Initial Investigation of Marine Pollution by Oil and Grease at Kuala Sg. Perlis, Perlis Using The Partition Gravimetric Method

Faridah Hanum Hj. Badrun

Zailuddin Ariffin

Baharudin Salleh,

An initial investigation was carried out to determine the status of marine pollution by oil and grease (O&G) at the jetty area of Kuala Perlis, Perlis. Five sampling points were chosen and the partition-gravimetric method was used to measure the concentration of the O&G pollutant. The results obtained indicated that the waters at the jetty are contaminated by oil and grease, and that tidal conditions affect the measurements due to the decreased boat and ferry activity during low tides. This finding on oil and grease contamination is consistent with results reported by the Department of Environment Malaysia, which indicate the oil and grease levels in the coastal waters off Kedah/Perlis have exceeded the set standard of 0 mg/L.

Introduction

Pollution in the Straits of Malacca is linked to high population density, heavy industrialization and changing land use patterns on the west coast of Peninsular Malaysia (Mohd Nizam Basiron, 1995). The Straits of Malacca is subjected to a great variety of environmental stresses due to its strategic location as a major international shipping lane and the concentration of agriculture, industry and urbanization which predominate on the west coast of Peninsular Malaysia. (Abdul Rani Abdullah et al, 1999).

Sea based pollution comes from operational discharges of vessels (including fishing vessels), and potentially catastrophic oil spills from tanker accidents. The Department of Environment (DOE) identifies total suspended solids (TSS), Escheria Coli (*E.Coli*) and oil and grease as chronic pollutants in the Straits. (Mohd Nizam Basiron, 1995) The Straits waters have been continuously polluted by oil and grease from the agricultural processing sector, beverage production, the sea food canning industry, textile, chemical and rubber based industry and from vessel pollution (Dow, 1994). The 1993 marine water quality monitoring data from DOE showed an alarmingly high level of non-compliance with the proposed Interim Standard of 0 mg/L. Kedah, Melaka and Negeri Sembilan were the worst hit of the Straits states, indicating 100 percent non-compliance.

As in previous years, the main contaminants of coastal waters in Malaysia were oil and grease and total suspended solids (TSS). In 1996, a total of 60 sightings of oily waste discharges from passing ships into Malaysian waters were reported. According to Environmental Quality Reports (1987-1993) Malaysian coastal waters are contaminated mainly with oil and grease, fecal coliform and suspended solids. Increased sediment load, pesticide run-offs, heavy metal discharges, palm oil and rubber effluents, sewage, reclamation of coastal and inshore areas for industrial or housing or agricultural use are the main causes of water pollution.

Oil and grease, total suspended solids (TSS) and *E. Coli* continue to be the main contaminants of the coastal areas in all the states in Malaysia. Since 2004, the DOE had identified two marine water quality monitoring stations for the state of Perlis, which are Kuala Sungai Baru and Kuala Sungai Perlis. The Environmental

Quality Report 1997 found that about 84 percent of the total number of monitoring stations were polluted by oil and grease, 65 percent by TSS and 37 percent by E. coli. Tar balls found in the beaches of Johor and Pahang between the months of February and July were attributed to "intentional or accidental" discharges of oil sludge or oily wastes from vessels, fishing boats or oil platforms.

Malaysia has a coastline measuring 4,675 kilometers, inclusive of Peninsular Malaysia and the States of Sabah and Sarawak. Coastal marine water quality monitoring started in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak. Monitoring has been identified as an effective way to provide early warning signs, identify harmful trends by determining the origin, pathway and destination of a pollutant. Hence, monitoring identifies unanticipated impacts and is known to be an essential tool towards successful environmental impact auditing.

Oil and grease pollution is measured by taking tar ball samplings on selected beaches. While this method does not give an overall picture of the level of marine based pollution, it does point to a growing problem from increased shipping activity in the area. A study carried out to expand the utility of hopanes in tar-ball samples in identifying the sources of petroleum pollution in the Straits of Malacca suggested that tanker-derived sources significantly contribute to petroleum pollution in the west coast of Peninsular Malaysia. (Mohamad Fauzi Zakaria, 2001). Furthermore, discharge of tank washings and ballast water from the tankers were suggested as pollution sources in the west coast based on the abundance in higher molecular weight *n*-alkanes and the absence of unresolved complex mixture (UCM) in the tar-ball samples.

