Purification of Water from Herbal Oil, Mineral Oil and Petroleum Products by Being Used Kapok Fiber

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ABSTRACT

Petroleum is a mineral oil with a very dark color, a specific odor and a density varying between 0.8 and 0.95 g/cm3. Knowing the composition, physical and chemical properties of petroleum and petroleum products and Kapok fibers this investigation has been done about the purification of water by absorbing these substances in water by petroleum products (crude oil-gasoline-diesel-fueloil etc.), mineral oil and vegetable oil mixed with water sources naturally or indirectly by using Kapok (Ceiba pentandra) fiber. Industrially

Key words: *petroleum, Kapok, absorbing, water*

1 Introduction

Kapok is a type of fiber obtained from plant seed such as cotton. This tree (Ceiba pentandra), whose homeland of the Kapok tree is the tropics of America and the West Indies, 2 today, mainly Java, and some Asian countries such as the Philippines, Malaysia and Sri Lanka. It is widely cultivated to obtain fiber in their countries. In general, the regions 15 degrees north and south of the equator are the regions where good kapok products are obtained.

Those grown at an altitude of up to 450 meters above sea level give the most yield and best quality products. Kapok tree exhibits a rather large appearance with its branches located almost perpendicularly to the trunk.

The white or pink kapok flowers turn into large cocoon-shaped fruits after pollination with the help of bats. There are many hairy seeds inside the kapok fruits, which are about 15 cm long. (Picture 1.2.3.) These hairs are removed from the fruit and used as fiber. (Picture 4.) For this, first the fruits are opened by breaking them with sticks, then the seeds are placed in a basket and mixed quickly; With the effect of these blows, the fibers are broken off and collected at the bottom of the basket.

Kapok Fiber; It has an extremely shiny, cream-yellow colour, silky appearance. It is a soft and elastic fiber. It is a single cell, visible under the microscope as thin longitudinal ribbons. Its cross-section is oval or round. The immature ones appear like the immature cotton fibers, that is, in the form of rods. Even in mature fibers, the lumen is wide and the wall is narrow. Its specific gravity is 0.0388 gr/cm³ at 30 degrees and it is very light. Fiber length is 1 - 3.5 cm. It contains 63% cellulose and 13% lignin in its structure. It is one-sixth the weight of cotton. Good air and heat insulation is provided due to the pores in the fiber structure. It does not get wet in water for a long time, dries quickly when wet. (It does not get wet quickly because the surface of the fiber is covered with wax) 1 kg of kapok easily holds a weight of 35 kg on water (1), (2). (Fig. 1).

Petroleum is a mineral oil with a very dark colour, a peculiar smell and a density varying between 0.8 and 0.95 g/cm3. Knowing the composition, physical and chemical properties of petroleum and petroleum products, their behaviour, changes and effects in nature is critical in order to determine the response methods to be applied in case of a spill. The composition of petroleum also differs depending on where it is extracted. For example, an oil extracted from Pennsylvania is fluid and brightly colored because it is paraffinic. Whereas a Venezuelan origin crude oil is black and more viscous due to the presence of highly aromatic hydrocarbons. That's why oil is named after the region where it is extracted. Low-density oils float on water as well as have low viscosity and high volatile components.

1-1 Behaviour of Oil in Marine Environment

After the oil is poured into the marine environment, undergoing some physical and chemical changes is generally called weathering. Knowing the oil leaching process and the factors that play a role is helpful when preparing and implementing response plans for oil spills. Physical properties of oil such as density, viscosity, pour point affect the behaviour of oil in the marine environment. The behaviour of oil in the marine environment is presented in Figure (1).

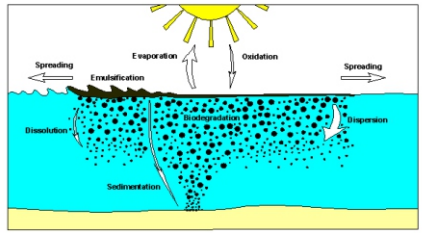

Fig. 1: Behaviour of oil in the marine environment (ITOPF, 2003)

Although the economic effects of oil spills are mostly temporary, such an event could hit some sectors such as

tourism, power generation and fisheries. Petroleum pollution has negative effects on living life due to both physical damage and toxic effects of its chemical components. The methods to be applied to remove oil from the sea are directly related to the length of the aeration phase of the oil. All physical and chemical properties affect the efficiency and therefore the choice of removal methods (Fig. 2).

