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SOME STUDIES ON NEEDLE PUNCHED NONWOVEN SORBENTS MADE FROM COTTON, KAPOK AND JUTE FIBRES

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Abstract - *Oil spills in the water bodies affects the entire food chain of ocean ecosystem. Aim of this project is to develop biodegradable needle punched nonwoven fabric by using natural fibre. Fibre webs are prepared using miniature carding machine and mechanically bonded using the needle punching machine. The tensile strength of nonwoven fabric samples was tested to ensure the usage in real time applications. Oil absorbency and retention were carried using HD Engine oil and Diesel. The suitable nonwoven fabric is identified by changing the ratio of jute, cotton and kapok content in the nonwoven fabric samples. The results show that nonwoven fabric is made with natural fibre like coarse and fine cotton, kapok, and jute has a good tendency to absorb oil in the water bodies.*

Key Words: Sorbent, oil, cotton, kapok, jute, retention

1. INTRODUCTION

In this present world, oil has gained an important place due to its various uses. It is a naturally formed material. The oil is formed by the decays of plants and animals that lived long time ago, under heat and pressure [1]. The petroleum and oil is not available in all parts and is has to be transported from the source place to different parts of the world through oceans and lands. [2] The mode of transport is through underground pipelines or through ships [3][4]. During the transportation, there will great amount of oil spills on the water body due to accidents. The oil contains hydrocarbons and other poisonous substances hence it has to be cleaned as soon as possible, before it effects the environment. Efficient methods must be implemented to clean the oil spill and it should be eco-friendly and cost efficient. Using a good sorbent fibre material for cleaning the oil spill is efficient method to solve this problem [5] [6].

The materials may include natural fibre or manmade fibre, has a great potential for oil spill cleanup, which can absorb oil from the water surface [7]. The kapok fibre with NaClO2 treatment can absorb the highest point of oil. On the removal of kapok wax on the fibre surface doesn't reduces the oil absorbency capacity [8] [9].The modified kapok fibre is covered by silica nanoparticles and surface becomes rough, the modified kapok fibre has the high oil sorption capacity and removal of oil in oil/water separation can be done [10].The material used has very high adsorption capacity and low cost and may successfully be used as an oil absorbance to clean the spills of oil product in water basin [11] [12]. The study proposed guidelines toward the development of a sustainable cleanup technology. The product in large scale by using the cotton as the precursor, twisted carbon fibre aero gel shows highly efficient sorption of organic liquor [13] [14].

The use of the raw palm fruit bunch is environmentally friendly, sustainable, and economical. The residue of the oil-based sorbents of empty palm fruit bunch waste at the end of its life cycle can be used as high-energy fuel [15]. Nonwoven pads were prepared using cotton and polypropylene fibers and their oil sorption capacities were compared. The results indicate that for light crude oil, the oil sorption capacities of the needle punched cotton-containing sorbents were slightly greater than those of sorbents made of 100% polypropylene fibre [16]. In our project work course and fine cotton fibre, kapok and jute are used in different composition and blended.

1.1 MATERIALS AND METHODOLOGY

In this project work kapok, jute, fine and coarse cotton fibre are used. Fine cotton was purchased from Andhra Pradesh at a rate of 130 per kg. Course cotton was purchased at a rate of 90 per kg from Madhya Pradesh. Kapok at the rate of 400 per kg from Erode and the Jute was purchased from the west Bengal at the rate of 70 per kg.

Table 1: Blend proportion of samples

Sample number	Fine Cotton	Coarse Cotton	Kapok	Jute
1	25 %	25 %	45 %	5 %
2	25 %	25 %	40 %	10 %
3	25 %	25 %	35 %	15 %
4	25 %	25 %	30 %	20 %

The fibre web is formed using miniature carding machine. The needle punched nonwovens are produced by mechanical orientation and interlocking the fibre carded web. This mechanical interlocking in achieved with thousands of barbed felting needles repeatedly passing in and out of the web. The needle penetrates into the web and makes the fibers to entangle with each other. Samples are punched on both sides by feeding again in upside down.

