Oil Spill in the Form of Tar Ball  
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Abstract. This research is focused on the collection of oil spill especially from the offshore drilling exploration which includes discharges and accident spills from the oil field operation. The methods for collecting the oil spill rely on the oil characteristics. The properties of crude oil from a drilling operation were subjected to the well. The crude oil from the offshore wells located around Kepulauan Seribu had been tested in the laboratory. The result shows that the oil from two wells has different characteristics and that the oil becomes solid whenever it contacts with water or in the ambient temperature at less than 28 °C. The oil spill from these wells that become solid is known as tar balls. The review on the available method and equipment for combating the oil spill in the form of tar balls such as containment, collection and recovery are presented. It is found out that all the current equipment which includes an oil boom could not handle the tar ball effectively. A simple design of a tar ball collector based on the fishing net is proposed.

Introduction

The energy consumption increased as the industry and population developed. The main source of energy is fossil fuel. The exploration of fossil fuel involves many investors with a huge amount of investment. A process for exploring this untapped oil can be done both on land and at sea. These activities increase the contamination probability.

Contamination occurs due to the blow out of wells, leakage on the pipeline or tanker accident. Based on internal report of a multinational oil corporation in the year of 2010, the oil spill was roughly about 100,000 barrels per day [1]. Losses due to this very large oil spill not only reduce the company profit but also damage the environment and it will propagate to the economic aspect of the local community and its sustainability. At sea, the influence of pollution or the impact of the pollution can be greater than that which occurs in the mainland. Within five minutes the spread of the pollutants in the ocean can pollute larger area if it is not handled and recovered properly. Examples of significant impact include the occasion of crude oil spill that caused failures on shrimp farming in Indramayu over 700 hectares [2], or the one that happened along Kepulauan Seribu sea shore [3]. Oil spill disaster that was more severe also occurred on April 20, 2010, that is the burning and sinking of an offshore oil exploration platform in the Gulf of Mexico approximately 64 km from Louisiana, United States. Platform Deepwater Horizon owned by the British Petroleum, one of the world's largest oil company and also the largest producer of oil and gas in America. Similarly, the hit of Montara oil well that took place in the Timor Sea in 2009, contaminated the surrounding marine environment. Although there has been a special team for tackling the case of pollution of waste oil, sometimes it still finds difficulties in the field. This is due to various factors including weather condition, the nature and types of waste oil and also the tools and equipment used in combating the oil spill cases. Fast and good handling of oil spill will reduce the impact of the destruction to the existing ecosystem.
Research Method

Crude oil from wells was investigated to determine its properties. From the laboratories result, the properties of crude oil are presented on a table. Method for separating oil from water was classified to find out the suitable methods for combating oil spill. Among the methods, it is found out that none of them is suitable for the specific oil spill. Problem of the research is shown in Fig. 1. The proposed design is based on traditional fishing net.

![Research Method Diagram]

Result and Discussion

Crude oil from two different wells was brought to Indonesian Oil and Gas Institute laboratory and was analyzed. The result is presented on Table 1.

Table 1. Oil Properties of two wells

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Oil from well I</th>
<th>Oil from well II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spesific Gravity @60°F</td>
<td>0.8607</td>
<td>0.8579</td>
</tr>
<tr>
<td>Viscosity at 122°F (50°C)</td>
<td>31.07</td>
<td>18.73</td>
</tr>
<tr>
<td>140°F (60°C)</td>
<td>18.06</td>
<td>12.37</td>
</tr>
<tr>
<td>82°F (28°C)</td>
<td>Solid</td>
<td>Solid</td>
</tr>
<tr>
<td>Pour point °F (°C)</td>
<td>110(43)</td>
<td>100(38)</td>
</tr>
<tr>
<td>Asphaltene % wt</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Wax % wt</td>
<td>21.9-41.32</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1 showed that whenever oil spill occurs from these wells, tar balls will form. Tarballs are often found in the ocean, either on the side or in the middle of the sea. Tarballs are small pieces that are dark colored. Tarballs are remnants of oil spill that floats above the sea level and have undergone changes in characteristics. The form of tarballs is shown in Fig 2.
Tar balls themselves occur due to the lighter components of the oil to evaporate away. At the same time, crude oil is mixed with water to form an emulsion, or often to look like chocolate pudding. This emulsion is thicker and stickier than the original oil. The wind and the waves constantly stretch and tear it into small pieces of oil or tar balls.

