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Oil Spill Cleanup by Using Non-Woven Fabrics

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***Abstract*: Oil is one of the important sources of energy in the modern industrial world. It has to be transported from the source of production to many places across the globe through oceans and inland transport. During transportation the chance of oil spillage over the water body occurs due to accidents or by deliberate action during war time and this causes environmental pollution. Sorbents made from structured fibre assembly are found to be the best. material to absorb oil spill. The oil sorption and retention behavior of sorbents are influenced by the material and structure of the sorbents and oil physical characteristics. For sustainable environment, disposal of used sorbents is a major issue. This paper reviews about oil spill cleanup with special emphasis on the phenomenon of oil sorption, methods of oil spill cleanup, characteristics of oil sorbent materials, fluid flow through fibrous materials, types of fibre materials envisaged for making sorbents and test methods for oil sorbents. In this project, we have planned to prepare samples using cotton, viscose, and polypropylene. The needle punched non-woven fabric was prepared by various parameters like needle punch density (100, 200, 300) and GSM (150, 250, 350). The oils used are diesel oil and 4T engine oil. After preparing, we have planned to test the samples by tensile strength, sorption, and retention test and give the conclude which sample has more oil spill cleanup absorption.**

***Keywords*: non-woven fabrics, needle punch, oil spillage, oil spill cleanup.**

1. Introduction

Oil is a naturally occurring substance. The organic residues from the decay of plants and animals are converted by heat and pressure into petroleum, migrating upwards, sometimes over extensive areas, either to reach the surface or occasionally trapped in to become oil reservoirs. Oil is one of the most important sources of energy and is also used as raw material for synthetic polymers and chemicals worldwide. Oil has been a part of the natural environment for millions of years. Oil spill occurs over the seas, water bodies and land surfaces due to tanker disasters, wars, operation failures, equipment breakdown, accidents, and natural disasters during the production, transportation, storage and use of oil. Oil spills into land, river or ocean and imposes a major problem for the environment. So, it is necessary to clean the water or land immediately after the oil spill. The impact of marine oil spills on coastal environments and marine resources has over the past decade created increased public and government awareness and concern to preserve and protect the marine environment. When oil comes in contact with water, it forms an oil-in-water emulsion or floating film that needs to be removed before it is discharged into the environment. Even very low concentrations of oils can be toxic to microorganisms responsible for biodegradation in conventional sewage processes. Removal of crude oil and petroleum products that are spilled at sea has been a serious problem of the last decades. Another important threat to the environment comes from polycyclic aromatic hydrocarbons which are known to affect a variety of biological processes and can be potent cell mutagens and carcinogens. Oil is a very complex mixture of many different chemicals, and a mixture of components consists of different hydrocarbons that range from a light gas (methane) to heavy solids with differing properties. When oil is spilled on water or on land, the physical and chemical properties of oil change progressively. This process is referred to as 'weathering', i.e., these physio-chemical changes enhance oil dissolution in sea water. The weathering process includes evaporation, dissolution, dispersion, photochemical oxidation, microbial degradation, adsorption onto suspended materials and agglomeration. The volatile components present in oil evaporate quickly. Some of the medium-sized polycyclic aromatic hydrocarbons are slightly soluble. Some of the products, which are degraded by sun and microorganisms, are highly soluble. Weather rates are not constant but are usually highest in the first few hours. In practice, cleaning up an oil spill is a difficult economic problem. It is uneconomical to store large quantities of sorbents materials that are used to clean up the oil spill and their disposal. Now we have tried to introduce textile material for oil spill cleanup in marines. The cleaning of oil spill is defined with two terminologies, namely clean and recovery. Cleaning, in the context of an oil spill, may be defined as the return to a level of petroleum hydrocarbons that has no detectable impact on the function of an ecosystem. Recovery of an ecosystem is characterized by the re-establishment of a biological community in which the plants and animals characteristic of that community are present and functioning normally. Sorbent is an insoluble material or mixture of materials used to recover liquids through the mechanisms of absorption or adsorption, or both. The objective of this study is to review research work done on oil spill cleanup, oil sorption behavior of fibre-based sorbents and test methods for oil sorbents.

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2. Materials and Method

A. Materials

The materials used are Cotton, Viscose, Polypropylene, Diesel oil, Engine oil. The properties of the used materials are mentioned below.