Sources of oil and grease pollution are found on land and at sea. In 1995, There were more than 16,000 registered fishing vessels on the west coast of Malaysia and the cumulative effect of their oil discharges have severe repercussions on the marine water quality, marine ecosystem and marine species. Non-accidental discharges in the form of oily wastes, garbage and noxious liquid substances into the Straits waters are also quite substantial. The likelihood of accidental oil spills in the Straits has been and will continue to occur. Seventy five shipping incidents were reported between 1975 and 1993 of which 54 resulted in oil spills and three (the Showa Maru, the Diego Silang, the Nagasaki Spirit) were considered as major oil spills (Razif Ahmad, 1995).

Kuala Perlis is known as one of the major routes to go to Langkawi Island. The other route being via Kuala Kedah in the state of Kedah. Located at the estuarine of the Perlis river and about 13 km from Kangar town, Kuala Perlis is the major ferry terminal for visitors departing for the island of Langkawi. The main activity in Kuala Perlis is fishing and there are many seafood restaurants which offer delicacies such as grilled fish in this small fishing town.

However, increased development requires that more activities are carried out which could provide economic growth for the area. Coastal development can reduce permeable surface area, which increases the rate of runoff and thus impacting water quality by transporting sediments, toxic chemicals, pesticides, herbicides, pathogens, nutrients and other pollutants to local waterways (Perspectives on Marine Environmental Quality Today, 2004). As urbanization and inland activities increase, so do the volumes of municipal and industrial waste discharged into the local waterways. Direct discharges include releases from vessels, discharges of municipal and industrial wastewaters via pipelines, and dumping of waste materials, such as dredged materials into ocean waters. For example, more than 2.8 billion gallons of industrial wastewater per day are discharged directly into U.S. ocean waters (U.S. EPA, 1994).

The travel and tourism industry is a fast growing segment of the service industry in Malaysia with tourism revenues helping to boost the economy of coastal states such as Perlis. Increasing demands for commercial fish have also spurred fishing activities in these coastal areas. These activities primarily cause environmental burden resulting from the emission of lubricants in the waterways. Stern tubes of ships, for example, are usually lubricated by grease which is applied under pressure. This results in a continuous emission of the grease to the surface water. The majority of lubricants used are based on mineral oils and it is well known that these compounds degrade poorly under normal environmental conditions. The mineral oils have a high potential to accumulate in the environment and are also known to taint water and fish, making it unsuitable for consumption (Environmental Aspects, 2004).

Besides being a major habitat for many marine creatures, the ocean helps to regulate the climate and dilute and degrade certain pollutants. It is the objectives of this study to investigate the presence of marine pollution due to oil and grease at the Kuala Perlis jetty under the increasing pressure of human activities in the area and to compare the results with the allowable limit set by the Department of Environment Malaysia.

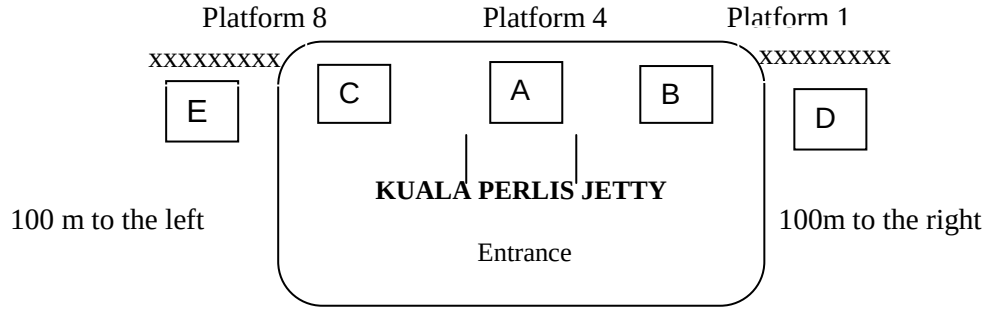
Methodology

Sampling

In this initial investigation seawater samples were obtained from the boat landing area as well as 100 m to the left and right of the landing area of the jetty.

Sampling points

Figure 2.2 below indicates the sampling points A, B, C, D and E at the Kuala Perlis jetty area.



Sampling schedule

One preliminary survey was conducted on 19/1/2004, followed by four sampling excursions from 10/2/2004 through 18/2/2004 to coincide with ferry schedules; peak times (early afternoon and evening) and off peak times (morning and night).