At first, the measurements are taken according to the stencils. The measurement of the stencils is based on the ISO 13934 – 1:2013 (En). Now the cotton net fabric in relaxed for 12 hours and the fabric is spreaded on the table, into number of layers required. Spreading is done with minimum ply tension, so chance of shrinkage will be less after the sewing process is done. Now the stencils are placed on the spread fabric and markings are done with marker. Then the cutting process is done with the help of hand scissors. Now the cotton net is cut into individual panel according to the stencil's measurement. The samples are stitched with three layers, they are top layers, middle layers and the bottom layer. The top layer and the bottom are cotton net and middle layer is needle punched nonwoven. The stitches are made with single needle lock stitch sewing machine.

1.2 Testing Procedure Followed

Step 1. 300 g of diesel or HD oil is taken in a glass container and 0.3 g of fibre sample for each test.
Step 2. Container is kept on weighing scale.
Step 3. Sample is immersed for 5 minutes.
Step 4. After 5 minutes, samples are taken out and hang above container to collect dripping oil.
Step 5. Weight is noted after every one min.

2. RESULTS AND DISCUSSIONS

Table 2: HD oil sorption – [Needle punched nonwoven fabric]

Sample Number.	Sample weight in g	Oil sorption in g					
		0 min	1 min	2 min	3 min	4 min	5 min
1	0.21	8.2	5.2	4.84	4.6	4.48	4.4
2	0.21	9.4	5.8	5.26	4.8	4.59	4.43
3	0.21	10.5	5.43	4.88	3.5	3.02	2.92
4	0.21	11.2	4.95	4.71	4.47	4.38	4.3

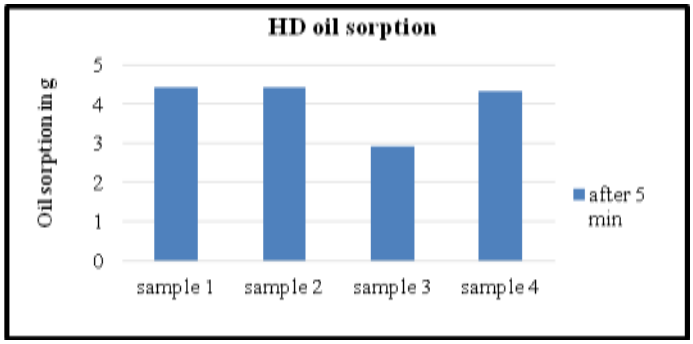


Figure 1: HD oil absorption

From the figure 1when the jute content is 5% then the absorption of oil for 0.21 g of samples is 4.43 g of oil is absorbed, then with jute content of 20% the absorption content is reduced in 4 g. From the above results increasing jute percentage reduces oil retention due oil absorption by jute fibre are low.

Table 3: Diesel sorption – Needle punched nonwoven fabric

Sample number	Sample weighing	Oil sorption in g					
		0 min	1 min	2 min	3 min	4 min	5 min
1	0.3	7.03	6.29	6.26	6.25	6.24	6.26
2	0.3	6.34	5.68	5.84	5.77	5.77	5.77
3	0.3	6.35	5.43	5.38	5.37	5.37	5.37
4	0.3	6.26	5.31	4.85	4.83	4.83	4.83

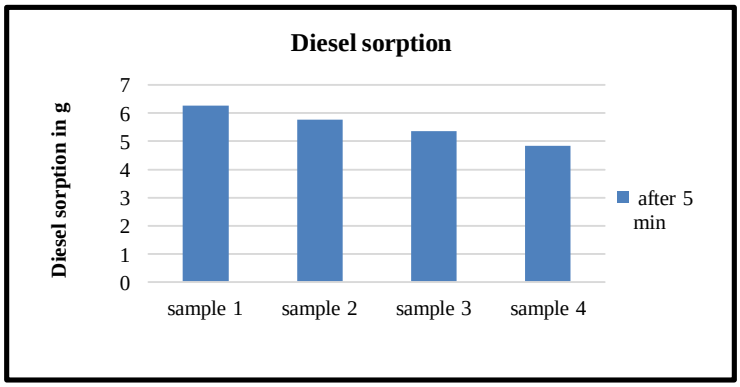
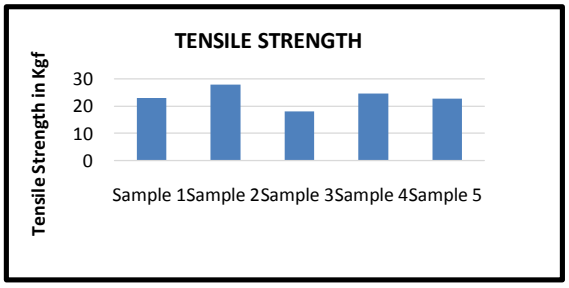


Figure 2: Diesel sorption – Needle punched nonwoven

From the figure2 when the jute content is 5% then the absorption of oil for 0.3g of samples the 6.26g of oil is absorbed, then 0.3g of sample with jute content of 20% the absorption the content is 5.37g. So then the jute content is increased then the absorption level decreases.

