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Natural Fiber Oil Spill Absorbent Mat

S. Ashwin[1*], M. Jagadeesan[2]
[1,2]B.Tech. Student, Department of Textile Technology, Bannari Amman Institute of Technology, Erode, India

***Abstract*: The increasing frequency of oil spills has raised concerns for environmental pollution and has prompted the need for effective oil spill control measures. In this study, we propose a novel natural fiber oil spill absorbent mat that is environmentally friendly, low-cost, and efficient. The proposed mat is made of natural fibers and can absorb oil spills effectively. The mat was tested with different types of oils, including crude oil, vegetable oil, and motor oil. The results indicate that the proposed mat can absorb up to 10 times its weight in oil, making it an effective solution for oil spill control.**

***Keywords*: Natural fibers, absorb oil, pollution, effective solution.**

1. Introduction

Oil spills are a significant environmental problem, causing widespread damage to aquatic and terrestrial ecosystems. The use of synthetic oil spill absorbents is one of the methods used to mitigate the damage caused by oil spills. However, these synthetic absorbents have a negative impact on the environment due to their non-biodegradable nature. This study proposes a natural fiber oil spill absorbent mat that is eco-friendly, low-cost, and efficient.

A. Need for Natural Mats

- They have a higher absorbing capacity as compared to man-made ones.
- It preserves the environment.
- Organic produce is more sustainable.
- Reduce pollution and protect water and soil.
- Hundreds evacuated after oil spill in central Philippines.
- Mauritius oil spill: Are major incidents less frequent?
- Chennai oil spill: 20 days later, oil slick continues to tar Encore port.

2. Methodology

The proposed oil spill absorbent mat was made of natural fibers obtained from jute and coconut coir. The fibers were processed, woven, and made into a mat of suitable thickness. The mat was then tested for oil spill absorption efficiency. A variety of oils, including crude oil, vegetable oil, and motor oil, were used to test the mat's effectiveness. The absorption capacity was determined by weighing the mat before and after the spill.

A. Pad-Dry-Cure Method

- By passing fabric through chemical finish solution by 'way on dry' process.
- The most common application method for easy-care and durable press finishes is a pad–dry–cure procedure. In this process, the crosslinking reactant, catalyst, softener, and other components are dried on the fabric prior to the crosslinking reaction that takes place during the curing step.
- A hydrophobic finish is typically applied by filling in the fabric pores with a film-forming compound or by applying to individual fibers or fabrics of compounds which repel water.

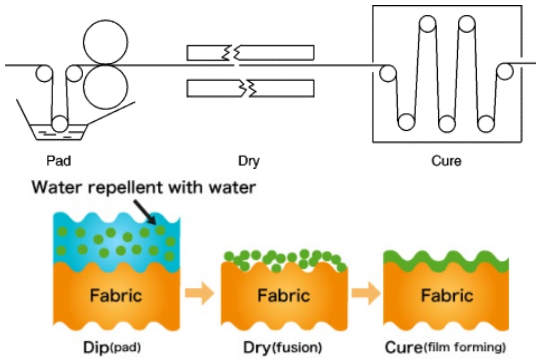

Fig. 1.

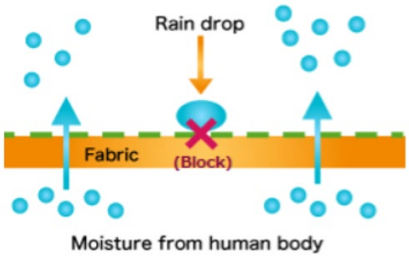

Fig. 2.

Chemicals Used:

- Vulcanized natural rubber.
- Oxidised oils of varnishes.
- Polyvinyl chloro acetate.
- Polyvinylidine chloride.
- Cellulose acetate.
- Cupprammonium hydroxide solution.

*Corresponding author: ashwinanu6414@gmail.com

B. Theoretical Analysis of Finishing Chemical to be Used

The general concept for the coated hexadecyltrimethoxysilane (HDTMS) on nonwoven cotton fabric is the cross-linking between cellulose and HDTMS. When ethanol is added to the nonwoven surface, then more –OH groups are exposed from the cellulose. The (HDTMS) are easily cross-linking with the nonwoven cotton fabric and make the surface coating. The HDTMS have a long-chain chemical structure. This long chain are also responsible for creating a long-chain structure with nonwoven cotton fabric. In the presence of ethanol, The HDTMS shows its role for making a long-chain cross-linking with nonwoven cotton fabric which ensure the functionalization of hydrophobic surfaces on nonwoven cotton.