Table 1
Cotton

Properties	value
Fineness	3.2 micronaire
Fibre length	40-60mm
Density	1.5–1.54 g / cm3
Moisture regain	8.5 %

Table 2
Viscose

Properties	value
Denier	1.2 denier
Tenacity	1.3-1.7 grams per dinear
Elongation	15% to 25%
Moisture content	12-13%
Density	1.52 g / cm3

Table 3
Polypropylene

properties	value
denier	1.8 denier
Tensile strength (gf/den)	3.5 to 5.5
Elongation (%)	40 to 100
Abrasion resistance	Good
Moisture absorption (%)	0 to 0.05
Softening point (°C)	140
Melting point (°C)	165

Table 4
Diesel

Properties	value
Surface tension mN/m	25
density	0.82

Table 5
Engine oil

Properties	value
Surface tension mN/m	31
density	0.9

B. Methods

The fabric manufacturing done needle punching. For the sampling purposes samples of various GSM has been made, the details of sampling mentioned below.

Table 6

No of samples	Fibres used	GSM	Needle punch density	Sample code
1	Cotton (C)	150 (1)	100	C1
2	Cotton (C)	250 (2)	200	C2
3	Cotton (C)	350 (3)	300	C3
4	Viscose (V)	150 (1)	100	V1
5	Viscose (V)	250 (2)	200	V2
6	Viscose (V)	350 (3)	300	V3
7	PP (P)	150 (1)	100	P1
8	PP (P)	250 (2)	200	P2
9	PP (P)	350 (3)	300	P3

3. Results and Discussion

A. GSM

We have tested the pre-determined GSM of non-woven fabrics of cotton, viscose, and polypropylene fabrics. We have got maximum determined only expect polypropylene 300 needle punch density.

Table 7

samples	GSM
Cotton 100 ND	169
Cotton 200 ND	215
Cotton 300 ND	251
Viscose 100 ND	186
Viscose 200 ND	246
Viscose 300 ND	315
PP 100 ND	159
PP 200 ND	272
PP 300 ND	402

B. Thickness

By the above thickness results of the non-woven fabrics of cotton, viscose and polypropylene 1-2mm mostly except polypropylene fabrics of 200 and 300 needle punch density has more thickness. By this we got to know that more oil sorption takes place in polypropylene fabrics when compared with other types of fabrics.

Table 8

samples	Thickness in mm
Cotton 100 ND	1.21
Cotton 200 ND	1.36
Cotton 300 ND	1.41
Viscose 100 ND	1.15
Viscose 200 ND	1.52
Viscose 300 ND	1.70
PP 100 ND	1.44
PP 200 ND	2.82
PP 300 ND	4.72

C. Tensile Strength

The tensile testing was taken in two directional ways longitudinal and traverse direction. When compared with both directions, the traverse direction has more tensile strength. The tensile strength and elongation of polypropylene non-woven fabric has more when compared with cotton and viscose fabrics.

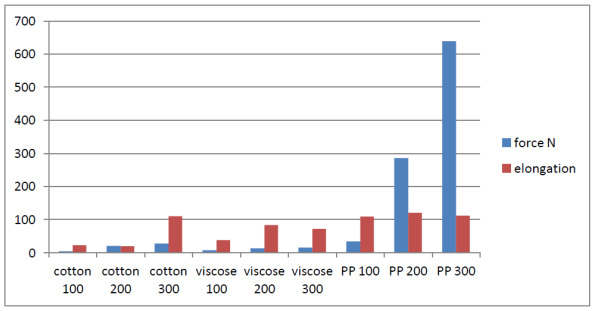

Fig. 1. Longitudinal direction

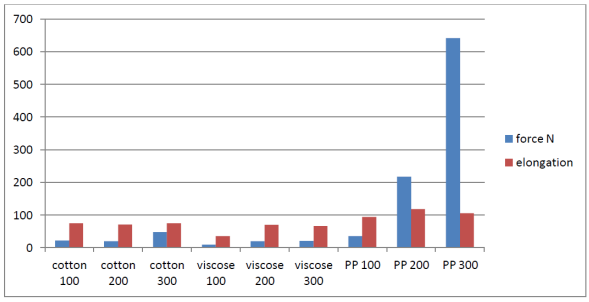

Fig. 2. Traverse direction

D. Oil Absorption Test

By the above sorption results for diesel oil was found that more absorbent in cotton and polypropylene fabric was good when compared with viscose fibre. The effect of GSM and thickness of the non-woven fabrics gives more sorption results. When the thickness increases the absorption also increases. The density of engine oil is more when compared with diesel oil. So that the after weight of the engine oil samples have more weight than the diesel oil samples. The dipping time also takes more in engine oil. The time required to immerse the sample in diesel oil is less than the engine oil.

