International Journal of Hybrid Information Technology
Vol. 9, No.12 (2016), pp. 55-66
http://dx.doi.org/10.14257/ijhit.2016.9.12.06

A Collecting Machine Design for Oil Slick

Chunhui Lu

School of Mechanical-Electronic Engineering, Hohai University
200 Jinling Beilu Road, Changzhou, China
chunhuill@yeah.net

Abstract

Oil spill accidents are likely to increase in three decades. An oil spill accident can lead to serious crisis to the marine environment. The wastewater and waste sludge all contains oil in the process of petroleum mining. The oil slick can move or transfer by spread, evaporate, dissolve, emulsifying, photolysis, and biodegradation and absorption which can pollute air, water and soil and is a disaster to the environment. The research analysis shows the oil slick flow with surface wave in wind and finds a few characteristics can help the design. A new collecting machine which can collect the oil slick efficient is designed by adjusting its position in the surface wave. The design includes three main parts of machine while the collecting plate is keeping under the wave but squeeze water surface. All the machine parts shall be controlled with a flexible smart system to adapt the changing surface wave in the ocean.

Keywords*: Collecting Machine, Oil Spill, Ocean, Surface Wave, Smart Sensor Control*

1. Introduction

Oil spill often caused serious consequence in last decades and most accidents left environmental pollutions and traces in water, soil and air in a long term. The river, soil and groundwater may be polluted by the oil so that the area may be barren in decades or even hundreds of years. Oil spill made the petroleum flowed into the ocean about 390000 tons per year. Meanwhile, the wastewater and waste sludge all contains oil and other pollutions in the process of petroleum mining. In the end, the poison shall do harm to people by groundwater or foods. The oil slick blokes the water dissolve the oxygen so that the marine plankton cannot grow. All these effects will destroy the ocean ecological balance in the future because the pollution has concealment and cumulative characteristics. Many research proved that some petroleum hydrocarbons have environmental carcinogenesis, teratogenesis and mutagenesis action to mammals and humans.

The Gulf war made 8 million barrels of crude oil leaked into the Persian Gulf and the oil floating over 101 times 42 miles, the thickness of oil up to 5 inches (about 12.7 cm) and then, orange color oil droplet were found in many crab larvae's bodies. [1] In the wake of BP's Deepwater Horizon oil spill that occurred in the Gulf of Mexico, it is necessary to examine the engineering failures that led to the spill, the environment impact of the spill, and the economic impact such a spill can have on the Gulf residents, 2010. The resulting catastrophe led to the death of 11 crew members and the worst environmental oil spill in U.S. history. Oil and gas gushed out into the ocean at approximately 35,000 to 60,000 barrels per day for 87 days. [2] In June, 2011, Penglai 19-3 oil field in China which was cooperated build by United States and CNOOC was found oil spill and the spill kept over half a year. The polluted area is over 5500km^2. [3] [4]

Oil can stick the fish gills that make the fish stifled, prevent the waterfowls' eggs hatching and destroy the feather's waterproof. Oil needs a long time to be degraded completely. The speed of degraded is different with circumstance and the petroleum

ISSN: 1738-9968 IJHIT

composition. [5] It is a signal which means ever-upward risk of oil leakage was walking along the food chain.

The crude oil can be changed into gasoline, diesel oil and kerosene, *etc*. When people need get oil from underground, oil spill accidents can not be prevented absolutely in the manufacture process, especially in offshore oil platform production. After the oil spill happened, the oil spread and turned into oil slick. The oil slick can move or transfer by spread, evaporate, dissolve, emulsifying, photolysis, and biodegradation and absorption which can pollute air, water and soil. [6] In July 16, 2012, the Marine Affairs Bureau of Liaoning Province in China arranged 9,000 meters long oil contain boom to limit the oil floating in an area. [7]

People choose methods to treat the oil spill. The tradition methods include oil barricade, burning and spraying chemical reagents, most adapted the oil contain boom to collect the oil on the surface of the ocean as soon as they can. [8] They must cut the pollution source at once to prevent the polluted area expand. Because the crude oil will separate into gas, liquid and emulsion by wave action, and the emulsion should not disappear in short time in ocean while it does great harm to birds and fish. In last three decades, many investigators have studied the transport and fate processes of oil spills based on the trajectory method. Sometimes people used materials which can absorb oil and oil spill dispersant to clean the sea water.