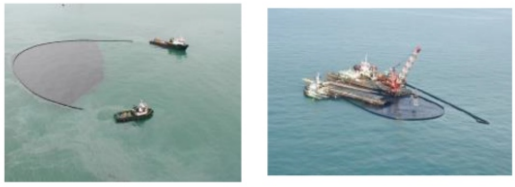

Fig. 2:U-shaped pulling of the barrier and the use of scrapers

Examples of living things affected by oil pollution are shown in Figures (3).

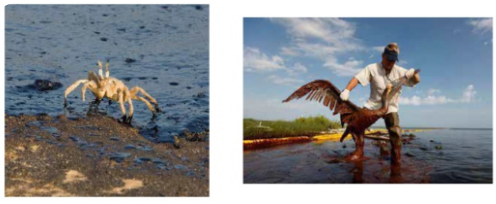

Fig. 3: Oil pollution endangers living organisms

Absorbent materials provide a useful resource in responding to an oil spill, allowing oil to be removed where other techniques are not suitable. However, secondary problems need to be minimized, especially by generating excessive amounts of waste of sorbent, which can contribute greatly to the costs of a response. This booklet considers the types of absorbent materials available and how they can be usefully used in a response. It should be read in conjunction with the ITOPF booklets in this series, particularly on the use of booms, the use of skimmers, shoreline cleaning techniques and oil spill disposal (3) (Fig. 4).

Fig. 4: Surface and coastal pollution caused by oil derivatives in the sea and on the coast (37)

1-2 Oil Absorbent Rolls

Only Oil Absorbent Roller is used to clean up petroleum-based spills and spills to absorb petroleum-based fluids, and is effectively applied in both marine industry and aviation oil spill emergency operations and oil spill in oil tank or car.

1. 100% polypropylene will not rip, tear or fray even when saturated.
2. Highly absorbent, fine fiber structure does not leave behind liquids or fiber residues. Absorbs and retains oils and oil-based fluids (including lubricants and fuels) without absorbing a drop of water.
3. Floats to clean up oil spills in the water
4. Bright white colour makes the absorbed oil easier to see; draws attention to machine leaks and clearly shows saturation level during spill response.
5. After being used to reduce waste or mix fuels, it can be opened and incinerated.
6. Mainly used to absorb crude oil; It is suitable for absorbing light oil, low and medium viscosity oils and volatile chemical liquids with light specific gravity.

Oil Absorbent Roller Applications:

- Transport companies.
- Marine Oil Spill
- Ship and dock
- Chemical and equipment factories
- Oil spill on lake and river (4)

Our Absorbent Pad is designed to absorb Chemical, Petroleum and universal spills. The Absorbent Pad is the fastest way to clean up a spill. The Absorbent Pad is available in a number of different weights and materials. Oil Absorbent Pad, Universal Absorbent Pad and Chemical Absorbent Pad material provide fast capillary action and excellent absorbent capacity and retention.

Oil absorbent pad that absorbs petroleum-based liquids and repellent water. Oil Absorber Pad is recommended for small amount of water oil leakage and indoor use. Perfect for pipelines, shipyards, ship and yacht decks, factories, industrial plants, loading docks, machine and maintenance shops, fire departments, municipal spills or spills of liquid, chemical or oil. The oil absorbent pad is always easily placed and removed (5).

Kapok fibers, which stand out with their hollow fiber structure, lighter-than-water specific gravity, and oil-absorbing character, display a profile quite different from known natural fiber types (7,12,13,36).

The fact that the fibers do not sink in water, provides sound and heat insulation (8,12,16-19,36) and has a high oil absorbing feature in contrast to their hydrophobic feature makes kapok fibers superior to many synthetic fiber types (6,11,20,21,36).

