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Effect of Polyurethane Finish on Hydrophobic Properties of Cotton Fabric

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Abstract: *The main purpose of this research is to produce hydrophobic finished on cotton fabric. In this study, hydrophobic finishes on cotton fabric are done by using different compositions of polyurethane and silicone oil.*

Firstly, cotton fabric, polyurethane and silicone oil are collected from local market and fabric analysis is carried out according to the testing procedures. Secondly, five different compositions of hydrophobic finishing solution are prepared to give the finishing treatment with the selected fabrics. Thirdly, the treated fabrics are subjected to heat treatment under a thermal press. Finally, the hydrophobic properties of treated fabric such as wetting by wicking and spray rating are tested. It is found that the finished fabric shows the rating of 90 for 80-20% and 90-10% compositions. Moreover, the surface morphology of all treated fabrics is studied by using polarising microscope.

Keywords: *hydrophobic, polyurethane, silicone oil, wetting by wicking, spray rating.*

1. INTRODUCTION:

Textile finishing is a series of processing operation that convert the woven or knitted cloth into a usable material and more specifically to any process performed after dyeing the yarn or fabric to improve their appearance, handle and functional properties [1]. Most of the textiles pass through a finishing process during or at the final stage of their production, where their visual and functional characteristics are modified and influenced positively [2]. In order to impart the required functional properties to the fibre or fabric, it is customary to subject the material to different type of physical and chemical treatments [3]. Chemical treatment of the fibres changes their appearance and improves their functional and comfort properties [2].

Functional finishing is being influenced by the need not only to develop innovative and improved functionalities but also to fulfill the demands in terms of health, safety and environmental protection. Apart from providing excellent protection, the developed functional textiles should offer good thermo-physiological properties and excellent skin sensory comfort for the wearer. The different functional finishes include insect repellent finishes, antimicrobial finishes, hydrophobic and oleophobic finishes, flame retardant finishes, ultraviolet production finishes, radiation protection finishes, ballistic and stab protection finishes, antistatic finishes, and chemical protection finishes [2].

Hydrophobicity of the surfaces is controlled by the chemical composition and geometry of surface. There are many methods of imparting hydrophobic character to fabric surfaces by the use of aluminium and zirconium soaps, waxes and wax like substances, metal complexes, pyridinium compounds, hydrophobic polymer films and attachment of hydrophobic monomers via physical or chemical sorption processes [4].

The formation of hydrophobic surface on the treated fabric prevents water to penetrate through the fabric and moisten textile material. Drops of water form spheres on the surface of the fabric and roll off its surface. After hydrophobic treatment the fabric remains breathable keeping the main hygienic properties. The fabric acquires waterproof property, but to a certain value, because inter-fibre space remains opens [5].

This research is intended to impart hydrophobic properties to cotton fabric by forming continuous thin film which protects the fibres from abrasion and improves the air-permeability. In this research, three portions are included. First portion is the collection of suitable cotton fabric and chemicals from the local market. Second portion is the treated of selected cotton fabric with hydrophobic agents to change the fibre structure for permanent effect. In the last portion, hydrophobic treated fabrics are analysed, compared, and discussed to determine the most preferable hydrophobic properties.

2. MATERIALS:

Collection and Preparation of Raw Materials

Cotton fabric (surface density 243.48 g/m^2), polyurethane and silicone oil were purchased from Theingyi Bazaar. These collected fabric is analysed to determine their physical properties. After that, various percentages of chemical solution were prepared for this treatment. The total amount of chemical solution used for this treatment was 25 g for each treatment

3. METHOD:

Experimental Procedure

Firstly, the sample fabrics are impregnated in aqueous solution of polyurethane and silicone oil. The impregnated fabrics are squeezed by using a padding mangle. In this treatment, wet pick-up percentage of treated fabric is 85%. After that, the padded fabrics are dried in an oven at the temperature of 110° C for 30 min. And then, the dried fabric is placed under thermal press at the temperature of 150°C for 15 sec. After treating the fabrics, all treated fabrics are analysed and tested in order to investigate the finishing effect and their related properties. The classifications of treated samples are shown in Table I.

TABLE I
CLASSIFICATION OF ALL TREATED SAMPLES

Types of Samples	Sample Code		Sample Composition (PU-Si) %
Cotton	C	C_0	Untreated Fabric
		C_1	50-50
		C_2	60-40
		C_3	70-30
		C_4	80-20
		C_5	90-10

- **PU- Polyurethane**
- **Si - Silicone**

4. RESULTS AND DISCUSSION:

A. Determination the effect of Treatment on Cotton Fabric

Five different samples are analysed and tested for hydrophobic properties such as wetting by wicking test (water absorption), spray test, and contact angle measurement. Moreover, polarising microscope applied to investigate the surface morphology of treated fabrics. Summaries of the results are shown in Table II.

