Cyclodextrin Treatment To Improve The Functional Property of P/C Blended Material

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Abstract:- **Blended textiles application is more in apparel industry due to the cost factor and functional properties. But, due to their partial hydrophobicity and soiling properties it makes the wearer for less comfort. This is due to the absence of water absorbing group in PET portion. And in general, Comfort properties are more important than the aesthetic properties, particularly when the textile material is in contact with the skin. Among all the comfort properties, good absorption and easy drying are two major requirements for apparel, which are in contact with the skin. When 100% PET is used as apparel it needs to absorb sweat quickly and transport it to the outer surface of the garment. From the outer surface, the sweat needs to get evaporated fast to keep the body dry and cool.**

Poor moisture retaining capacity of the PET fibre does not allow it to dissipate static charges built up on the surface during normal wear conditions of the P/C garment. These static charges cause discomfort when in contact with human skin. This is especially so in conditions of low temperatures and low humidity (RH) where it causes the fabric to "stick" to the skin when wearing 100% PET. These static charges also play an important role in attracting dust particles and stains onto the fabric causing to be "Soiled" easily. These are difficult to remove by conventional washing. This makes the P/C materials is difficult to wash and re-soiling can be happen very easily during washing.

PET fibre has an ability to resist most bacteria, microbes, and insects because PET is not digestible. However, soiled fibre can cultivate microbes because of the added source of food. This still makes the wearer very less comfort. To overcome combined moisture management, stain/soil release and antimicrobial treatment on PET is necessary.

This research work is aimed to impart the above discussed requirements on P/C to find out overall solution for the hydrophobicity, soiling and antimicrobial problem by simple cyclodextrin treatment. Cyclodextrin (CD) application in finishing has emerged as the best alternative to fibre modification. This study has been tried out by using commercial specialty chemicals with Cyclodextrin. The result was analyzed for wicking, stain release, Drying time and microbial growth. The result was compared with untreated PET and the results prove that it has drastic changes in the case of hydrophilic property. As P/C material has made into hydrophilic it can counter natural fibers where they are in very much demand and costlier these days.

Key words: P/C Blend, Beta cyclodextrin, sodium hydroxide, wicking, soil release, antimicrobial, drying time

1. INTRODUCTION

Increasing concern about the multi functional property for the textile fibre, it is important to improve the functional property of the fibre through chemical group introduction (1). Textile apparels are commonly produced from mixture of cotton and PET fibre.100 % PET fibre made up of garment may be uncomfortable sensation which may cause frictional festers on wearer. In some other application also, the problem of moisture transport through fabric is crucial, especially sports wear.

Cyclodextrins are the most widely used molecules that form host/guest-type inclusion complexes. The aim of such derivations may be:

a) to improve the solubility of the CD derivative (and its complexes)(2-4);
b) to improve the fitting and/or the association between the CD and its guest, with concomitant stabilization of the guest, reducing its reactivity and mobility(5-7);
c) to attach specific (catalytic) groups to the binding site (8-10); or
d) to form insoluble, immobilized CD-containing structures, polymers (11-12).

With the beginning of the 1950s, two groups led by French (13) and Cramer (14) began to work intensively on the enzymic production of CDs, on fractionating them to pure components, and on characterizing their true chemical and physical properties. French (15) discovered that there are even larger CDs, while Cramer's group mainly directed their attention toward the inclusion complex-forming properties of the cyclic dextrins.

The need to preserve fabrics against rotting and mildew stain, particularly in industrial usage, has long been recognized. However, the use of antimicrobial agent to inhibit odor development resulting from biological growth on textiles exposed to perspiration had not been considered a real need until relatively recently. The greater use of synthetic fibers and blends in such items as shirts, hosiery, blouses, and underwear has accelerated the need for antimicrobial finishes on clothing. The moisture transport characteristics of such blends tend to cause a greater degree of "perspiration wetness" than occurs with fibers of wholly natural fibers (16).Additionally, there is a growing volume of literature demonstrating the survival and growth of microorganisms in textiles and their dissemination as a health risk (17-18).

