
2-2	0.0487t	0.021	0.042
1-1	0.1860t	0.079	0.163
sm-2	0.2290t	0.111	0.192

It can be seen from Table 5 that in rectangular and trapezoidal water tanks, the oil slick transport distance is proportional to the flow velocity along the center line of the water tank, which meets the formula:

$$L_{oil} = 1.15vt \tag{8}$$

in which: v is the average flow velocity of the segment, m/s; t is the time of oil slick transport, s.

In the initial stage of oil spill in rectangular and trapezoidal water tanks, the longitudinal length of the oil slick continues to increase, and the change rate of longitudinal length over time meets the formula:

$$\frac{dD_{oil}}{dt} = 0.5v \tag{9}$$

According to the numerical simulation and the physical model test, the transport and spreading rules of oil slick on water transfer channel are different from those in marine waters. It is difficult for emergency response or treatment measures to reach the oil spill location on the sea, so the response time is long. Most of the studies are focused on the movement track of oil slick under the influence of ocean current and wind field. The time scale under these studies is usually /day, and the sea surface is wide without any side wall. Therefore, the time taken for the self-extension of the oil slick only takes a tiny part in the overall length of such studies. However, research on oil slick transport and spreading on water transfer channels are aimed at identifying the transport and spreading rules of oil slick within the response time of emergency control measures, and the time scale is short, usually /minute or /hour. In such short period of time, the transport and spreading of oil spills in the waterway are limited by the side walls, therefore the horizontal length of the oil slick is limited. Within few hours after the initial oil spill, the oil slick transports with the water flow and continues to spread and becomes thinner, thus the longitudinal length of the oil slick continues to increase. Therefore, the results of this paper are reasonable in the initial stage of oil spill and can be used to predict the characteristic parameters of oil slick transport in the initial stage of sudden oil spill incident on long-distance water transfer channel.

4 Study on Factors Affecting Oil Slick Transport and Spreading

4.1 Wind Field

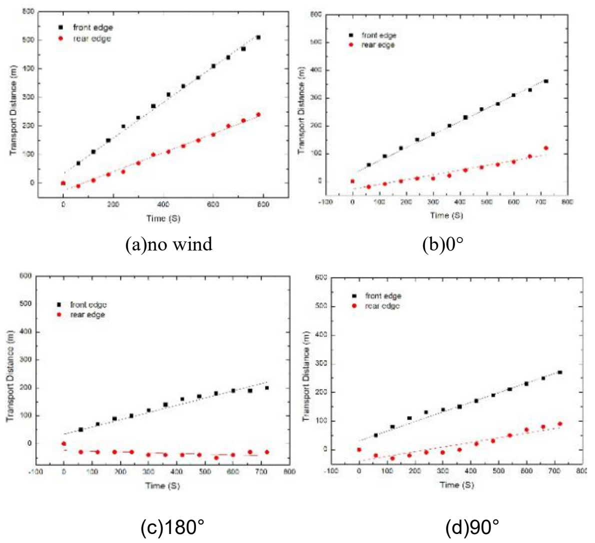
Four groups of numerical simulation conditions are set as shown in Table 6, in which the canal segment characteristics and oil spill characteristics are set as follows: the river length is 10km, the bottom width is 20m, the bottom slope is 1/20000, the roughness is 0.015, the river depth is 4.5m, the amount of oil spill is 10 m^3, and spill form is instant oil spill.

Table 6 Numerical Simulation Conditions

Condition	Slope	Flow m^3/s	Oil Spill Location	Wind Field m/s
3-1	2.5	100.0	Middle	/
3-2	2.5	100.0	Middle	5(Wind in the direction of the river flow /0°)
3-3	2.5	100.0	Middle	5(Wind against the direction of river flow /180°)
3-4	2.5	100.0	Middle	5(Wind perpendicular to the river flow/90°)

The flow velocity on open channel of water transfer project varies greatly in the horizontal direction, with high velocity along the central line and decreasing velocity towards both sides. The maximum central flow velocity under condition 3-1 and 3-4 is 0.691 m/s, 0.427 m/s , respectively. Under the above three groups of hydrodynamic conditions, the impact of wind field conditions on the characteristic parameters of oil slick were simulated.

The influence of wind field on the transport and spreading of oil slick is mainly achieved by changing the flow velocity of the surface water of the river. At present, studies on the characteristics of oil slick under the action of wind field are mainly focused on the influence of wind direction on the drift direction and drift velocity of the oil slick. Progress has been made in these fields. In the process of oil slick drifting with water flow, by considering the influence of wind speed 10m above the water surface on the transport and spreading, the wind-driven drift impact factor has been proposed, ranging 0.02~0.03. Since the wind direction and wind speed are uncertain above open waters, the oil slick may stick to the bank under the action of the wind field, or even remain still on the water surface under strong wind against the direction of the water flow. The influence of different wind direction and wind speed combinations on the transport rules of oil slick is studied through conditions 3-1~3-4. The numerical simulation results are shown in Fig. 6.