Table 4: Strength of cotton net fabric

S. No	Mean tensile strength [Kgf]	Mean elongation [mm]
1	23	12.6
2	28	17.6
3	18	12
4	24.7	16.4
5	22.7	22.1
Mean	23.28	16.14



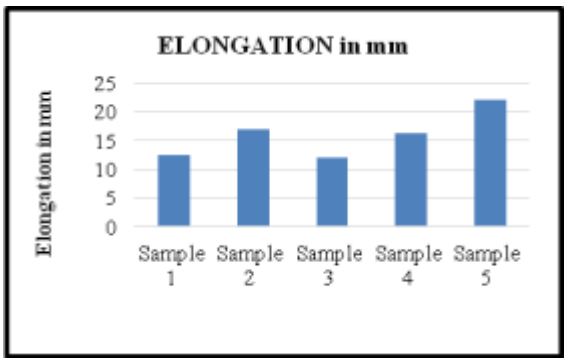
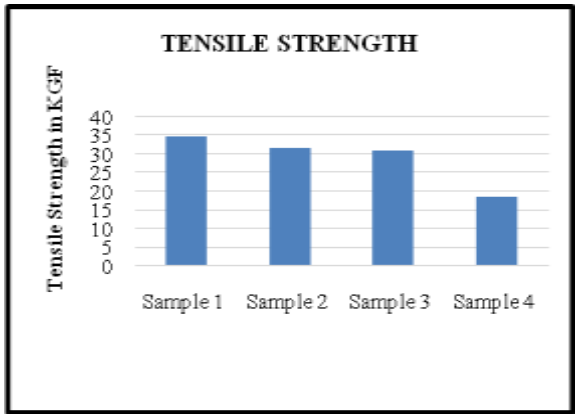


Figure 3: strength and elongation of cotton net fabric

The cotton net is selected for top and bottom layers of sorbents and tensile strength and elongation are tested in the universal tensile strength tester.

Table 5: Strength of stitched nonwoven in dry condition

Sample number	Mean tensile strength [kgf]	Mean elongation [mm]
1	34.9	19.5
2	31.9	19.9
3	31.1	23.6
4	18.7	19.1



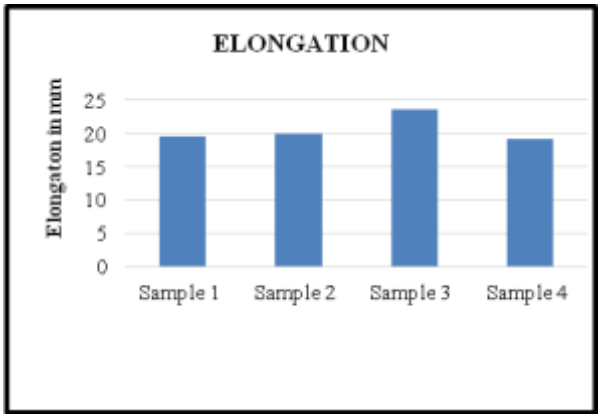
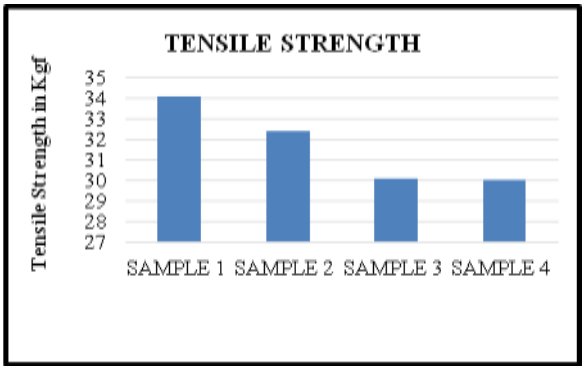


Figure 4: strength and elongation of stitched nonwoven in dry condition

The sorbent is tested in the dry condition for the elongation and tensile strength using universal automatic strength tester. The results from the figure 4 show it can be effectively used in real time applications.

