



Identity of Handling Water Pollution Caused by Petroleum Pollution in Indonesia by Adsorption: A Review

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ABSTRACT

Indonesia is a maritime country known for its vast territorial waters of sea, reservoirs, rivers, lakes, and bays compared to its land area which makes Indonesia rich in natural resources of sea and other waters. However, many problems are faced when preserving the sea such as marine pollution in the form of petroleum spills which are very dangerous for marine ecosystems. Therefore, there needs to be a handling effort to overcome this. The purpose of this research is to provide information about handling by adsorption to overcome petroleum pollution. The preparation method is carried out by analyzing articles from various literature sources such as journals, scientific papers, report books, and Google Scholar. The conclusion is that the treatment that can be applied to overcome the pollution of the sea and other waters due to petroleum in Indonesia by adsorption using activated carbon cassava peel, cocoa pod skin, water hyacinth, banana peel, and banana stem is classified as effective, efficient and economical management and has its advantages in reducing the levels of parameters contained in petroleum waste.

Keywords: Adsorption, Petroleum, Handling, Pollutants

INTRODUCTION

Indonesia is a maritime country known for its vast marine waters compared to its land area, which is about 2/3 more than its sea area. The vast area of Indonesian waters causes a lot of potential waters that can be utilized and managed for natural resources such as high-potential fisheries and mining. This is what makes Indonesia known as rich in water resources. Therefore, the condition of Indonesian waters must continue to be maintained and preserved both in terms of marine areas and coastal areas.

The marine problems faced by the people of Indonesia today are many regarding marine areas, especially coastal communities. One of the problems often faced is the existence of marine pollution caused by various pollutants such as petroleum spills into marine waters. Marine pollution caused by petroleum has a very dangerous impact on the environment, especially for coastal communities because it disrupts community activities and disrupts the availability of natural resources, as well as disturbing the beauty of the sea and disturbing biota in the sea. This is because pollution from petroleum is a carcinogenic and mutagenic compound that can interfere with the health of living things (Astuti & Titah, 2021) (Wardhani & Titah, 2021).

According to Almeda 2013 in Incardona (2011) which states that if oil accidentally enters marine organisms, it will interfere with their organs and can be seriously damaged (Almeda et al., 2013). In addition, (Ahyadi et al., 2021) also stated that oil spills will form a layer on the sea surface due to density differences and hinder the transfer of oxygen from the atmosphere to the water column. Oil pollution in

the ocean is difficult to clean up and takes a long time to handle and manage, especially if the pollution reaches nearby coasts (Chang et al., 2014) (Pradhan et al., 2021). Amffa 2023 also suggested that the impact of waste, especially oil spills, is very influential on coastal and marine waters, especially in direct contact with the ocean. Aquatic organisms are impacted due to fishing activities, marine tourism, and indirect impacts from other environmental disturbances (Amffa et al., 2023).

Petroleum waste contains hazardous compounds and if these compounds are discharged into the environment, they can adversely affect the ecology and the surrounding environment (Kondaveeti et al., 2023). Apart from fishermen's activities at sea, petroleum waste production is also increasing due to global energy needs or demands, so the amount of wastewater produced by the industry is getting bigger. Indonesia has oil refineries scattered in several areas of Java, Sumatra, Kalimantan, and Irian Jaya with a total capacity of 994,000 barrels/day (Jurdilla et al., 2019). Petroleum waste contains many hazardous substances, one of which is phenol, phenol is the most dangerous organic contaminant for the environment (Akkaya, 2022). Petroleum spills can spread due to ocean currents and wind patterns so that petroleum waste can be found far from the spill site (Ahyadi et al., 2021).

Handling of petroleum wastewater can be done in various ways using advanced oxidation technology, chemical precipitation, wet oxidation, coagulation, flocculation, EC technology (Akkaya, 2022) and waste management can also be done using the solar evaporation method, membrane bioreactors using microorganisms, advanced oxidation, electrocoagulation, and membrane filtration (Beni et al., 2023). This research uses the adsorption method. Adsorption is an event of attaching both atoms and molecules of a substance to the surface of another substance due to an imbalance of forces on the surface (Anggriani et al., 2021) (Meila Anggriani et al., 2021). The adsorption process using activated carbon as an adsorbent can occur due to the absorption of petroleum pollutant particles on activated carbon and then into the pores and finally the absorption on the inner wall of activated carbon so that the oil and fat content in petroleum wastewater can be absorbed and decreased (AHDIATY, 2022) (Budiman, 2021).