Biological methods are trying in test stage and some of them need a long time to dissipate the oil. Oil spill dispersant can disperse the oil slick into small and mini balls to promote the decomposition of oil or settlement. But it perhaps leads the second pollution and just can be used while clean a small amount of oil. This method is not agreed by more and more people because it perhaps polluted the ocean as well as it is not cheap. This method can only clean a little amount oil. Although the method may have some bad effects, it can clean the emulsion which is very difficult to clear up. The two methods we stated above cannot be used in mass collecting work. [9]

Now, people often used physics or mechanical method popularly in accidents. After one accident happened, oil barricade were often used to prevent the oil slick spread to all directions and pollute larger water areas. Oil barricade is one type of isolation floating on the sea to limit the oil spread. Oil absorption felts were used in many accidents, and the pump was used to get the oil water. At the same time, water cascades and oil scrappers were used to collect the oil slick faster. The separator separate the oil and water by separate the two different physical characteristics and bump the oil into storage cabin to wait for the reuse on the seashore. The water separated from oil-water will return into the ocean and oil will be recycled.

People used oil absorption felts to absorb oil before oil spill dispersant. Also this method can clean the water faster than machinery, the materials which absorbed oil is difficult to recycle the oil for reuse. Oil absorption felts always sink into ocean in working time and cannot salvage from the bottom of sea. This equals to make a new pollution in the ocean. Finally, oil absorption felts will be thrown away on land.

The general cleaning methods in the world are burn and abandon to let the oil disappear in people's view. It can clean 50% to 90% oil floating on the sea. The burn method suits to the oil slick height over 2mm on the sea. When the burning finished, there are many balls of a type of tar floating on the sea to wait people collecting. But the shortcomings are obviously that the burn will pollute the air in a great area. In the end, it may destruct marine life greatly. [10] All these methods are physics methods, and people should recovery the oil spill to deduce the lost of oil leakage. So it can be concluded that the effort shall focus on the oil recovery ratio after an oil spill happened. The main task is to collect the lighter liquid oil-water and emulsion. Collecting by machine is a good, quick effect method which made lightest ocean pollution and no remaining problem to marine environment. Until today, there is no better method than recovery the oil.

In people's image, the dirt floating on the water is easier to be collecting than it at the bottom. But oil slick was difficult to collect when the boat follow the trace. Because the oil slick is on the surface of ocean, it kept moving with the surface wave constantly. To get the oil more efficiently, we shall make a model for the oil slick moving on the surface wave so that a machine include a smart system can collect the oil slick. The most important technology is that the collecting action must fit the moving water as the boat driving forward.

2. Analysis of Oil Slick Characteristics

2.1. How the Marine Oil Spill Happened

The oil spill came from tanker traffic, offshore drilling and accidents. And accidents are the most famous in the all because ocean oil spill kept long time and led serious consequence as marine pollution. After the completion of an exploration well, it is customary to seal the wellbore annulus and the casing from the reservoir until such a time when production is to begin. This is done so that the flows of hydrocarbon (oil & gas) into the casing can be restricted, preventing inflow towards the well head.

According to documents provided by Haliburton's (cement company) cement engineer, the cement slurry had about 55%-60% nitrogen (by volume) in the slurry at surface; with hopes that at the bottom of the hole (with 1000psi injection pressure and temperatures above 150F) the cement foam will have a quality of 18%-19% nitrogen (by volume). And the shoe track is a mechanical barrier that consists primarily of a float collar, 2-track valves and shoe track cement. It is designed to prevent back flow of hydrocarbons into the conversions that take place. The blowout prevent is an integral structure that is part of the drilling system, which named BOP in brief. It is placed on top of the wellhead, with several devices that allow its operator to maintain control of the well while oil, gas and other drilling fluids flow between the riser pipe and the well below. [2] Once the cement or the shoe track or BOP had failed to seal the well, the oil was gushing out at several locations. Another path which caused the leakage is the transport leakage such as pipes and boats. An ordinary polluted cause is produced water in the product process. All these processes can lead a crisis to the ocean.

2.2. Oil Slick Characteristics in Surface Wave.

In ordinary thoughts, the dirt floating on the water is easier to be collecting than it at the bottom. But the fact is not as the image. The crude oil will separate into gas, liquid and emulsion soon by wave action in few days after oil spill happened. At the time, people should collect the lighter liquid oil-water and prevent the oil slick turn into gas and emulsion. But the collecting speed could not get up with the separate speed. Marine oil spill is more difficult to control due to lager open area without the inhabited. Oil slick shall be recovery in a hurry to deduce the lost of oil leakage after an oil spill happened. In the collecting process, asphalt is a great trouble in the ocean and it can stick things anywhere so the storage cabins were stuck by asphalt on the oil spill area. With the time going on, mainly of the floating oil residual material is tar on the sea while it is very difficult to degrade.