Table 6: strength of stitched nonwoven in diesel

Sample number	Mean tensile strength [kgf]	Mean elongation [mm]
1	34.1	20.8
2	32.4	21.8
3	30.1	17.2
4	30.0	19.2



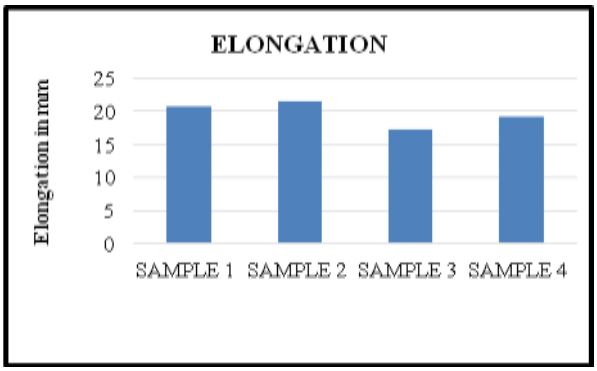


Figure 5: strength and elongation of stitched nonwoven in diesel

The sorbent is tested after immersing in diesel for 2 min for the elongation and tensile strength using universal automatic strength tester. The results from the figure 5 shows the there is no difference in tensile strength of dry and diesel immersed fabrics.

Table 7: strength of stitched nonwoven in HD engine oil

Sample number	Mean tensile strength [Kgf]	elongation [mm]
1	35.3	18.8
2	34.9	32.3
3	34.6	52.5
4	25.1	17.7

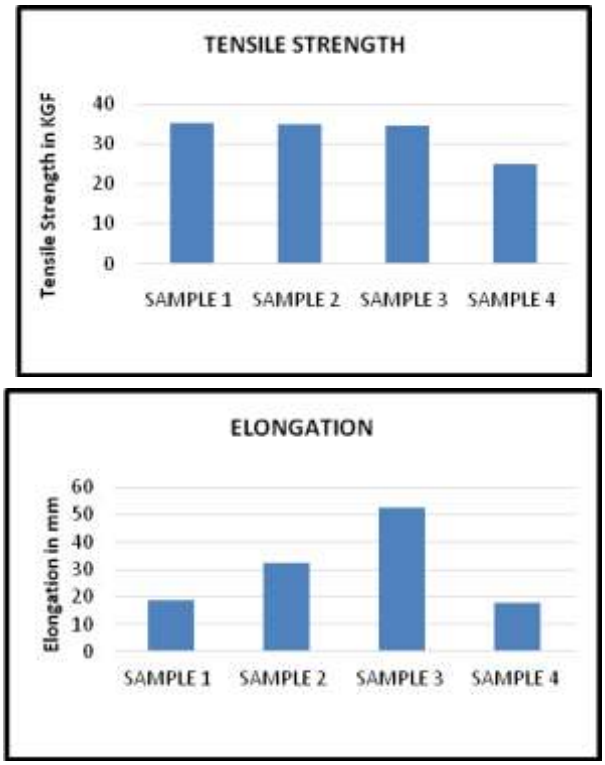


Figure 6: strength and elongation of stitched nonwoven in HD engine oil

The sorbent is tested after immersing in diesel for 2 min for the elongation and tensile strength using universal automatic strength tester. The results from the figure 6 shows the there is no difference in tensile strength of dry and diesel immersed fabrics.

3. CONCLUSION

In this work, sorbents are made from biodegradable fibre like cotton, kapok and jute fibre. Needle punched nonwoven fabrics are produced and sorbents are made by sandwiching cotton net fabric in top and bottom layers. The following conclusions were made from the research work; Sorbent is capable of retaining 40 to 60 g oil on its own weight of material. Increasing jute content in blend reduces oil retention capacity because of low sorption of oil by jute fibre. Needle punched fabric can't used directly because of poor tensile strength after absorption of oil. Tensile strength of sandwiched sorbent is in the range of 20 to 40 kgf based on blend component. This strength is enough for real time applications.

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