Kapok tree has been grown in large plantations in Southeast Africa for both kapok fiber and wood pulp, but demand for kapok fibers has declined as synthetic materials become more preferable (22,36). Another reason for the decrease in kapok production, whose annual production exceeded 40 million kilograms before the Second World War, was the widespread use of synthetic fibers as well as the destruction of kapok cultivated areas due to the war (23, 36).

Kapok fibers are a type of cellulosic fiber with a soft and silky touch. However, it differs from other cellulosic fibers with its hollow tube-shaped fiber structure (24, 36). Kapok fibers keep mold and harmful insects away, as the fibres contain a large amount of lignin and wax. Kapok fibers, which are yellowish or light brown in colour, have a silky shine (9, 12, 18, 25, 36). Kapok fibers, which are also odorless and soft, are non-toxic or allergenic and resistant to decay. Kapok fibers have similar characteristics with silk grass fibers both in terms of appearance and general characteristics (10, 36). Silk grass fibers, like kapok fibers, are a type of seed fiber that has a hollow fiber structure, low fiber density, and exhibits hydrophobic and oleophilic fiber properties (10, 36).

It has been noted that the rebound (compression

kapok fibers is good (15, 36) (Fig.5).

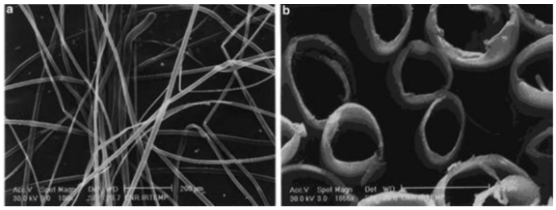

Fig. 5: SEM images of Kapok fiber taken in longitudinal (100x magnification)-(a) and cross-section (1855x magnification)-(b) (26)

The hydrophobic and oleophilic character of Kapok fibers gives very successful results in the separation of fatty substances from aqueous solutions. In particular, kapok fiber filters produced for the separation of oil and similar spills from sea water are both very durable and can be used very effectively in the separation process (10,11,14,21,28,31-33,36). Considering that approximately 10 million tons of petroleum and its products are used in the world every year, it is obvious how high the probability of contamination of water resources such as sea, lake and ocean is during the use or transportation of these products. Cleaning the oil and its derivatives contaminating water resources causes very serious costs. Filters produced with Kapok fibers, on the other hand, can provide a more efficient and more economical alternative to filters produced mostly from synthetic materials.

In the separation of oily substances from water and oil mixtures, separation can be achieved at a process efficiency of up to 100%. In addition, kapok fibers can be used more than once in this separation process and ensure that the separated oil can be reused (11, 36). Polypropylene is used as a raw material in the most widely used products for cleaning oily structures on the water surface (14, 36). In a study comparing the oil absorbing capacities of polypropylene and kapok fibers, it was noted that the kapok fibers absorb almost all the oil on the water surface, but only a very slight oil trace that cannot be seen on the water (6,36). In the evaluation performed using diesel, hydraulic oil (AWS46) and machine oil (HD40), it was observed that the oil absorbing capacity of kapok fibers was much higher than the oil absorption capacity of polypropylene fibers for all three substances. It was reported that after the fourth use of Kapok fibers, only 30% of the initial oil sorption capacity was lost (6, 36). In another study, it was noted that kapok fibers could retain 70% of their oil absorbing capacity even after 15 use [for diesel with a compression (packing) density of 0.04 g/cm3] (11,36). According to the researches, it can be said that kapok fibers have a very successful use in separating substances such as diesel, gasoline, machine oil, hydraulic oil from the water surface (11, 31, 36).

2 Method

All of our work was carried out by our project team in the equipped physics laboratory determined as the research environment. Kapok fiber, cotton, three different microfiber cloth samples were used for impregnation. Other materials used are; glass beaker, fuel-oil, diesel, motor oil, mineral oil and liquid vegetable oil.

The samples were allowed to absorb liquids on the water (impregnation method) and then by measuring how many grams of liquid each sample absorbed (Picture 12-25) Table.2-5 is given.