When the oil films floating on the ocean surface, it affects the backscattering of water and thus can be detected by Radar-Synthetic Aperture Radar which is microwave sensing with the wavelength. Oil spill tend to have bigger and more coherent black blocks compared with clean ocean surface. [12] While oil floating on the surface, it make the ocean surface relative calm and smooth, lead to a different surface texture of Radar. The more heavy oil in ocean, the more difficult degraded it

is. If there is more salt in the sea water and fewer nutrients, the decomposition will be slowly. [13]

In mechanical collecting process, the oil slick flew with the wave so that the machine could not collect the oil in high efficiency. When the machine followed the oil slick, it may burst and tattered in all small areas on the ocean. So the clean process was always long for follow the oil slick in one area within few days.

2.3. Troubles in Cleaning.

Oil spill tends to have bigger and more coherent black blocks compared with clean ocean surface on the figure of instrument which adapt data from Radar. But not every black block in the ocean is oil slick. Sometimes the oil blocks are separated in one area and turned into large curved blocks and result into fewer blocks. In the sea, the oil spill undergoes weathering over time, making treatment much more difficult. [14]

As we know, the crude oil will separate into gas, liquid and emulsion by wave action in few days, and the emulsion should turn to dark blocks. Finally, the floating oil slick is only tar existing on the sea. And tar is very difficult to degrade in the ocean. On the contrary, asphalt is the most effective thing that it can stick water birds' feather and leads them dead for no food on the oil spill area in the ocean. It is difficult to collect because the tar sticks storage cabins. The tar has the smallest value compare to other oil slick compositions. The moving waves and limited information effected on the oil slick will keep a long term remediation process. For example, the Florida oil spill in Massachusetts in USA was still detectable 30 years after the incident. Some efficient and environmental-friendly methods for treating oil slick are necessary to Human beings.

So it can conclude that the effort shall focus on the recovery of oil after an oil spill. Experts introduced a large-scale collecting work to clean the oil slick. If the machine can "grasp" the oil slick in high efficiency, the machine can recover oil in a high speed. The recovery oil should be treated in time while the useful composition retained. The oil collecting boat used absorb machine before the oil pollution began to disperse in a larger area. The key movement is to draw the oil from oil water in the boat cabin. When the collecting efficiency is much higher than before, the collecting machine is successfully. How to get the oil slick on wave is a nuclear of the collecting movement analysis. Thus we must study the surface wave of ocean.

3. The Analysis of Surface Wave Flow

Ocean is a large area and the water flows to the coast every minute. It is important to note that advection forces are independent of each other so that the wind and waves can act in the direction same or opposite to the tide. The amount of time that each particle remains on the surface layers is, in turn, determined by the balance between the buoyancy and the vertical diffusion rate. Therefore, droplets of higher buoyancy spend proportionately more time on the surface currents. The spreading of the oil slick is a three-dimensional process controlled by the droplet size distribution adhere diffusion processes. [15]

Delvigne (1994) and Delvigne and Sweeney (1989) conducted a series of laboratory investigations and found that the distribution of vertical diffusion oil droplets' diameter was a normally distributed random number with a mean value of 250μ m. [15]

When we observe the oil spill in wind, we can conclude some special. Ocean wind-generated gravity waves (henceforth simply referred to as waves) give rise to near-surface velocity known as Stokes drift (SD) (Stokes 1847) which can contribute significantly to the near-surface transport of mass. This drift can also be

important to the upper-ocean momentum balance since temporal and spatial changes in the SD give rice to fluxes of momentum into the Eulerian mean flow. Finally, SD influences upper-ocean mixing through the induction of so-called Langmuir turbulence. [6] Many processes, such as advection, turbulent diffusion, surface spreading, evaporation, dissolution and emulsification, may influence the transport of oil spill shall follow the drift moving. What we study is the law of oil spill follows upper-ocean wave as turbulent or another flow.