Experimental procedure

The determination of oil and grease in seawater using the partition-gravimetric method was done based on Method 5520 B of the Standard Methods for the Examination of Water and Wastewater, American Public Health Association (APHA, 1992). Glass sampling bottles were washed with soap, rinsed with water, and finally rinsed with solvent to remove any residue that might interfere with the analysis. When analysis had to be delayed for more than 2 hours, the water sample was acidified to pH 2 or lower with 1:1 HCl and refrigerated. 250 mL glass sampling

bottles were used to collect seawater samples and water levels were marked for later determination of sample volume. Samples were acidified with 5 mL of 1:1 HCl and transferred into separatory funnels. Portions of the extracting solvent (80% *n*-hexane : 20 % methyl-*tert*-butyl ether) were added into each separatory funnel. The upper layers were filtered and passed through some drying agents. The combined extracts were collected in tared distilling flasks. Solvent was removed using a rotary evaporator and the dried distilling flask was weighed. The sample bottle was filled with water to the mark and the initial volume of seawater sample was measured.

Results and Discussion

Table 3.1: Concentration of oil and grease at Points A, B, C, D and E.

Date	Time	Concentration of oil and grease (ppm)					Comments
		Pt A	Pt B	Pt C	Pt D	Pt E	
10/2	11am - 12:30pm	4.51	4.84	4.00	-	-	1. Low tide 2. Water looked oily and cloudy 3. Points D and E too shallow for sampling.
12/2	4:15 - 5:45 pm	4.78	5.06	4.17	3.85	4.17	1. High tide 2. Water looked cloudy 3. A ferry landed at point B. 4. Construction work in progress at point E.
16/2	6:30 - 8:00 pm	4.74	4.96	4.62	3.95	4.59	1. High tide 2. Water looked cloudy 3. Three ferries landed at point B.
18/2	7:15 - 9:00 am	4.55	4.95	4.20	-	-	1. Low tide 2. Water looked oily and cloudy 3. Points D and E too shallow for sampling.

A summary of the results obtained in the determination of oil and grease (O&G) is shown in Figure 3.1.

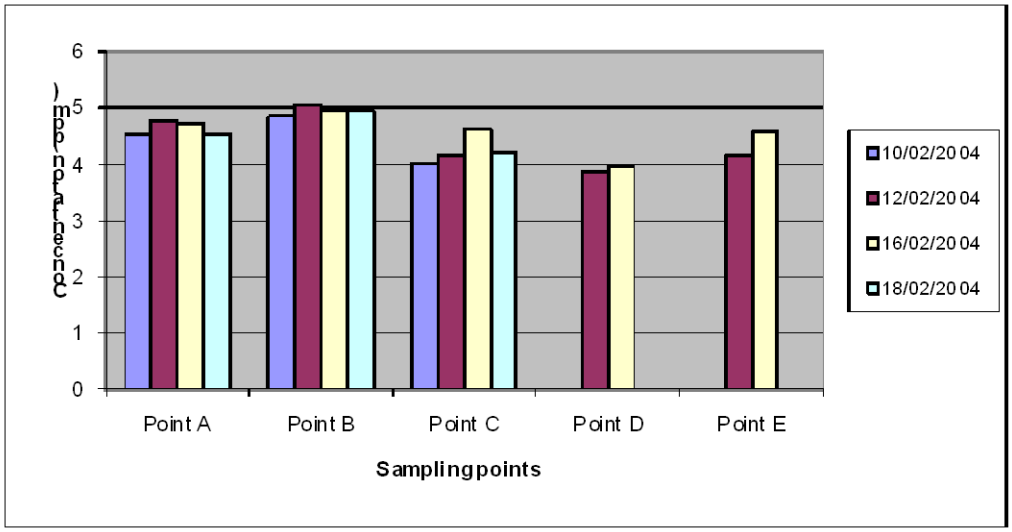


Figure 3.1: Concentration of oil and grease at Kuala Perlis jetty area.

The most important tool for protecting the Straits of Malacca from land-based sources of marine pollution is the 1974 Environmental Quality Act (EQA) which provides control over a wide range of land based activities. Parts of the EQA protect the marine environment from land-based sources of marine pollution. These regulations are designed to control polluting activities and their discharges into freshwater bodies and the sea. Marine water quality monitoring has been carried out by the DOE since 1978.