Each measurement was repeated 5 times, and the completion of our project took 12 weeks (Fig.6).

Fig. 6: Experimental setup and procedure

Fuel-oil, diesel oil, motor oil, mineral oil and liquid vegetable oil, kapok fiber added to the water absorbed much more than other samples, allowing them to separate from the water. Petroleum spillages or accidents can cause irreparable damage to life.

3 Results

Made with Kapok fiber, cotton and three different microfiber cloth samples; Kapok fiber gave very different results compared to other materials in the impregnation of fuel oil, diesel, motor oil, mineral oil and liquid vegetable oil over water, and completely cleaned the water from the liquids used. It also enabled the reuse of liquids purified by absorption from water.

Comparative values of the materials used in the impregnation; Chart.1-4, the values obtained in the multiple use (10 repetitions) of Kapok fiber are given in Figures (7-13).

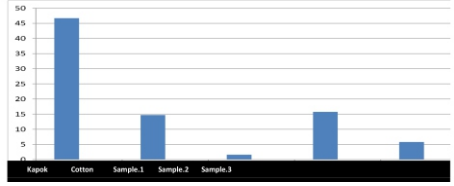

Fig. 7: Liquid-herbal oil absorption - 1 g of material (kapok, cotton and 3 more samples) in gram

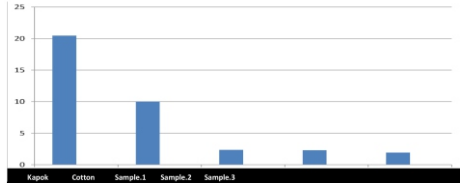

Fig.8: Fuel-oil absorption - 1 g of material (kapok, cotton and 3 more samples) in gram

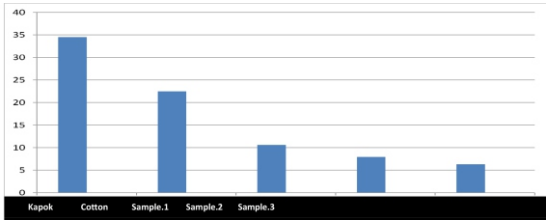

Fig. 9: Motorine absorption - 1 g of material (kapok, cotton and 3 more samples) in gram

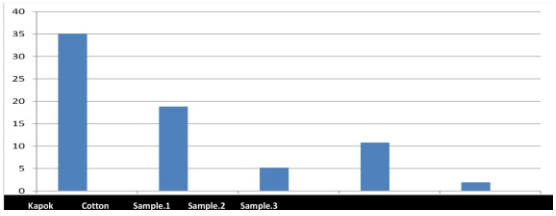

Fig. 10: Diesel fuel absorption - 1 g of material (kapok, cotton and 3 more samples) in gram

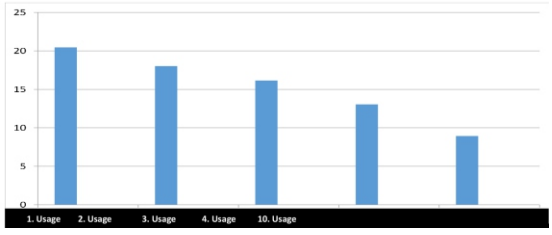

Fig. 11: Fuel oil absorption of 1 g Kapok fiber

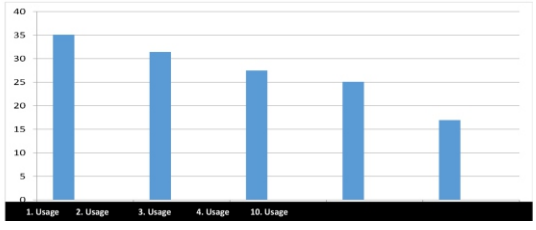

Fig. 12: Diesel fuel absorption of 1 g Kapok fiber

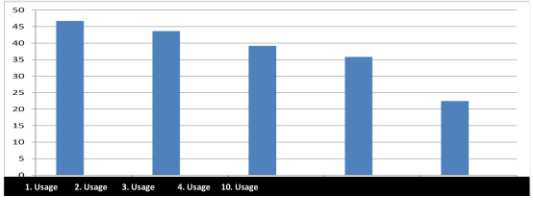

Fig. 13: Herbal Oil absorption of 1 g Kapok fiber

Made with Kapok fiber, cotton and three different microfiber cloth samples; Kapok fiber gave very different results compared to other materials in the impregnation of fuel oil, diesel, motor oil, mineral oil and liquid vegetable oil over water, and completely cleaned the water from the liquids used. It also enabled the reuse of liquids purified by absorption from water.