On the practical side, it is particularly important for accurate transport predictions and/or analyses of plankton, pollutants, larvae, oil spill, and search-and-rescue operations. The surface SD is persistently high over both seasons at the Southern Ocean storm belt over the path of the Antartic Circumpolar Current (ACC). Wind-sea waves under growth and highly correlated with the local wind field; they have short wave-lengths and slow propagation speed. In contrast, swell travel faster than the local winds; they have longer wavelengths and, as stated, faster propagation speeds. [11]

It is observed that clean water surface tend to be composed by stripes in a certain direction related to the wind, while oil spill surface tend to be composed by round and curved stripes related to the scattering oil droplet. That is, texture of clean water surface tends to have an obvious directionality. Directionality is well known texture feature that can be calculate in horizontal, vertical and diagonal respectively. [16]

Sea waves under growth and brightly correlated with the local wind field; they have short wave-lengths and slow propagation speed. In contrast, dwell travel faster than the local winds; they have longer wavelengths and, as stated, faster propagation speeds. Analyzing the horizontal divergence of the drift transport, the high wave-induced divergence in coastal areas is mainly due to wind-sea whereas high positive divergence areas in the middle of the ocean basins are mainly due to swell. Regions of low convergent wave-induced transport are principally located in the tropics and receive contribution from both wind-sea and swell. Spatial and temporal changes in the Stokes transport are associated with exchanges of momentum between the waves and the mean flow. [6]

The slick spreads over the water surface tension force, while composition of the oil changes from the initial time of the spill. Depending on turbulence, the formation of an oil-in-water or a water-in-oil emulsion may take place. It is assumed that such a formation occurs within days after the initial spill. [17]

Patterns of turbulent dissipation are compared to internal wave generation from winds and tides because internal wave breaking is thought to be responsible for most turbulent dissipation in the ocean interior. These two sources of power have distinct global patterns. The majority of the total global wind power input generates surface waves and mixed layer turbulence. [10] What we want to design is a machine can collect the oil slick more efficiently than ever, while need to know the range of wave change include its direction and wave length. The range is large because of the sensitivity of the calculation to the wind product used.

As we observed, the waves are not the same height and the same wave length in the ocean. But they normally keep changing in a range. In ordinary, the range of wave height and wave length change shall not wide in a term (For example, few hours) in a normal climate when the collecting machine works. So the research range of the wind speed was limited in 2-12m/ s.

The different wind, wave and water flow may act the blocking effect of oil barricade. If the oil leakage happened more or kept destroying circumstance for a long time, people cannot image how bad the world will be. A good system is needed to be using in oil collecting to collect oil slick faster. Our research focuses on oil slick which on the horizon so we shall not give attention to the deep water waves.

Analyzing the data of recorder, the surface of ocean is smooth when the wind is weak. There have been few studies showed the oil spill flew with the surface wave by low speed when the sea waves had short wave-lengths and slow propagation speed.

When liquid was limited by a Newton friction, it is obey the Navier-Stokes equation

$$\rho \frac{Du}{Dt} = \rho\left(\frac{\partial u}{\partial t} + u \bullet \nabla u\right) = \rho f - \nabla p + \mu \nabla^2 u \quad (1)$$

In the equation, f is the mass power.

If the liquid molecular forces field obeys Newton friction law, it means the liquid particle move equation. The friction force should show a fight to all sorts of Kinesiology differences so it will not resist to tangent sliding direction. [17,18] If the friction force is seemed as acted in liquid molecular force field, the force should react any dynamic differences in all styles and should not react against the only one which sliding along single in tangent direction.

According to Newton friction force law, if the liquid particles had exact material meaning, the equation about particles and adjacent materials is

$$\sum = \mu \nabla u \quad (2)$$

Non-zero viscosity means inviscid flow in some parts of flow field. And the explanation is that the ideal liquid has no react deformation. By the way, the opposite movement in any direction will lead different action.

Study the global data of the flows, there are some change in wind field. On the practical side, it is particularly important for accurate transport predictions and/or analyses of plankton, pollutants, larvae, oil spill, and search-and-rescue operations. Sea waves under growth and brightly correlated with the local wind field; they have short wave-lengths and slow propagation speed. In contrast, dwell travel faster than the local winds; they have longer wavelengths and, as stated, faster propagation speeds. [11] Our research focuses on the surface of oil slick so we shall not give attention to the deep water waves.

The surface SD is persistently high over both seasons at the Southern Ocean storm belt over the path of the Antarctic Circumpolar Current (ACC). [11] Patterns of turbulent dissipation are compared to internal wave generation from winds and tides because internal wave breaking is thought to be responsible for most turbulent dissipation in the ocean interior. These two sources of power have distinct global patterns. The majority of the total global wind power input generates surface waves and mixed layer turbulence.