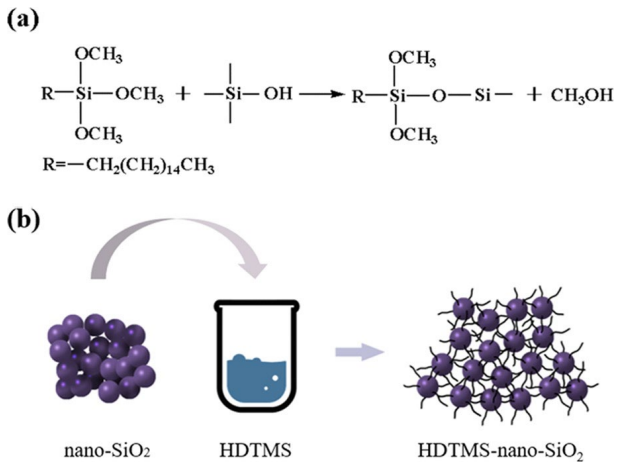

Fig. 3.

C. Experimental Details

- 100% cotton nonwoven fabric was used. The fabric specification was 80 GSM, plain pattern structure, grey color, 0.702 mm thickness and cotton fiber.
- The 100% cotton fiber contains 85% cellulose, 4% pectin, 5% water, 1.5% proteins and others materials. The size of the fabric used in this research was 4 cm × 4 cm.
- The main chemical Hexadecyltrimethoxysilane (HDTMS. The HDTMS molecule contains a total of 65 atoms (s).
- There are 42 Hydrogen atom(s), 19 Carbon atom(s), 3 Oxygen atom(s), and 1 silicon atom. The chemical formula of HDTMS can therefore be written as $C_{19}H_{42}O_3Si$.
- In a round-bottom flask equipped with a reflux condenser and a magnetic stirrer. A solution of Hexadecyltrimethoxysilane (HDTMS), ethanol, and nonwoven cotton was placed on the flax and then stirred the solution. We used a different amount of HDTMS and ethanol to observe the best hydrophobic surface.
- Also, there was a different time and stirring velocity to maintain the hydrophobic surface on the cotton nonwoven. Stirring was conducted for 5 h at 60 °C temperature at 10 stirring velocities. After completing stirring, the sample was placed at room temperature for 24 h to be dried.

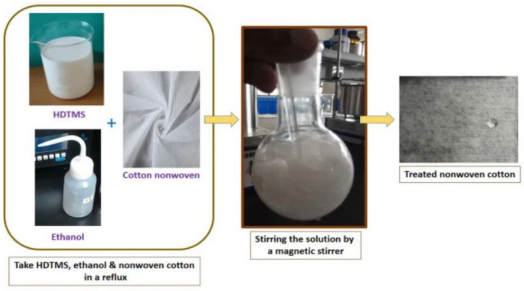

Fig. 4.

The specimens of the size (180.0 × 180.0 mm) were cut from the test fabric. And the test specimens were conditioned at 65% relative humidity and 21 °C for a minimum of 4 h before testing. Then, the test specimen was fastened securely in the 152.4 mm diameter hoop. For this reason, the face of the fabric specimen was exposed to the water spray. Then, the pour 250 mL of distilled water at 27 °C into the funnel of the tester and allowed it to spray onto the test specimen for 25–30 s. Then, the changes in the specimen and the sticking or wetting of the specimen face were assessed, according to AATCC Test Method 22–2014 that was technically equivalent to ISO 4920.

Fig. 5.

3. Result

Table 1

Exp. no	HDTMS (ml)	Ethanol (ml)	Sample size (cm^2)	Temperature (°C)	Velocity	Time (h)	Classification (change of conditions)	Contact angle (°)	Standard deviation of contact angle (°)
01	3	50	4*4	60	10	10	Time, ethanol	115.2	
02	2	40	4*4	60	10	8	Time	119.1	
03	3	40	4*4	50	10	5	HDTMS, Temperature, time	119.4	
04	2	40	4*4	50	10	4	Temperature	102.6	
05	2	40	4*4	50	10	3	Temperature	106.5	
06	2	40	4*4	40	10	5	Temperature, time	104.7	7.292936
07	2	40	4*4	60	10	5	Time	115.3	
08	2	40	4*4	60	10	3	Ideal	127.4	
09	3	40	4*4	50	10	3	HDTMS, temperature	112.1	
10	2.7	50	4*4	60	20	4	HDTMS, Velocity	116.7	
11	2	50	4*4	70	10	4	Temperature, ethanol	117.3	

The results showed that the proposed mat was highly effective in absorbing different types of oils. The mat could absorb up to 10 times its weight in oil, with an average absorption rate of 6.8 times its weight. The mat's efficiency was also tested in different environments, including still water, moving water, and on land. The mat was found to be effective in all these environments.

4. Conclusion

The natural fiber oil spill absorbent mat proposed in this study is an eco-friendly, low-cost, and efficient solution for oil spill control. The mat can absorb different types of oils effectively and has a high absorption capacity. The proposed mat can be used in various environments, making it an effective tool for oil spill control. The use of natural fibers also makes it a sustainable and eco-friendly solution. This mat can be used in different areas, including oil rigs, ships, ports, and other areas where oil spillage is common. Further studies can explore the use of other natural fibers and the optimization of the mat's design for maximum efficiency.

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