Comparative values of the materials used in the impregnation;(Figs. 7-10), the values obtained in the multiple use (10 repetitions) of Kapok fiber are given in Figures (11-13).

For example, with 5 kg Kapok fiber (5000 g) For diesel;

5000 x 35.08 = 175.400 g = 175.4 kg at first use,

5000 x 16.94 = 84.700 g = 84.7 kg. It can be separated from water in the 10th use.

For fuel-oil;

5000 x 20.46 = 102.300 g = 102.3 kg at first use,

5000 x 8.94 = 44.700 g = 44.7 kg. It can be separated from water in the 10th use.

For liquid vegetable oil;

5000 x 46.70 = 233.500 g = 233.5 kg at first use,

5000 x 22.45 = 112.250 g = 112.25 kg. It can be separated from water in the 10th use.

5 kg Kapok fiber cost (kg price is between 9-12 TL)

5 x 12 = 60 TL.

The price of petroleum absorbers used for the same purpose is 393 TL.

The price of oil (and chemical) absorbents used for the same purpose starts from 333 TL. Kapok fiber is seen to be very advantageous in terms of usage and price comparison and multi-use.

4 Advices

a) In a study on composite materials that can be used in oil and water filtration/separation processes; Various properties of the composite structure obtained by coating polyvinlidine fluoride (PVDF) on the kapok fiber nonwoven surface using electro-spinning technology were investigated. Polyvinylidene fluoride (PVDF) polymer is a type of material with superior mechanical properties, high chemical resistance, and good pyroelectric and piezoelectric properties. When these unique properties of PVDF fibers are combined with the light, non-sink and water resistant structure of kapok fibers, composite materials with high oil/water separation performance and resistant to a wide variety of environmental conditions can be produced (30,36).

b) Kapok fibers also have the potential to be used in the production of high-performance electrode materials with their hollow structure (34,36).

c) The high absorbency of Kapok fiber is used in large kitchens (hotels, restaurants, food factories, etc.) industrially and in all residential areas (hotel, school, dormitory, etc.) to prevent slipping on the floor, multiple use (in the form of simple mats or mobs or locally covering the floor). It is thought that it will be very useful as it is possible.

d) With the use of Kapok fiber in car wipers; Incidents such as oil on the windshield, fuel spilled on the roads, etc., which will cause complete loss of vision during the operation of the wiper, can be prevented and accidents can be prevented. (We are still working on this subject)

e) It is thought that kitchen drains, waste water drains, blockages caused by oil or petroleum-derived products that may occur in all types of sinks, and the filter system, where water can be separated, can significantly prevent water pollution.

f) Since it is possible to turn it into a product that can also allow cleaning of large areas (sea, lake, river, tanker leaks and accidents, factory wastes, etc.), it is also suitable for this purpose.

g) In addition, we continue to work on the use of the Archimedean Screw filtering system (Fig.14) for waste water installations and drains.

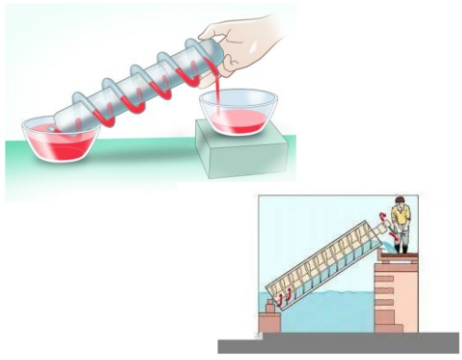

Fig. 14: Filtering System

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