When the wind is slightly, the wave flows calm, the water in the ocean can be regarded as a simple liquid. The oil slick has viscous when spreading in the sea. One research about oil spill showed that the floating oil was generated by breaking waves by wind. The shape of the spill will depend in whether the oil was released from a stationary object or from a moving ship, the amount of oil involved, and the wind and current history between the release and the image acquisition. Wind and current have created one clear and one more diffuse edge of the spill. [8]

Can we suppose that the wind can help the oil slick turned thicker in one direction? In wind speeds below 2-3m/s there is no backscatter from the sea surface and hence no signature of oil slicks. Thinner oil will be invisible due to oil-spill dispersion. Thick oil can be visible in higher wind speeds as well. We can see that the wind force shall make the oil slick turn thicker in one direction, but not very obviously.

In a flow field, at any time and other limited time interval, the liquid particles should not permit any destroy to the principle which the flow must spend the lowest energy. This is the famous Least Action Principle. It is suitable to explain the water

keeps a constant speed in sometime in vortex. So the oil water flow must spend lowest energy by keeping a constant speed when there is no other outside force. Because any change shall use more energy and the different direction shall lead particles to conflict each other while spend more energy. The minimize cost of energy is keeping a constant speed in one direction in a flow field.

What we need to do is let oil slick flow into vessel and return the water out in the machine.

Ignored all height change among the waves, the waves are marching to seashore as a stability average speed.

So, essentially, when we ignore the effecting of the wave height, the simple liquid moving rule is as a laminar flow:

$$V=u \tag{3}$$

In this equation, the vector v means the reality moving speed distribution of liquid particle, and the Navier-Stokes equation is a detail but real describe to liquid particle moving. And u in the equation is the macroscopic speed of the liquid. [13] Oil slick followed the ocean flow with speed v and along the surface wave's direction. So the collecting machine can adjust collecting part according to this equation for higher efficiency.

The key technology about oil spill collecting is how to get the oil slick on wave. The collected oil should be treated in time while the useful composition retained. When the drift main regularity of surface wave can be recorded, the oil slick should follow the drift moving. And the collecting machine will be designed.

When we considered to collect the oil slick, we must considered all the characteristics of oil and the wave statistic data, the differences for the machine design appeared in front of us.

4. The Design of Smart Model

4.1. The Goal of the Collecting System

After analysis the surface wave, we can conclude that the oil slick follows surface wave in a constantly moving speed. If the collecting part is under a floating part which is on the ocean surface, the collecting part will work efficient so it can collect more ratio of oil slick and few of water. When we considered the differences for the machine, the design appeared need more flexible smart control system and calculate parts to apply the wave change. The machine shall be convenient to operate and get more oil to recycle.

For this purpose, the collecting machine was consisted of three parts and all actions will be finished by automation control system put buttons on control panel. All the parts in the machine shall be controlled with a flexible smart system to adapt the changing surface wave in the ocean. Part one in the design is the control system which has a smart "head" to adjust the collecting part's position and collecting movement speed. The second part is the drive control part which can adjust the move speed to get the oil. It will be combined with the boat driving system so that easy to observe and operate by people. The third one is cleaning part and the main part is a collecting plate which can collect oil water in the boat cabin in the bottom of boat.

When the oil water and emulsion entered the boat cabin, the oil ratio in the cabin will increase and the oil slick will be thicker in the boat cabin. Thus we are easy to recycle the oil from the oil water while the collecting plate is keeping under the wave but squeeze water surface.

As was stated above, the oil slick shall follow the ocean drift flow moving and move to one direction in a short distance. We shall collect the oil slick with a

stability speed in another direction. The design model is easy to operate with a flexible structure which has periodic output feedback control method.

The system consists of actuator, controller, sensor and the auto control system can be controlled by people in urgent time. All these design details are prepared for changing waves and the collecting plate can adjust to collect oil slick below the water. By the way, when the boat cabin in the bottom of boat are full of oil water, the machine will give signal to people and transfer the oil water to seashore to recycle oil in time.

4.2. The Smart Sensors in Control System

Smart sensor refers to those elements containing sensing and signal processing capabilities and understanding, with objectives ranging from simple viewing to sophisticated remote sensing, surveillance, search/track, robotics, perceptronics and intelligence applications. The smart sensor is expected to have the capability that functionality and architecture, as well as raw data acquisition, are based on the existence of a microprocessing unit.

