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ANALYSIS OF TOTAL OIL CONTENT IN THE MARINE WATERS OF DUMAI CITY

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ABSTRACT

The Dumai City area is one of the regions currently designated as an industrial zone, a transportation route, and a busy international port. This situation puts significant pressure on the marine waters of Dumai City due to the waste produced. The primary source of marine pollution comes from oil spills, whether from ship operations, offshore drilling, or ship accidents. Pollution from oil spills in the ocean is a significant source of marine contamination that has consistently been a focus of public attention. This study aims to analyze the total oil content, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Total Organic Matter (TOM), as well as the effect of total oil content on DO, BOD, and TOM. The survey method used in this research involves collecting data from DO, BOD, TOM, and oil content measurements. The total oil content in Dumai City waters ranges from 0.14485 – 0.30214 ppm. The total oil content below the threshold still supports aquatic biota and does not damage the ecosystem. The DO content in Dumai waters ranges from 3.6 to 6.8 mg/L, and some measurements are below the threshold required to support marine biota. The BOD content of Dumai waters ranges from 10 to 11.3 mg/L, meaning that biological activity is still within optimal limits. The TOM content ranges from 17.38 – 35.22 mg/L, which does not support the life of aquatic biota, and there is potential for organic material pollution.

Keywords: Marine Pollution, Oil Content, Water Quality

1. INTRODUCTION

The Dumai City area is one of the regions currently designated as an industrial zone, a transportation route, and a busy international port. This situation places significant pressure on the marine waters of Dumai City due to the waste produced. Marine pollution is defined as the presence of dirt or waste resulting from the activities of living organisms that enter marine areas. Sources of marine pollution include oil spills, remnants of war ammunition, waste from ship operations, industrial waste, oil drilling processes, waste from land transportation through rivers, emissions from maritime transport, and pesticide runoff from agriculture. However, the primary source of marine pollution is oil spills, whether from ship operations, offshore drilling, or ship accidents.

The oil content contaminating the waters can disrupt ecosystem activities and biota. As a result, photosynthetic productivity will decline because sunlight entering the water is obstructed. Oil pollutants will interfere with photosynthesis, leading to decreased oxygen levels in the water[1]. Oil that pollutes the ocean is often categorized as floating solids, which float on the water's surface. Oil's natural properties tend to vary in the marine environment, particularly due to interactions with factors such as temperature, waves, and biological activity in the water[2].

Therefore, it is important to conduct research on the analysis of total oil content

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in an effort to comprehensively understand its impact on the marine ecosystem. Additionally, it can provide the necessary information to assess the level of marine pollution by oil and develop effective mitigation strategies

2. RESEARCH METHOD

Time and Place

This research was conducted in March 2024, taking place in the sea waters of Dumai City, Riau Province (Figure 1). And Analysis of seawater samples will be carried out at the Marine Chemistry Laboratory, Department of Marine Science, Universitas Riau.

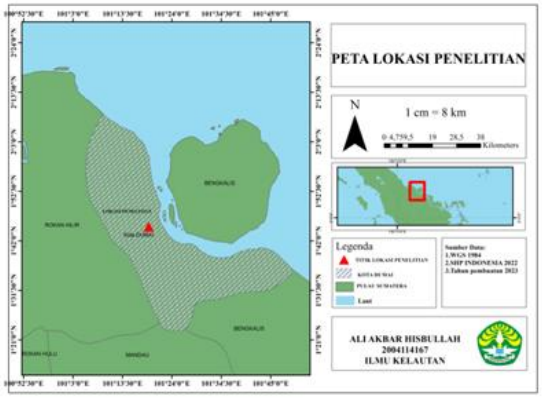

Figure 1. Map of research location

Method

The survey method is used in this research. Primary data collection will consist of measurements of DO, BOD_5, TOM, and oil content. Secondary data will include literature related to this research. The determination of sampling points will be conducted using purposive sampling, which is considered representative of the research object in the waters of Dumai City.