High rate of growth of polyester fibres is due to their outstanding physical properties, chemical resistance, easy properties, and resistance to moth, mildew and microorganism. In spite of its outstanding performance (19-24), there are some shortcomings in PET, for example:

- Hydrophobic nature,
- Ease of soiling,
- Static charge build-up,
- Tendency to pill,
- Lack of dye receptor sites in the polymer chain.

Extensive research has therefore, been carried out on PET to overcome the above mentioned drawbacks. Such changes (physical and chemical) have led the manufacture of modified polyester fibres. Modification of normal polyester has been accomplished by following routes (20-26):

1. Change in the chemical composition of the PET molecule by introducing a third and/or fourth component into the polymer chain during polymerization.
2. Use of certain additives (particulate fillers, pigments of polymers) in the melt phase prior to extrusion.
3. Modification during melt spinning such as hollow varied profile and micro-denier fibres for specific applications.
4. Surface modification of normal polyester fibre for producing specific effects.

2. MATERIALS AND METHODOLOGY:

2.1. Substrate:

80/20 Polyester-Cotton woven bleached fabric (EPI-76; PPI-58); COUNT-40^{S} X $40^{S;}$ GSM -120

2.2. Chemical:

Beta cyclodextrin

2.3. Auxiliaries:

Sodium Hydroxide

2.4. Methodology:

Padding (80% expression by one dip one nip process)-Drying –Curing

3. TESTING:

3.1. Wicking Test Method

The fabric strip is cut into 1(inch) width x 8 (inch) length, using a graduated scale was marked using a pen. In this test fabric strip marked 1 inch is immersed vertically with its lower edge in a reservoir of distilled water. For identification water-soluble dyes is added with distilled water. After regular interval of time, the wicking height is noted and measured using scale.

3.2. Stain Release Test (AATCC 130)

This test measures the ability of a fabric to release oily stains during home laundering.

3.3. Antimicrobial Testing (AATCC147)

Evaluation of antimicrobial activity was performed qualitatively using AATCC 147. The test was performed on samples taken in order to determine both the antimicrobial effect of the laundered and unlaundered samples as compared to an untreated control.

3.4. Determination of Drying Time:

In house test method is used: A sample of the fabric is weighed and a measured amount of distilled/de ionised water introduced onto the balance, The fabric is placed centrally and carefully on the balance with the face of the fabric over the water and then re-weighed The drying time is determined by the time taken for the fabric to return to the original recorded weight.

4. Result and Analysis

4.1Wicking result analysis:

The wicking property of the P/C material shows that the wicking time after 30 min is low compare to other treated fabric since the fibre is fully hydrophobic in nature and when it is treated with sodium hydroxide the polyethylene teraphthalate is converted in to sodium teraphthalate resulting which the wicking property after treating with sodium hydroxide is increased and due to the presence of hydroxyl group in CD, the water retaining property and wicking is getting increased .It can be seen with the result given in Table.1 and Fig.1

TABLE 1. Wicking Results of Treated and Untreated Sample

S.NO	Sample	Sample Code	Wicking results in cm After 30 min	
			WARP	WEFT
1	Un-finished	S1	8.2	7.8
2	CD 2 gpl	S2	8.4	8.3
3	NaOH-5 gpl	S3	8.9	8.6
4	CD 2 gpl NaOH-5 gpl	S4	9.1	9.1
5	CD 4 gpl NaOH-8 gpl	S5	9.4	8.3
6	CD 6 gpl NaOH-10gpl	S6	9.8	9.4
7	CD 8 gpl NaOH-12gpl	S7	9.9	9.4
8	CD 10 gpl NaOH-15gpl	S8	9.8	9.4