In the control system, sensor networks need to be fast, easy to install and maintained and self-adjusting to pervasive platform. That is smart environment which enable to fit the wave change. So the machine can be a smart machine. Smart machine which stresses the creation, stand-alone systems uses embedded processors. Within this goal, it is important to remain current in new sensors, actuators and interfacing methods which are being introduced at a rapid pace with a trend towards lower cost and higher performance. [19,20] An appropriate integration which combined mechanics, electronics and information got successful products and experimental systems so we can choose the stand-alone system to give the order to the machine. [21]

The collecting machine design needs sensors to adjust the position of the collecting part all the time so that the machine can collect the oil water below the oil slick. So we use position sensors to control the collecting part up and down while detecting the part status. To get faster ad more efficient data for people to analyze and give command, each position sensor should be packed on a single chip to send signals. Another type of sensor is the force sensor. When the boat is moving forward along the trace of oil slick, microprocessor-based boards on sensor was inserted into the collecting plate can send data to the control system. This sensor requires power supply rails of high integrity, even under extreme conditions because the ocean climate changes and the machine may be used in bad condition such as high speed wind and wave. A larger VSNS drop in RSNS results in an easier-to–measure differential signal, and reduces the severe requirements of offset voltage and common-mode rejection of the instrumentation amplifier. On the other hand, a smaller VSNS increases the complexity of the instrumentation amplifier, but also provides more voltage to the load. [19] Usually, inputs to instrumentation amplifier need to be level shifted down to system operating voltage levels. At the same time, the control system has a feedback circle to give alarm to people in case of the accident of machine.

In the control system, the force sensor gives signals to the control center to show the load on the collecting plate and another type position sensor give signals to show the oil water levels in the boat cabin on bottom of the boat as Figure 1.

5. The Composition of Collecting Machine

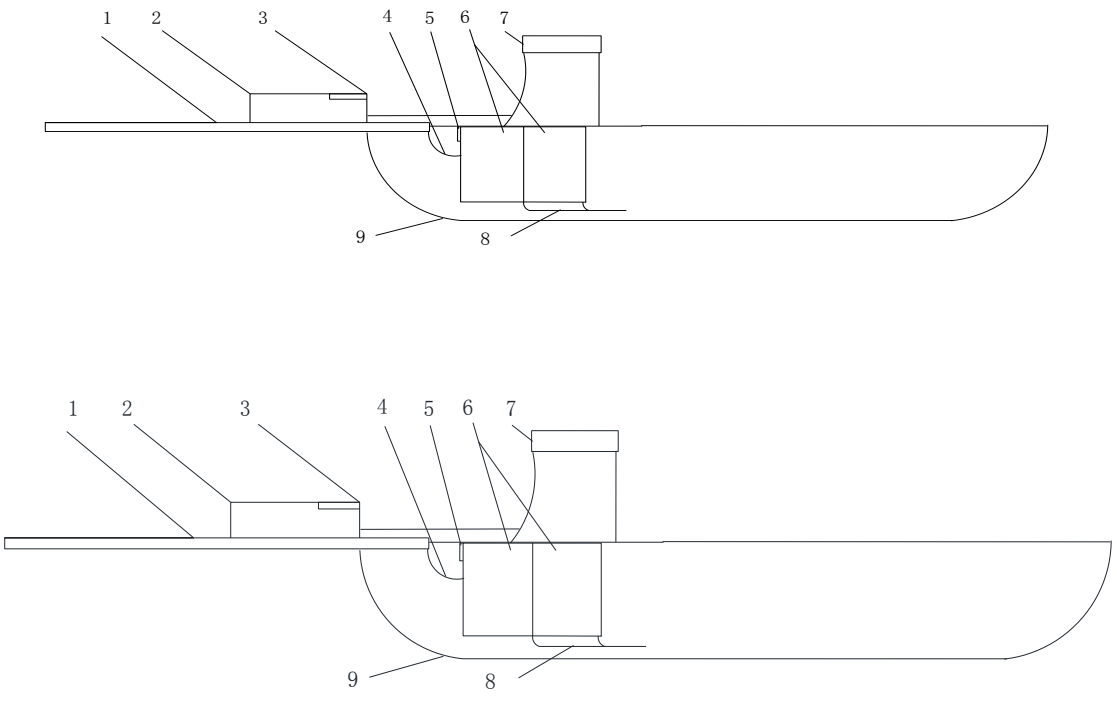

Figure 1. The Design Sketch Map of Collecting Part and Sensors in Collecting Machine

(1. The collecting plate 2. Floating 3.Position sensor 4.Oil water pipe 5.Force sensor 6. Boat cabins 7.The control system panel 8.The drain pipe 9.The bottom of boat)

As was stated above, part one in the design is a control center of boat which has a smart "head" to adjust the collecting part's position and collecting movement speed. The second part is the drive control part which can adjust the move speed of boat to get the oil. The third part is cleaning part and the main component is a collecting plate which can collect oil water in the boat cabin in the bottom of boat. We can see there are a few numbers in Figure 1. The collecting part is under a floating part which is on the ocean surface. The number 1 is the large plate which can collect the oil slick by a few guide-slots on it and the number 2 is a floating. The position sensor 3 put in the floating face plate so that it can send signal to the control system in control box 7. The position sensor 3 will used to show the position of collecting plate 1. And the big floating 2 which supplies enough buoyant force and keeps the collecting plate close but under the wave surface to collect the oil slick on the sea and the emulsion in water.