Procedures

The research location is in the waters of Dumai City, Riau Province. This study conducted measurements and sample collection at four stations: the mouth of the Dumai River, the Pelindo industrial area, the Koneng beach tourism area, and the Purnama beach ecosystem area. The locations of the stations were determined using GPS (Global Positioning System). Water samples for the analysis of DO, BOD5, TOM, and total oil content were collected at each research station with two repetitions during high and low tides.

Water samples were collected using Winkler bottles. According to Alaerts & Santika[3], samples intended for laboratory testing require handling by established standards. Water sample handling includes labelling each sample container, preserving the samples (through cooling and adding concentrated sulfuric acid), and transporting the samples (from the collection site to the laboratory). Sample preservation is intended to prevent physical and chemical changes.

3. RESULT AND DISCUSSION

General Conditions of the Research Location

Geographically, the city of Dumai is located at 101°24’14.39” - 101°27’53.24” N and 103°9’48” - 104°2’16” E. This area is situated on the eastern coast of Sumatra Island, directly facing Rupat Island. Generally, the topography of Dumai and its surroundings has a flat elevation with a slope of 30 degrees, and the coastal area around the river mouth is gentle. The seasons in this region are similar to other areas in Indonesia, consisting of the dry season and the rainy season, with rainfall ranging from 200-300 mm and rain days occurring 10-15 days per month[4].

The city of Dumai has 16 rivers with a total length of 222 km. The population of Dumai is 253,803 people, managed across five (5) sub-districts and 33 villages, with the following territorial boundaries: to the north, it borders the Rupat Strait; to the east, it borders Bandar Laksamana Sub-district in Bengkalis Regency; to the south, it borders Bathin Solapan and Bukit Batu Sub-districts in Bengkalis Regency; and to the west, it borders Tanah Putih and Sinaboi Sub-districts in Rokan Hilir Regency[5].

Water Quality

The water quality parameters observed include temperature, pH, salinity, clarity, and current velocity. The results of the water

quality parameter measurements are presented in Table 1.

The highest average oil content is found at station 2, which is 0.30214 ppm during high tide. In contrast, the lowest oil content is found at station 3, which is 0.14485 ppm during low tide. From this data, it can be concluded that there is variation in oil content across different observation stations, and the tidal conditions also affect the measured oil levels

Table 1. Results of measuring the water quality of Dumai City

Parameter	Situation	Station			
		1	2	3	4
Temperature (^{0}C)	High tide	29	30	30	30
	Low tide	32	31	31	30
pH	High tide	8,4	8,25	8,28	8,89
	Low tide	8,23	8,19	8,2	8,49
Salinity (ppt)	High tide	21,2	20,7	19	19,4
	Low tide	19,2	19	18,6	19,2
Clarity (m)	High tide	0,35	0,36	0,39	0,33
	Low tide	0,34	0,35	0,38	0,32
Current Speed (m/s)	High tide	0,52	0,55	0,33	0,61
	Low tide	0,63	0,65	0,27	0,45

The results of the DO measurements indicate that the DO content in Dumai's waters ranges from 3.6 mg/L to 6.8 mg/L. The highest DO is found at station 3, which is 6.8 mg/L during high tide. Meanwhile, the lowest DO is found at station 2, which is 3.6 mg/L during low tide. The results of the BOD measurements show that the BOD content in Dumai's waters ranges from 10 mg/L to 11.3 mg/L. The highest BOD is found at station 1, which is 11.3 mg/L during high tide. Meanwhile, the lowest BOD is found at station 3, which is 10 mg/L during low tide.