Table 9
Engine oil absorption

ENGINE OIL				
S no	**Sample**	**Before sample weight**	**After sample weight**	**Oil sorbent (g)**
1	COTTON-100 ND	0.33	6.34	19.21
2	COTTON-200 ND	0.37	7.52	20.32
3	COTTON-300 ND	0.43	8.13	18.9
4	VISCOSE-100 ND	0.34	5.32	15.64
5	VISCOSE-200 ND	0.44	6.17	14.02
6	VISCOSE-300 ND	0.6	7.05	11.75
7	PP-100 ND	0.37	8.62	22.29
8	PP-200 ND	0.48	8.99	18.72
9	PP-300 ND	0.87	10.49	12.05

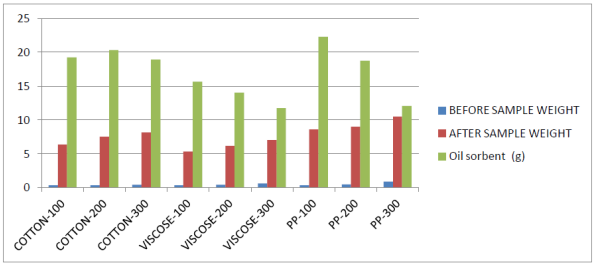

Fig. 3. Engine oil absorption

Table 10
Diesel oil absorption

Diesel Oil				
S.No	**Sample**	**Before Sample Weight**	**After Sample Weight**	**Oil Sorbent (g)**
1	Cotton-100 ND	0.29	4.52	15.58
2	Cotton-200 ND	0.36	5.15	14.3
3	Cotton-300 ND	0.42	5.62	13.38
4	Viscose-100 ND	0.31	3.63	11.7
5	Viscose-200 ND	0.46	4.91	10.67
6	Viscose-300 ND	0.6	5.73	9.55
7	PP-100 ND	0.34	6.45	18.97
8	PP-200 ND	0.9	11.1	15.69
9	PP-300 ND	0.9	11.1	12.33

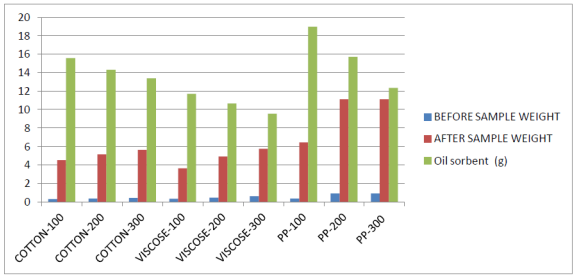

Fig. 4. Diesel oil absorption

E. Retention Test

The retention test results show that polypropylene fabric can retain more oil than the cotton and viscose fibre.

Table 11
Retention test by using diesel oil

Retention test by using diesel oil

	DIESEL								
TIME (SEC)	*COTTON (100D)*	*COTTON (200D)*	*COTTON (300D)*	*VISCOSE (100D)*	*VISCOSE (200D)*	*VISCOSE (300D)*	*PP (100D)*	*PP(200D)*	*PP (300D)*
00:20	0.04	0.03	0.03	0	0	0	0	0	0
00:40	0.07	0.04	0.06	0	0	0	0	0	0
01:00	0.09	0.06	0.09	0	0	0	0	0	0
01:20	0.102	0.06	0.1	0	0	0	0	0.02	0
01:40	0.11	0.09	0.12	0	0	0.01	0.03	0.02	0
02:00	0.118	0.11	0.15	0	0	0.01	0.03	0.02	0
02:20	0.122	0.12	0.15	0	0	0.01	0.03	0.02	0
02:40	0.13	0.13	0.16	0	0.02	0.02	0.06	0.02	0
03:00	0.138	0.15	0.16	0	0.02	0.03	0.06	0.02	0
03:20	0.14	0.15	0.16	0.02	0.02	0.03	0.06	0.04	0
03:40	0.142	0.17	0.17	0.02	0.02	0.03	0.06	0.04	0
04:00	0.147	0.17	0.17	0.02	0.04	0.05	0.06	0.04	0
04:20	0.148	0.17	0.17	0.02	0.04	0.05	0.09	0.04	0
04:40	0.149	0.17	0.19	0.02	0.04	0.05	0.09	0.06	0
05:00	0.15	0.17	0.19	0.02	0.04	0.07	0.09	0.06	0
INITIAL WT	0.29	0.31	0.49	0.36	0.41	0.52	0.39	0.51	0.83
FINAL WT	4.54	4.25	5.79	5.09	4.5	5.87	7.02	8.3	9.36
FTER 5MIN FINAL W	4.19	3.99	5.52	5.06	4.38	5.76	6.47	8.07	9.19

1) Diesel oil

1. The cotton fabric will retain diesel oil, slowly the weight of the sample will decrease by losing the oil from the fabric when hanging. By this we can say the

cotton cannot retain diesel oil for long time.

2. The viscose fabric will retain more diesel oil when compared with the cotton fabric, the oil can withstand in the fabric up to 3min constantly without losing weight and after that the oil slowly comes out from the fabric.
3. The polypropylene fabric will have excellent retain properties for diesel oil. It can withstand oil more time than viscose and cotton.