According to the figure 1, the design has a big plate to collect the oil water automatically and the collecting part will work efficient as it collecting more ratio of oil slick and few of water. It can make the oil slick and little water through the guide-slot into oil water pipe (number 4 in Figure 1) connecting boat cabins. As we stated above, while oil floating on the surface, it make the ocean surface relative calm and smooth. So the collecting plate can get more oil for the calm and smooth wave indeed. If the plate can not keep in the proper position, the guide-slot is under

the water surface deeply. This can make the cabin full with sea water but little oil. It is one reason why the old machine did collect oil slowly and the oil slick kept floating on the sea in past years. The number 5 representative force sensor in the boat cabin and send signals with press increasing to the control system. So we can see all the signals are given to control system by 3 and 5.

Anyway, the design considered the wave height and using a large plate under a float to keep the position still, when the boat moving forward, the wave must affect the collecting process and more water than oil slick enter the boat cabin.

The machine shall use something to solve the problem and get more oil not water on the ocean. This time we adapt another method at the boat cabin to finish a mini cycle in the sea.

When the oil water is full of the boat cabin, the sensor shall give a signal to operator plate, and the switch will be turned on after the oil water in cabin were kept still for half an hour. Thus the water and oil will be calm and some water shall depart from the oil slick. So the oil water in boat cabin shall be floating oil and water in two layers. We set a switch in each cabin and it can be turn on or off by manual control. The number 8 representatives the drain pipe at the bottom of the boat cabin. When the drain pipe's opening is open, the water at the bottom of boat cabin flow into the ocean slowly by bump but the oil slick is still floating on the oil water in the cabin. This can make the oil slick be thicker in the cabin than before and recyclable few times until the oil is a large proportion in the cabins. By the way, the oil water cannot be drained much each time (to prevent the oil slick mixed with water go back to the sea), and the cabin can pour into more oil water after draining.

If there is no other type of sensor, people should take sample water from the boat cabins and see how much the oil slick and emulsion in the bottle while we want to decide if the draining repeat. A better design is that deposit a sensor to show the oil water proportion and know the number change at any time.

Now, when the oil collecting boats is working, some of them had used this method to get more oil. But they haven't use sensors to control the position of collecting plate and just pump oil water into the cabins. The collected oil water in boat cabin includes much water. So the collecting is in low efficient and the boats should go back to seashore many times to drain the oil water.

In the end of the recycle term, the oil wiper must be used at the collecting plate and guide-slot to clean the oil. It can keep the machine part clean and prepare for use next time.

6. Conclusion

This paper has discussed the oil slick collecting methods and surface wave characteristics; design a smart control system for the collecting machine. If the machine recovery the oil slick faster, the marine oil pollution can be reduced. Anyway, in this decade, the oil spill and produced water at oil platform will keep pollute the marine environment in product process. Although the collecting machine need analysis the friction of oil slick on surface wave, the move speed is the most important element in the equation (1).

Many people had done the research about the oil slick harm, collecting materials and the cleaning methods. As we stated in the paper, other research observed the oil slick flow in macro angle that they analyzed the flow moving in a great area in the sea. Some reports gave wind-sea waves changing in maps. Some reports showed the tidal currents in one area. One research of oil slick proved that the oil slick moved vertically and simulate the moving in the water column due to the buoyancy on the water surface. In same time, there is no new collecting machine design to improve the oil collecting efficiency.

Compare to other research reports about oil slick, this design focuses on the oil collecting ratio and add a smart control system to adjust the position of collecting plate. The machine design is based on the research of oil slick fluent law and surface wave flow. At the same time, the design focuses on oil slick characteristics for the collecting control. The waves are not the same height and the same wave length in the ocean, but they normally keep changing in a range. A realistic smart control system can make the collecting plate adjust the position in the wave to get more oil and the drain pipe in the boat cabin can make the collecting efficient increase once more. It is a useful design model to clean the oil slick on the ocean. To get a satisfactory result, a simulation model and tests in small area shall be used in research. Numerical simulation and test will be tasks in the future.