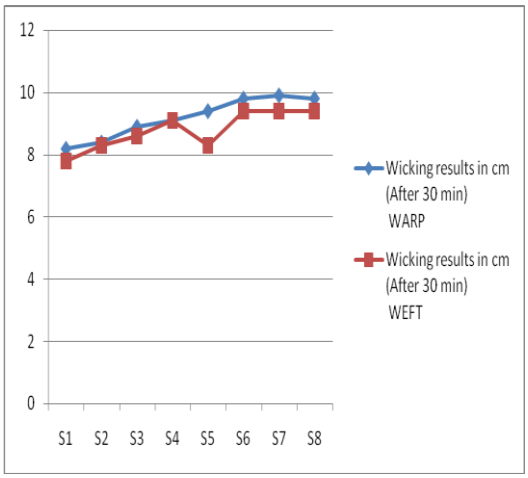

Fig.1 Comparison of Wicking Property of Treated and Untreated Sample

4.2. Stain Release Property:

The hydrophobic and hydrophilic property of the textile materials is directly influenced by the presence of water loving group in the fibre and when the fibre has more water loving, the stain release property get increased due to less adherence property between fibre and stain. The result shows that treated material is having more stain release property than untreated one. Due to the ability of water absorption property of sodium hydroxide and CD treated P/C, the stain releasing property get increased. Refer Table.2 and Fig.2

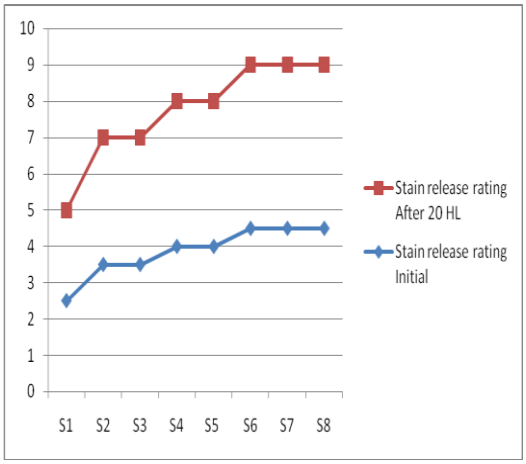

Fig.II Comparison of Stain Release Property of Treated and Untreated Sample

4.3. Bacterial Reduction Analysis:

In general, the PET fibre has good antimicrobial property than cotton since it is not biodegradable in nature and the fibre is inert in nature against the fungal and mildew growth. However, the stained sample may shows the different microbial growth based on the type of stain and its origin. And the synthetic fibre also get affected by the presence of stain and the result shows the stained P/C has less bacterial reduction than untreated. And the CD & sodium hydroxide increase the bacterial reduction due to the antibacterial property of those treatments. The below Table.3 and Fig.3 shows the bacterial reduction of various treated samples

TABLE 2.Stain Release Property of Treated and Untreated Sample

S.NO	Sample	Sample Code	Stain release rating	
			Initial	After 20 HL
1	Un-finished	S1	2.5	2.5
2	CD 2 gpl	S2	3.5	3.5
3	NaOH-5 gpl	S3	3.5	3.5
4	CD 2 gpl NaOH-5 gpl	S4	4.0	4.0
5	CD 4 gpl NaOH-8 gpl	S5	4.0	4.0
6	CD 6 gpl NaOH-10gpl	S6	4.5	4.5
7	CD 8 gpl NaOH-12gpl	S7	4.5	4.5
8	CD 10 gpl NaOH-15gpl	S8	4.5	4.5

TABLE 3. Bacterial Reduction Property of Treated and Untreated Sample

S.NO	Sample description	Sample code	Bacterial reduction (%)
1	Stained sample	S1	65
2	Unfinished sample	S2	78
3	CD 2 gpl	S3	80
4	NaOH-5 gpl	S4	76
5	CD 2 gpl NaOH-5 gpl	S5	76
6	CD 4 gpl NaOH-8 gpl	S6	78
7	CD 6 gpl NaOH-10gpl	S7	79
8	CD 8 gpl NaOH-12gpl	S8	80
9	CD 10 gpl NaOH-15gpl	S9	80