The results of the TOM calculations show that the TOM values range from 17.38 mg/L to 35.22 mg/L. The station with the highest TOM content is station 2, which is 35.22 mg/L during low tide, while the lowest TOM content is found at station 3, which is 15.8 mg/L during high tide

Correlation between Oil Content and Water Quality

The results of simple linear regression analysis show that the correlation between oil content and Dissolved Oxygen (DO) is weak, with an r value of 0.1131 and a coefficient of determination (R^2) of 0.0128. This means that 11.31% of oil content is influenced by DO, while 88.69% is influenced by other factors (Figure 2).

The results of the simple linear regression analysis indicate that the correlation between oil content and Biological Oxygen Demand (BOD) is strong, with an r-value of 0.8031 and a coefficient of determination (R^2) of 0.645. This implies that 80.31% of the oil content is influenced by BOD, while 19.69% is influenced by other factors (Figure 3).

The temperature measurements recorded a minimum of 29 °C during high tide at Station 1 and a maximum of 32 °C during low tide at the same station. This difference occurs because, during high tide, the water is deeper, and sunlight penetrates less into the lower layers of the water, whereas during low tide, warmer water becomes trapped. This indicates that the temperature in the waters of Dumai City still meets the quality standard for marine life. Nedi & Manik[6] state that temperature differences arise from variations in measurement time, depth, and weather conditions at the time of measurement. This is further supported by Nedi et al.[7], that sea water temperature is influenced by various factors, including weather, water depth, wave action, measurement time, convection

movements, altitude, upwelling, seasons, convergence, divergence, human activities around the water, and the intensity of light received by the water.

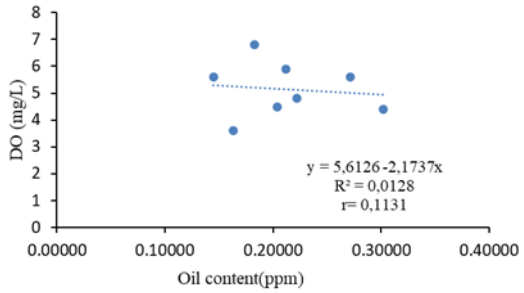

Figure 2. Correlation between oil content and DO

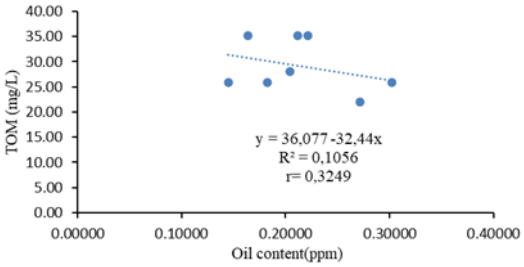

Figure 3. Correlation oil content and TOM

The average pH value obtained in the waters of Dumai is 8.4, indicating that the water condition there is slightly alkaline, which meets the quality standards for marine life. The pH value can be influenced by biological activities such as photosynthesis, which reduces CO_2 in the water and increases pH. Additionally, the water conditions around Dumai and potential pollution from human activities can also affect the pH value, but it remains within a range that supports marine ecosystems.

The low salinity in the waters of Dumai is due to dilution from large volumes of freshwater entering through the river mouths, especially during the rainy season. It is suspected that the low salinity is caused by high rainfall, while higher salinity is due to significant evaporation processes and limited freshwater supply to these waters. Moreover, salinity is also influenced by the depth of the water. This is supported Djuandi et al.[8], who states that salinity increases with greater water depth.

The clarity in Dumai's waters ranges from 0.32 to 0.39 m, indicating that the clarity is very low. According to the quality standards set by Government Regulation No. 22 of 2021, optimal clarity is greater than 3 m; however, the clarity values in Dumai do not support marine life. Low water clarity can be attributed to high sedimentation due to port activities, industrial pollution (oil and gas), and organic pollution from household waste. This is in line with Harefa et al.[9], which states that seawater clarity is determined by the turbidity of the water itself from the sediment content carried by river flow. Therefore, monitoring water quality, controlling erosion and sedimentation, and managing industrial and domestic waste are necessary to maintain water quality.