References

[1] W. Kang and Z. Wei, "The Methods of Oil Spill and Collecting on Ocean", J. The World of Clean, vol. 28, no.11, **(2012)**, pp. 29-32.
[2] L. Kolawhole Osi, "BP's Horizon Oil Spill: Engineering Failures", D. Environmental & Economic Impact, **(2011)**, pp. ii-33.
[3] L. Qieni, G. Baozhen and Y. Wenda, "A Method for Measuring the Thickness of Transparent Oil Film on Water Surface with Laser Trigonometry", J. Laser Eng, vol. 49, no. 1, **(2010)**.
[4] C. Cai, S. Jiao and Y. Yin, "The petroleum pollution situation and preventive measures about near rock area in Chinese sea", J. Chemical Technology and Development, vol.41, **(2012)**.
[5] T. Xiao, "An Ozonation Treatment System for Oil Spill", D. UMI Dissertation Publishing, **(2012)**, pp. 4-27.
[6] A. Carrasco, A. Semedo, P. Erik Isachsen, K. Hakon Christensen and O. Seatra, "Global Surface Wave Drift Climate from ERA-40: The Contributions from Wind-sea and Swell", J. Ocean Dynamics, **(2014)**.
[7] A. Berry, T. Dabrowski and K. Lyons, "The Oil Spill Model OILTRANS and Its Application to the Celtic Sea", J. Marine Pollution Bulletin, vol. 64, **(2012)**.
[8] B.H. Rissik, "Recovery of a Freshwater Wetland for Chemical Contamination after an oil Spill", J. Environ Monlt, vol. 13, no. 3, **(2014)**, pp. 713-720.
[9] C. Wu, Editor, "Hydraulics", Higher Education Press, Beijing, **(2003)**, pp. 88-168.
[10] J. P. Pietroski, J. R. White and R. D. Delaune, "Effects of Dispersant Used for oil Spill Remediation on Nitrogen Cycling in Louisiana Coastal Salt Marsh Soil", J. Chemosphere, vol. 119, **(2015)**, pp. 562-567.
[11] B. Yang, "Turbulence and Reconstruction of Theoretical Fluid Dynamics", Shanghai Jiaotong University Press, Shanghai, **(2003)**, pp. 57-93.
[12] X. Zhang, "Discrimination Marine Oil Pollution by Using Ocean Water Surface Texture", J. 978-1-4244-9171-1/11 20, **(2011)**.
[13] A. F. Waterhouse, "Global Patterns of Diapycnal Mixing from Measurements of the Turbulent Dissipation Rate", J. Journal of Physical Oceanography, **(2014)**.
[14] M. Jian and L. Liu, "Texture Image Classification Using Perceptual Texture Features and Gabor Wavelet Features", Asia Pacific Conference on Information Processing, **(2009)**, pp. 55-58.
[15] S. Wang, Y. Shen, Y. Guo and J. Tang, "Three-dimensional numerical simulation for transport of oil spills in Seas", J. Ocean Engineering, vol. 35, **(2008)**, pp. 503-510.
[16] Y. Ng, "An Environmentally Friendly Approach to Treat Oil Spill: Investigating the Biodegradation of Petrodiesel in the Presence of Different Biodiesels", J. Journal of Fuel, vol. 139, **(2015)**, pp. 523-528.
[17] H. Bi and H. Si, "Numerical simulation of oil spill for the Three Gorges Reservoir in China", J. Water and Environment, **(2014)**, pp. 183-191.
[18] H. Wang, T.-Z. Huang and Y.-Q. Du, "A Global Minimization Hybrid Active Model with Applications to Oil Spill Images", J. Computer and Mathematics with Applications, vol. 68, **(2014)**, pp. 353-362.
[19] D. E. Suarez, "Smart Sensors and Sensing Technology", Published by Nova Science Publishers, Inc. New York, **(2010)**, pp. 5-15.
[20] J. E. Shigley and C. R. Mischke, "Mechanical Engineering Design", Published by China Machine Press Beijing, **(2011)**.
[21] D. G. Ullman, "The Mechanical Design Process", Published by China Machine Press,**(2012)**.

Author

Chunhui Lu, she exchange scholar to USA in 2008-2009, a lecturer in School of Mechanical-Electronic Engineering in Hohai University, China; research on machine design, compressor, mechanical-electronic system and nano materials.