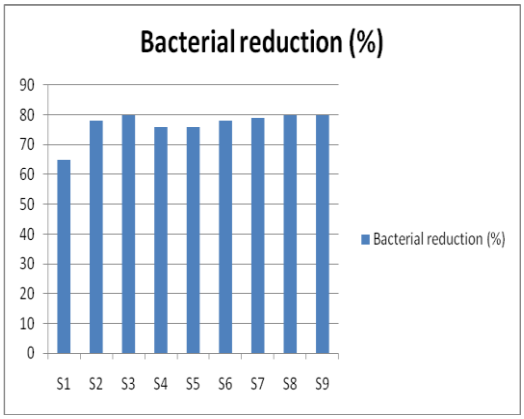

Fig.3 Comparison of Bacterial reduction property of treated and untreated sample

4.4. Drying Time Analysis:

The water absorption and transporting of water molecule in the PET fibre is less compare to natural fibre. And the water evaporation time is prime important in case of sportswear and due to high tenacity the synthetic fibre, the application of synthetic fibre in sportswear is more. The treatment with CD and sodium hydroxide increase the hydroxyl group of PET fibre and resulting which the water evaporation time increased and the alkali treatment cause hydrolysation of PET and the crystalline of the fibre altered and the drying time increased The below Table.4 and Fig. 4 shows that the treated samples has more drying time than untreated sample.

TABLE. 4 Drying Property of Treated and Untreated Sample

S.NO	Sample description	Sample code	Drying time
1	Un-finished	S1	>30 min
2	CD 2 gpl	S2	25 min
3	NaOH-5 gpl	S3	>30 min
4	CD 2 gpl NaOH-5 gpl	S4	24 min
5	CD 4 gpl NaOH-8 gpl	S5	23 min
6	CD 6 gpl NaOH-10gpl	S6	20min
7	CD 8 gpl NaOH-12gpl	S7	19 min
8	CD 10 gpl NaOH-15gpl	S8	19 min

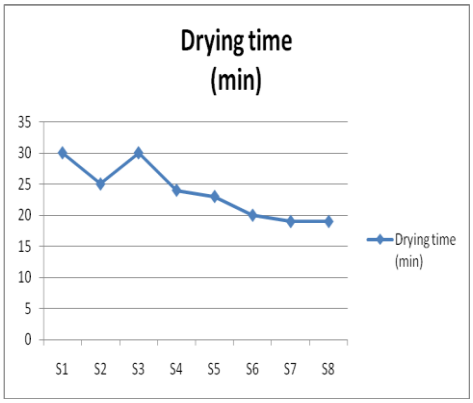

Fig.4 Comparison of drying property of treated and untreated sample

4.5. SEM Analysis:

The SEM analysis of the treated and untreated sample clearly shows the presence of etching and the dotted area show the presence CD on the treated sample.

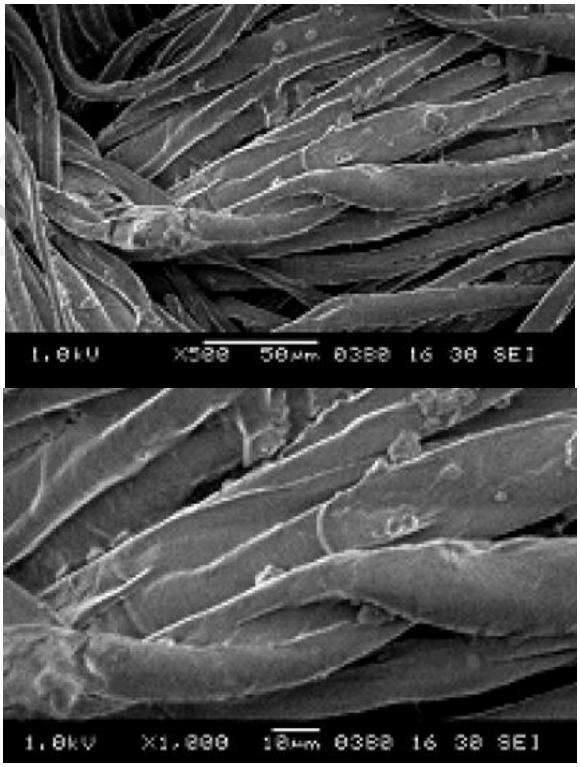

Fig. 5 SEM analysis of treated and untreated sample

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