Pollution from marine sources in the Straits is attributed to marine transportation, marine dumping and oil spills. However, monitoring by DOE covers only pollution by hydrocarbon or more specifically by oil and grease. A major spill in the Straits would be catastrophic on the marine and coastal systems, which includes the loss of livelihood of fishermen in the area. The quality of the marine water plays an important role in the conservation of marine resources such as the coral reefs, fisheries and mangroves. All of the above contributes to the continuity of the food chain and the stability of the marine ecosystem. Any sources of pollution from land as well as sea would threat and drive these priceless resources to depletion. (Department of Environment-Marine Monitoring, 2008)

In this initial investigation, results from all four samplings indicate that O&G concentrations are highest at Point B and lowest at Point D. The range of O&G concentration for Point B is from 4.84 to 5.06 ppm. For Point D, the range is from 3.85 to 3.95 ppm. Point B is Platform 1 at the Kuala Perlis jetty and Point D is outside the ferry landing area, which is about 100 m to the right of the jetty area. Since the results consistently show that Point B had the highest concentration of O&G, this is also indicative of the fact that a greater amount of O&G remains on the surface of the water at the right section of the ferry terminal. Point D which is located outside the terminal, at the far right of the terminal building, however is less affected by O&G contamination. This is probably because all ferries will pass through Point E before docking to unload passengers at the three platforms, Platforms 1, 4 and 8. To depart

from the jetty, ferries will reverse again through Point E to Langkawi island. Thus Point D remains relatively isolated from the movement of ferries.

The concentration of O&G also depends on tidal conditions. The O&G concentration is higher during high tide compared to low tide. This is because during high tide more ferries arrive and depart, which accounts for peak hours for movement of vessels in the area. This is consistent with ferry scheduling which begins in the morning, starts to increase by mid afternoon and early evening, before ending at about 7 at night. Ferries can only reach the landing area of the jetty during high tide when the water levels are higher. During low tide, the shallow waters make it difficult and risky for boats and ferries to manoeuvre through the muddy estuarine bed.

For all sampling points, the O&G concentrations have been found to exceed the allowable limit set by the Malaysia Interim Marine Water Quality Standard, Department of Environment (DOE), which is 0 ppm. This shows that the waters around the Kuala Perlis jetty area are contaminated by oil and grease which comes from the activity of boats and ferries, such as leakages of oil and grease from these vessels as well as possible indiscriminate disposal of used engine oil from ferries and boats. The results of this investigation is also consistent with the findings of the DOE which reported that the main contaminants of coastal waters in all states in Malaysia were from total suspended solids (TSS), oil and grease and *Eschericia coli* (Malaysia Environmental Quality Report 2000). The report also indicated that oil and grease pollution remained a significant problem particularly in the coastal waters off Kedah/Perlis, Langkawi and Penang while the Pahang coastline was free of oil pollution.

The impact of marine pollution is most acute in the estuarine and inshore coastal areas of the Straits of Malacca, which is one of the busiest and most polluted seaways of the world. The marine environment is suffering from rapid industrialization, increased domestic and industrial effluents, pesticide and fertilizer runoff from agriculture and sediment runoff from land development schemes. It is estimated that up to 80 percent of marine pollution comes from land-based sources. Operational and accidental discharges from tankers and shipping vessels and offshore oil exploration and extraction also contribute to pollution of the sea.

Conclusion

The results from this initial investigation showed that there is marine pollution due to O&G contamination at the jetty area of Kuala Perlis, with the highest concentration detected at Platform 1 and the lowest at the far right area of the jetty terminal. Tidal conditions affect the O&G measured because during low tides there were no movement of boats and ferries in the area and O&G levels were lower during low tides. The concentration of O&G at the Kuala Perlis jetty area was found to exceed the limit of 0 mg/L set by the DOE.

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FARIDAH HANUM HJ. BADRUN, Faculty of Applied Sciences,Universiti Teknologi MARA Perlis,02600 Arau, Perlis.

ZAILUDDIN ARIFFIN, Faculty of Applied Sciences,Universiti Teknologi MARA Perlis,02600 Arau, Perlis.

BAHARUDIN SALLEH, Faculty of Applied Sciences,Universiti Teknologi MARA Perlis,02600 Arau, Perlis.