Based on the many problems caused by petroleum pollution to marine waters, an effort is needed such as handling to reduce these pollutants by adsorption by utilizing organic waste in the form of cassava peels, cocoa fruit peels, water hyacinth, banana peels, and banana stems. This article was prepared with the aim of providing information on efforts to deal with petroleum problems in the sea and other waters. The preparation was carried out by collecting information from various literature sources from several journal articles, scientific papers, report books, and Google Scholar. This article is expected to provide information, descriptions, and analysis regarding the handling of petroleum in waters, especially Indonesian waters.

RESEARCH METHODS

The method of preparing this article is a literature study by collecting and analyzing various literature sources. A literature review is carried out by tracing various references related to the problem of pollution of water areas both seas, bays, rivers, lakes, and others by petroleum pollutants and how to handle them. The sources of literature obtained are from several journals, scientific papers, report books, and Google Scholar published from 2020 to 2023 so that the data and information obtained are the latest and most recent data. Snyder (2019) provides a conclusion regarding literature studies, namely having a big role in becoming a foundation for types of research from the results of literature review can also

receive an understanding of various developments, can bring up new ideas, the most important of which is to guide research in various fields.

RESULTS AND DISCUSSION

Sources of Petroleum Spills

There are many sources of petroleum spills into marine waters, some are intentional and some are unintentional, such as originating from the activities of fishermen who use boats that require fuel oil so that the fuel waste becomes waste in the sea. Furthermore, unintentional collisions and spills result from accidents. Some cases of oil spills in Indonesian waters in the past five years are as follows:

Table 1. Oil spill cases in Indonesia in the last five years

No.	Year/case	Location	Description
1	March 2018	Teluk Balikpapan	The anchor of the KM Ever ship broke a Pertamina pipeline, spilling 5000 L of oil. (Ahyadi et al., 2021)
2	July 2019	Karawang	Kebooran of PHE ONWJ's YYA-1 well (Amfa et al., 2022)
3	August 2020	Kepulauan seribu	Oil spill in Pari island to Tidung island (Putra & Muhammad., 2023)
4	Every year	Bintan Kepulauan Riau	Sludge Oil Spill (Kurniawan.,2023)
5	Three cases	Cilacap Sea	As a result of the Tanker (Purwendah. 2020)

In all existing cases for handling or efforts made when oil spills occur such as the formation of a response team is still relatively weak because the operational mechanism has not been established (Kurniawan, 2023) (Rahmawati et al., 2023). The response efforts that have been carried out tend to be still informative, administrative, and only manual cleaning in the affected waters. Petroleum pollution in one of Indonesia's seas as a result of an oil spill is in picture 1.



**Picture 1. of Pertamina Oil Spill in Karawang Sea
(Image Source: Kompas.com)**

The picture shows several residents making efforts to handle it by manually cleaning pollutants or oil waste using their hands and sacks as pollutant containers. Handling this way can endanger workers doing the cleaning, takes a lot of time, and requires extra energy. Every year there are always oil spills on the beaches of Bintan, Riau Islands Province, one of the appearances is in picture 2.



Image 2 of Bintan Black Oil Waste
(Image Source: Mongabay Indonesia)

The black oil plumes that were visible were the result of the activities of illegal foreign ships carrying out tank cleaning. The ships took advantage of the bad weather to disguise the oil discharge (Negara,2020). The list of Bintan beaches polluted by petroleum waste is in Table 2.

Table 2: Polluted beaches of Bintan Regency

Name of beach	Long	Sacks	Blob	Stephan
Lagoi	42,36 km	25%	45%	30%
Syakera	18,19 km	20%	35%	45%
Berakit	13,22 km	14%	25%	61%
Trikora	27,64 km	1%	10%	89%

Handling steps

Waste oil pollution in waters can be overcome in various ways starting from public awareness that the importance of keeping the sea, reservoirs, or rivers clean at least reduces waste pollution in water. In addition, by processing petroleum waste as well as processing that can be done in Indonesia the adsorption method:

Adsorption uses absorbents that are easy to find and economical, adsorption is carried out to treat petroleum wastewater by utilizing organic waste so that it is more friendly to the environment. This adsorption method is also considered economical because of its low cost and easy maintenance (Septiariva & Suryawan, 2021). The adsorption method in this study used absorbents including cassava peel, cocoa pod skin, water hyacinth, banana peel, and banana stem as raw materials for making activated carbon.