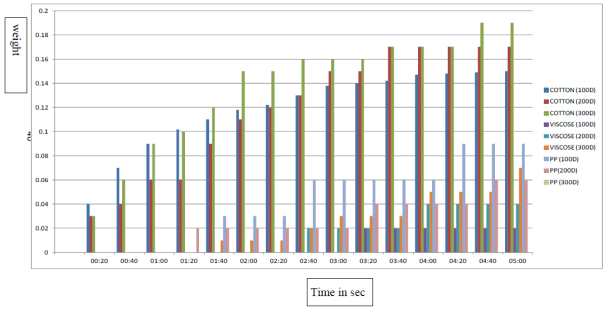

Fig. 5. Retention test by using diesel oil

2) Engine oil

1. Due to high density of engine oil, the oil will come out fast while hanging and have less retain property.
2. The viscose fabric can retain up to 10-20 sec than the cotton fibre.
3. The polypropylene fabric also cannot withstand the engine oil due to its high density, but has better retention property when compared with cotton and viscose.

By this we can say that polypropylene has better sorption and retention properties than viscose and cotton fabric.

Table 12
Retention test by using 4T engine

Retention test by using 4T engine

				4T ENGINE OIL					
TIME (SEC)	COTTON (100D)	COTTON (200D)	COTTON (300D)	VISCOSE (100D)	VISCOSE (200D)	VISCOSE (300D)	PP (100D)	PP(200D)	PP (300D)
00:20	0.03	0.09	0.26	0.1	0.1	0.11	0.15	0.03	0
00:40	0.11	0.22	0.51	0.19	0.19	0.22	0.28	0.14	0.05
01:00	0.2	0.31	0.64	0.27	0.29	0.32	0.38	0.21	0.07
01:20	0.26	0.37	0.78	0.32	0.34	0.4	0.44	0.28	0.11
01:40	0.32	0.46	0.84	0.39	0.41	0.45	0.49	0.34	0.12
02:00	0.38	0.53	0.93	0.44	0.45	0.52	0.56	0.37	0.16
02:20	0.44	0.57	1.02	0.49	0.51	0.57	0.59	0.41	0.19
02:40	0.51	0.61	1.07	0.53	0.56	0.6	0.61	0.44	0.19
03:00	0.55	0.64	1.11	0.57	0.6	0.63	0.65	0.44	0.21
03:20	0.59	0.7	1.13	0.6	0.63	0.67	0.68	0.47	0.21
03:40	0.63	0.76	1.2	0.63	0.63	0.71	0.71	0.47	0.24
04:00	0.68	0.79	1.21	0.65	0.67	0.73	0.71	0.49	0.24
04:20	0.72	0.82	1.25	0.67	0.7	0.75	0.73	0.51	0.24
04:40	0.75	0.85	1.26	0.7	0.72	0.79	0.73	0.51	0.26
05:00	0.79	0.9	1.26	0.72	0.76	0.81	0.75	0.51	0.26
INITIAL WT	0.39	0.32	0.48	0.34	0.44	0.59	0.35	0.57	0.9
FINAL WT	7.9	6.45	8.61	5.19	5.92	7.24	8.34	9.13	11.53
AFTER 5MIN WEIGHT	6.76	5.35	7.08	4.36	5.05	6.31	7.24	8.52	11.08

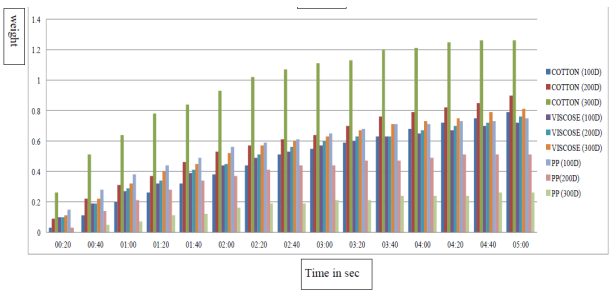

Fig. 6. Retention test by using 4T engine

4. Conclusion

In this project work, three available fibre materials were used after non-woven fabric preparation for sorbent materials for the oil spill. The Sorption capacity of the fibres was increased with time and thickness of the oil film. All the three different fibre materials were converted into non-woven fabrics by needle punching technique, these non-woven fabrics were tested GSM (402 of polypropylene 300 needle density), thickness (4.72 mm), tensile strength (polypropylene in both longitudinal and transverse direction), sorption test and retention test. Sorption test and retention test are directly proportional to GSM and thickness of the fabric. There is indeed great scope in realizing a clean environment free from pollution with the use of fibre-based oil sorbents. The predetermined structures of cotton, viscose and polypropylene needle punched fabrics were used. From the study, it may conclude that polypropylene non-woven fabric has greater oil sorbent and oil retention capacity than viscose and cotton fabric. The polypropylene is hydrophobic and can absorb oil only without water.

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