(a)no wind (b)0°

(c)180° (d)90°

Fig. 6 The transport and spreading curve of oil slick on water transfer channel under the influence of wind field

（1）The wind direction is parallel to the water flow

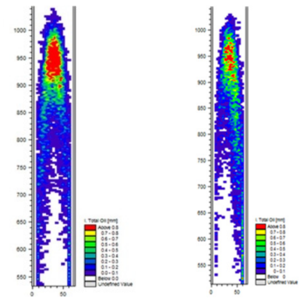
By comparing Fig.6 a), b), and c) which show the transport distances of the front and rear edges of the oil slick under four groups of conditions, it can be seen that when the wind direction is parallel to the water flow, the wind force has an influence on the transport distance of the oil slick. Within the same period of time, the transport distances of oil slick from long to short are: oil slick transport distance under the influence of wind in the direction of water flow (5m/s), no wind, and wind against the direction of the water flow (5m/s); The linear fitting of the relationship between the time and the transport distance of the front and rear edges of the oil slick under three groups of conditions is conducted. The time derivatives of the differences between the two are the change rates of the longitudinal length of the oil slick when the wind field is parallel to the water flow. The results are approximately the same, which all meet the following formula:

$$\frac{dD_{oil}}{dt} = 0.19 = 0.5v \qquad (10)$$

Therefore, under the wind speed conditions set in this paper, when the wind direction is parallel to the water flow, the wind field has little influence on the longitudinal length of the oil slick, but the prediction formula is still met. Literature carried out an experimental study on influence of wind on oil slick spreading and drift. It is found that when the wind and flow velocity are in the same direction, the wind speed has no effect on the spreading scale of the oil slick, i.e., the oil slick spreading coefficient does not change with the wind speed. The numerical simulation results in this paper are consistent with previous experimental studies.

（2）The wind direction is perpendicular to the water flow

Comparison of oil slick position and shape under condition 3-1 and 3-4 five minutes after the sudden outbreak of oil spill incident, as shown in Figure 7.



(a) Condition 3-1 (b) Condition 3-4

Fig. 7 Oil slick shape under no wind or under wind field perpendicular to the water flow

It can be seen from Fig. 8 that under the action of perpendicular wind field, the oil slick drifts along the wind direction, and is concentrated along the right bank; the influence of perpendicular wind field on the surface flow field in the open channel of water transfer project is strong. Due to the limited width of the open channel of water transfer project, the oil slick floating on the surface of the water body will reach the bank in a short time. In the end, the oil slick will be completely banked under the influence of the wind field.

4.2 Influence of the oil spill quantity

In the incident of sudden oil spill pollution, different pollution sources will lead to different scale in the amount of accidental pollution overflow. According to the pollution source investigation and analysis, the amount of leakage for the marine tankers capsized, the tanker and the automotive fuel tank are from much to little. According to the different pollution source magnitudes, the physical model test is used to carry out the research on the oil slick migration and expansion of the sudden floating oil pollution in the water transfer project. The hydrodynamic conditions of the physical test are the same as those of working condition 1, and the oil spill is 10ml, 20ml, 50ml respectively. The test results are shown in fig.8.

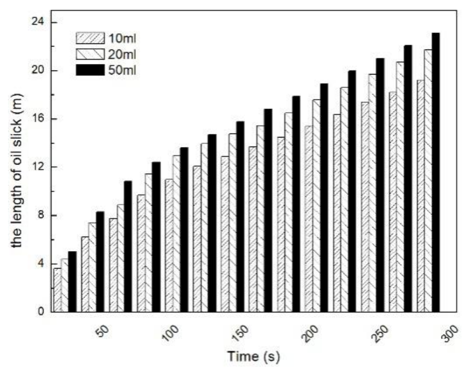


Fig.8 The oil slick longitudinal length under the influence of oil spill quantity

According to fig.8, under the same hydrodynamic conditions and within a short oil spill time, the longitudinal length of the oil film changes slightly with the increase of oil overflow, but the range of variation is small.