Based on the literature review, adsorption using cassava peel activated carbon as an adsorbent to reduce the concentration of oil, BOD5, COD, sulfide, and ammonia in petroleum wastewater can improve the quality of wastewater with a decrease in pollutant concentration (Kuncoro & Soedjono, 2022). Adsorption using cocoa pod-activated carbon in petroleum wastewater treatment using an H₃PO₄ activator is the most effective adsorption method compared to using 2nCL₂ (Budiman, 2021). Adsorption using dry water hyacinth activated carbon using H₃PO₄ at 600 ° C for 3 hours can reduce COD parameters and also turbidity in petroleum wastewater, COD parameter levels can be reduced by 54.65% for 240 minutes with an absorbent dose of 5g and turbidity levels in the waste can be reduced by 73.82% for 240 minutes with a dose of 1 g of adsorbent. The results of the analysis show that water hyacinth-activated carbon can be used as an effective adsorbent in petroleum wastewater treatment by reducing the levels of COD and

turbidity parameters (Nenohai et al., 2023). Adsorption using banana peel-activated carbon can remove the levels of BOD, oil, and fat parameters from petroleum wastewater. The decrease in BOD parameter levels was 24%, with a dose of 4.5 g of activated carbon for 30 minutes, oil and fat by 97% with a dose of 3 g and 4.5 g of activated carbon for 90 minutes (Rofikoh et al., 2023). Adsorption with banana stem activated carbon as an adsorbent can reduce phenol levels which is a dangerous substance contained in petroleum wastewater, for a percentage reduction of 62% for 30 minutes. Banana stems, cannot adsorb any better because it is still lacking in meeting SNI requirements as activated carbon (Rafdi, 2023).

Table 3. Percentage of parameter reduction for each activated carbon

Parameter	Cassava Peel (%)	Cocoa pods (%)	Water hyacinth (%)	Banana peel (%)	Banana stem (%)
BOD	10	-	-	24	-
COD	7,93	84	54,46	-	-
Sulfide	37,5	-	-	-	-
Ammonia	30,8	75	-	-	-
Phenol	-	92	-	-	92
PH	-	9	-	-	-
Oils and fats	36,95	91	-	97	-
Turbidity	-	-	73,82	-	-

Handling water pollution caused by petroleum pollution by adsorption using organic activated carbon which is easily found in Indonesia is effective, efficient, and economical whether the management is carried out on a small or large scale. The use of different activated carbon, the results of the decrease in levels in each parameter are also different, each activated carbon has its advantages to reduce the parameters contained in petroleum waste. Based on the table of decreasing levels of BOD parameters, it is better to use activated carbon from banana peels, COD is better to use cocoa peels, Sulfide is better to use cassava peels, Ammonia is better to use cocoa peels, Phenol is better to use banana stems, PH is better to use peels cocoa fruit, oils and fats are better to use banana peels and finally for turbidity it is better to use water hyacinth.

CONCLUSION

Based on the findings and discussions from various literature reviews, it is evident that petroleum sources contribute to sea pollution through incidents such as ship anchor falls damaging Pertamina pipes, oil spills, accidents, fuel use by fishing boats, and the increasing output of oil refineries. The resultant marine pollution poses significant threats to the environment, particularly affecting coastal communities by disrupting their activities, depleting natural resources, and harming marine ecosystems. Current water pollution management practices in Indonesia are predominantly manual, focusing on informative, administrative, and legal measures. To address marine pollution caused by petroleum, a viable solution is adsorption, recognized for its effectiveness, efficiency, and cost-effectiveness. Utilizing materials like cassava peel, cocoa fruit peel, water hyacinth, banana peel, and banana stem as carbonates presents distinct advantages in mitigating the various parameters found in petroleum waste.

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