The low current speed in the waters of Dumai is related to oil content, as slow currents lead to oil accumulation in certain areas without dispersion. Additionally, wind direction influences the current; if the wind blows in the same direction as the current, it can cause water stagnation. According to Nontji[10], ocean currents are affected by various factors, including seasonal wind patterns. Moreover, changes in sea surface temperature also play a significant role. Current speed is determined by wind conditions, which tend to increase during low tide and as temperatures rise. As a result, low current speed and favorable wind directions for stagnation can hinder sedimentation and oil accumulation, simultaneously worsening water quality and disrupting aquatic ecosystems.

The highest oil content was found at station 4, measuring 0.22186 ppm during low tide, while the lowest oil content was observed at station 3, at 0.14485 ppm during low tide. The high oil content at station 4, located in the Purnama coastal ecosystem, is attributed to its proximity to the river mouth and shipping activities. This aligns with Amin[11], who states that various pollutants originating from land are carried by surface runoff into rivers and eventually flow into estuarine areas, spreading into marine

waters. The total oil content in Dumai's waters falls below the threshold limit, ranging from 0.14485 to 0.30214 ppm, indicating that the waters are not polluted.

The average oil content during high tide is higher than during low tide, influenced by the heavy shipping activity around the research stations. The elevated oil content during high tide is due to the increased number of vessels passing through the waters, where ships discharge oil from engine waste, fuel loading, and ballast water discharge.

The DO content in Dumai's waters ranges from 3.6 mg/L to 6.8 mg/L, with an overall average DO of approximately 5.2 mg/L during both high and low tides, which is categorized as lightly polluted. The water quality is still relatively good for biota. However, the study indicates that the water quality in Dumai is not fully adequate to support marine life, as some stations recorded DO values below 5 mg/L. This may occur due to an increase in organic materials from industrial (oil and gas) and household waste. The levels of dissolved oxygen in a body of water are influenced by organic matter[12].

Nedi et al.[7], also stated that the decrease in Total Potrelium Hydrocarbons (TPH) in water was followed by an increase in dissolved oxygen in the water medium. The BOD levels in Dumai's waters range from 10 to 11.3 mg/L, with an average of approximately 10.56 mg/L. The highest BOD was recorded at station 1, measuring 11.3 mg/L during high tide. In contrast, the lowest BOD was observed at station 3, at 10 mg/L during low tide. These values still meet the quality standards for seawater for marine life, which set a maximum BOD level of 20 mg/L. A higher BOD indicates a greater level of pollution in the water[13].

The measured TOM levels in Dumai's waters range from 17.38 mg/L to 35.22 mg/L, with an average of approximately 29.17 mg/L. The highest TOM content was found at station 2, measuring 35.22 mg/L during low tide, while the lowest TOM content was at station 3, at 15.8 mg/L during high tide. The ideal TOM range is between 20-30 mg/L, and total organic matter exceeding 30 mg/L is considered polluted. According to Alfi[14], TOM refers to the total amount of organic matter in a body of water, which includes suspended, dissolved, and colloidal organic materials. This organic matter may originate from decomposed plant and animal residues in the soil.

Water bodies with either excessively low or high levels of total organic matter (TOM) are detrimental to aquatic fertility. An ideal water body is one that maintains TOM levels within the specified quality standards.

4. CONCLUSION

The total oil content in Dumai City waters ranges from 0.14485– 0.30214 ppm. The total oil content below the threshold still supports aquatic biota and does not damage the ecosystem.The DO content in Dumai waters ranges from 3.6 to 6.8 mg/L, some measurements are below the threshold required to support marine biota. The BOD content of Dumai waters ranges from 10 to 11.3 mg/L, meaning that biological activity is still within optimal limits. The TOM content ranges from 17.38– 35.22 mg/L, which does not support the life of aquatic biota and there is potential for organic material pollution. The correlation between oil content and DO shows a weak correlation with a value of r = 0.1131.

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