There are three phases on oil spill mitigation efforts in tackling oil spills at sea as shown in Fig 3.

![Figure 3. Oil spill mitigation efforts](image)

Containment is only the first act when oil spills at sea. This is useful so that the oil spill has not spread into the wider area caused by wind and waves. The most common type of equipment used to contain the spread of the oil spill was floating border known as oil boom.

Oil boom as shown in Fig. 4 is a floating barrier designed to contain the spread of the oil spill on the surface of the sea. Oil boom is the equipment used for the first action when oil spill occurs. There are three types of oil boom i.e inflatable boom, solid floatation boom and net boom. These booms could not collect tar balls. Tar balls could pass through the barrier as ocean waves push the tar balls far away. These boom was reported that they work well on a very calm water such as in lake or pond [6].
On the stage of collection, the oil spill has been localized by using the oil boom, later it is collected by the oil skimmer or sorbents. Then the oil spills are kept in the storage tank. An oil skimmer is a mechanical tool that has the ability to separate the oil from the water and transfer the oil spill into temporary storage tanks until further proceedings. The level of effectiveness of the oil skimmer depends on the type of skimmer, water conditions and type of oil. The oil skimmer is divided into three types according to how it works, among which are oleophilic skimmer, weir skimmer and vacuum skimmer.

Oleophilic skimmer as shown in Fig. 5 uses a belt, chain or mop disc made of oleophilic oil to diminish oil on the surface of the water. Skimmer had also failed on collecting tar balls which are very sticky and impede the belt, chain or mop in working continuously.

Weir skimmer as shown in Fig. 6 works based on the basic principles of weir and dam that is placed on the border of water and oil. It will let the oil that floats above the water pass through the weir so that oil will fall into a gathering space and then pumped to storage tanks in the meantime. The same condition as oleophilic skimmer, weir skimmer had also failed on collecting tar balls because tar balls would obstruct the weir.

Vacuum skimmer works like a household vacuum cleaner. Where the oil is smoked through the inlet and pumped into a tank of temporary shelters. Tar balls would block the inlet of vacuum skimmer.

Sorbents as shown in Fig. 7 is a tool that can absorb the liquid and is commonly used in the process of collection or recovery. Sorbents is made from polypropylene material or cellusorb where the material can be removed with water. Sorbents would also fail to collect tar balls for sure.
Recovery is the process of recovering the oil spill which had previously undergone the process of containment and collection. Most of the recovery process uses the oil dispersant. Dispersant is a kind of chemical substances that are composed of active ingredient. It is known as solvents and surfactants. Solvent molecules are composed of carbon chains that have in common with organic oils and greases, meanwhile surfactants have an affinity with water. These properties make the oil into smaller parts and will sink to the ocean floor and will bio-remediate by micro-organisms. As the tar ball is relatively bigger than dispersant it could not dilute tar balls.

A simple design of tar ball collector was inspired by a conventional shrimp net fishing. The proposed design to collect tar balls consists of nine components which are hinge clamp, long support, holder, net frame, main ring, net ring, pulley ring, clamp and net. The tar ball collector will simply be mounted to the ship through a hinge clamp. The net with 24 rings will hang on the net frame. The net frame will be connected to a long support using the main ring. Tar ball will be swept and will enter the net as the ship sails. If the net is full it will be pulled using a pulley through the net ring [9].

**Summary**

Property of oil depends on the sources of oil; in this case it is the well. The oil from two wells which are located near Kepulauan Seribu have such a unique characteristic that it becomes a solid form whenever it contact with water. This solid form is known as tar ball. Combating the oil spill in the form of tar balls have been investigated applying the available methods. However, they did not work well. Therefor a proposed design of a tar ball collector has been presented. Further studies on mechanical analysis of this design need to be done.
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References