4.3 Influence of the oil type

According to the statistics of oil spill accidents, because of the variety of goods transported through shipping and

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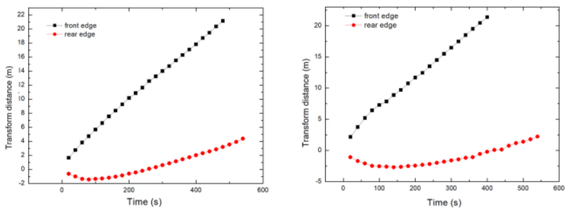
road network, the types of oil spilled in inland rivers is more diversified than that in sea. The composition, density and viscosity of different oils are different, which may affect the migration and expansion of oil slick. This section uses the physical model test method to study the effect of oil type on oil film migration and expansion. In this section, the influence of oil type on oil slick migration and expansion is studied by physical model test. The setting of the model test conditions is shown in Table 7. The flow condition is as same as the condition of 1-1 and 1-2.

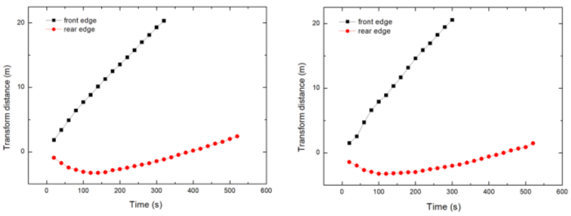
Table 7 physical model test Conditions

scenario	Oil type	Oil spill volume /ml	Density /g/cm^3	Viscosity /mm^2/s
4-1	lubricating oil	20	0.82	0.76
4-2	lubricating oil	20	0.82	0.76
5-1	vegetable oil	20	0.92	9.5
5-2	vegetable oil	20	0.92	9.5
6-1	diesel oil	20	0.87	3.0~8.0
6-2	diesel oil	20	0.87	3.0~8.0

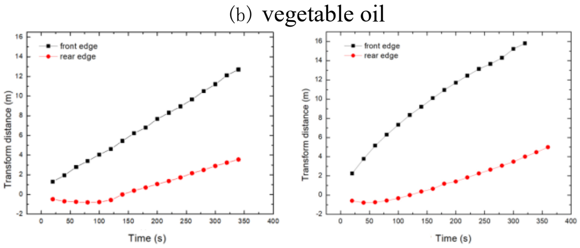
Fig. 9 shows the oil slick expansion of the above 6 scenarios.



(a) lubricating oil



(b) vegetable oil



(c) diesel oil

Fig. 9 The oil slick expansion progress under the scenarios of different oil type

Table. 8 the change rate of the longitudinal length of the oil slick under the scenarios of different oil type

scenario	Oil type	Velocity /m/s	dD_{oil}/dt	$\frac{dD_{oil}/dt}{v}$
4-1	lubricating oil	0.026	0.0338	1.35
4-2	lubricating oil	0.026	0.0329	1.42
5-1	vegetable oil	0.026	0.0480	1.85
5-2	vegetable oil	0.026	0.0440	1.69
6-1	diesel oil	0.026	0.0130	0.50
6-2	diesel oil	0.026	0.0150	0.57

It can be seen from Table 8 that the change rate of the longitudinal length of the oil film of different oils is different, and the change rate of the longitudinal length of the oil slick from the largest to the smallest is: vegetable oil, lubricating oil, diesel oil.

From the point of view of viscosity, the viscosity of diesel oil is larger than that of lubricating oil. Under the same oil spill condition, the expansion range of diesel oil is smaller. Therefore, the longitudinal length of oil slick changes greatly. The viscosity of vegetable oil is the largest. However, the change rate of longitudinal length of oil slick is highest. Therefore, the viscosity is not the only factor influencing the range of oil slick.

In this paper, the effect of different types of oil on the transport and expansion of oil film is only obtained qualitatively, and further research on this problem is carried out with the combination of numerical simulation and physical modes test.

5 Conclusion

Targeted at oil spill pollution incidents on open channel of water transfer project, this paper conducted two-dimensional numerical simulation and physical model test to describe the transport characteristics of oil slick on water transfer channel, and obtained the results as following:

(1) Oil slick transports about 1.15 times as fast as the central flow velocity and the change rate of the longitudinal length of the oil slick is about 0.5 times of the central flow velocity.

(2) In the case of sudden pollution, neither the transport distance of the oil slick nor its longitudinal length change rate is affected by the oil spill quantity;

(3) The wind field has a greater influence on the transport distance of oil slick; when the wind direction is parallel with the water flow, the wind field has little influence on the change rate of the longitudinal length of the oil slick; when the wind direction is perpendicular to the water flow, the oil slick will be banked under the action of the wind field.

(4) the change rate of the longitudinal length of the oil film of different oil type is different, and further research on this problem is carried out with the combination of numerical simulation and physical modes test.

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