TABLE II
SUMMARY OF THE HYDROPHOBIC RESULT ON UNTREATED AND TREATED COTTON FABRICS

Sample Code	Wetting by Wicking	Spray Rating	Contact Angle	
			30 sec	60 sec
C_0	201.06	0	0°	0°
C_1	77.77	70	120°	120°
C_2	56.28	80	122°	120°
C_3	47.18	80	130°	120°
C_4	44.72	90	134°	120°
C_5	41.40	90	140°	121°

(1) Wetting by Wicking: Wetting by wicking is one of the important factors in determining the hydrophobic properties of treated fabrics. Water absorption percentages of untreated and treated fabrics are shown in Fig.1. From the experimental results, it is found that water absorption percentages of all treated fabrics are slightly decreased as comparing the untreated fabrics. This is due to the fact that, polyurethane resins cover the fibre surface and block the hydrophilic group in the fibres. The greater the amount of polyurethane resin, the higher the hydrophobic effects can be achieved.

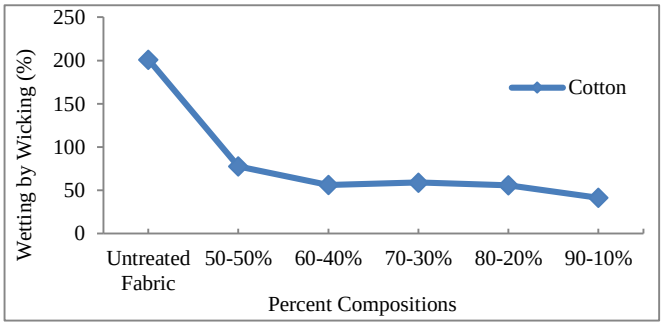

Fig.1 Wetting by wicking of untreated and treated fabrics

(2) Spray Test: The spray test determines the resistances of the fabrics by water. All treated fabrics are appreciably better than untreated fabrics in all compositions. Among them, 80-20 % and 90-10% composition of treated fabrics has the highest rating. In both cases, it can be noted that the water resistance is increased when the amount of silicone oil used is reduced. To get the desired degree of repellency, the amount of silicone oil used must be especially controlled in this study. The more decrease the water absorption percentage, the more increase the spray rating. Spray rating of all treated fabrics is compared with the following rating chart. The spray ratings of untreated and treated fabrics are shown in Table III.

(3) Contact Angle Measurement: Contact angle is the angle between the solid surface and tangent to the water surface. On the hydrophobic surface, the contact angle is greater than 90° and the water drop tends to bead up on the surface. On the other hand, if the surface is hydrophilic, the contact angle is less than 90° and the water drop tends to be spread out and wet the surface. In this research, the digital photographs are used to measure the contact angle. These measurements are performed in the two time conditions (30 sec and 60 sec). At first, the contact angles of untreated fabrics are measured. It is observed that the water drop seeped into the fabric within 5 sec to 10 sec and thus, the contact angle of untreated cotton fabric is zero. When the water drop is placed on the untreated rayon fabric, the water drop does not seep instantly into the fabric.

According to the contact angle measurements, the water repellent effects are obtained in treated cotton fabrics. However, it can be seen that the values of contact angle are varied with their measuring time (30 sec and 60 sec). The values of contact angles in 30 sec are greater than that of the contact angles in 60 sec. The reason for this is that the water drop seeped into the fabric as long as the time taken. Nevertheless, the value of contact angle is greater than 90° and thus these treated fabrics are retained the hydrophobic effect. Moreover, it is also found that, the content of chemical compositions influences the repellency effect. In this research, the greater the amount of polyurethane used, the higher the contact angles are formed in both fabrics.

(4) Polarising Microscope: Surface morphological feature is important for hydrophobic fabric to maintain its comfort properties in terms of air permeability and moisture permeability during its practical usage. Morphological investigations can be done by using polarising microscope.

In this research, the surface morphology of untreated and treated fabrics is studied with the aid of the photomicrographs taken by polarising microscope. These photomicrographs are shown in Fig.2. Based on visual study, it is found that the untreated fabrics have open structure with protruding fibres. The surface morphology of all treated fabrics did not noticeably change as comparing the untreated fabrics. This is due to the formation of crosslinking formed by the hydroxyl groups in the fabrics and hydrophobic finishing solution.

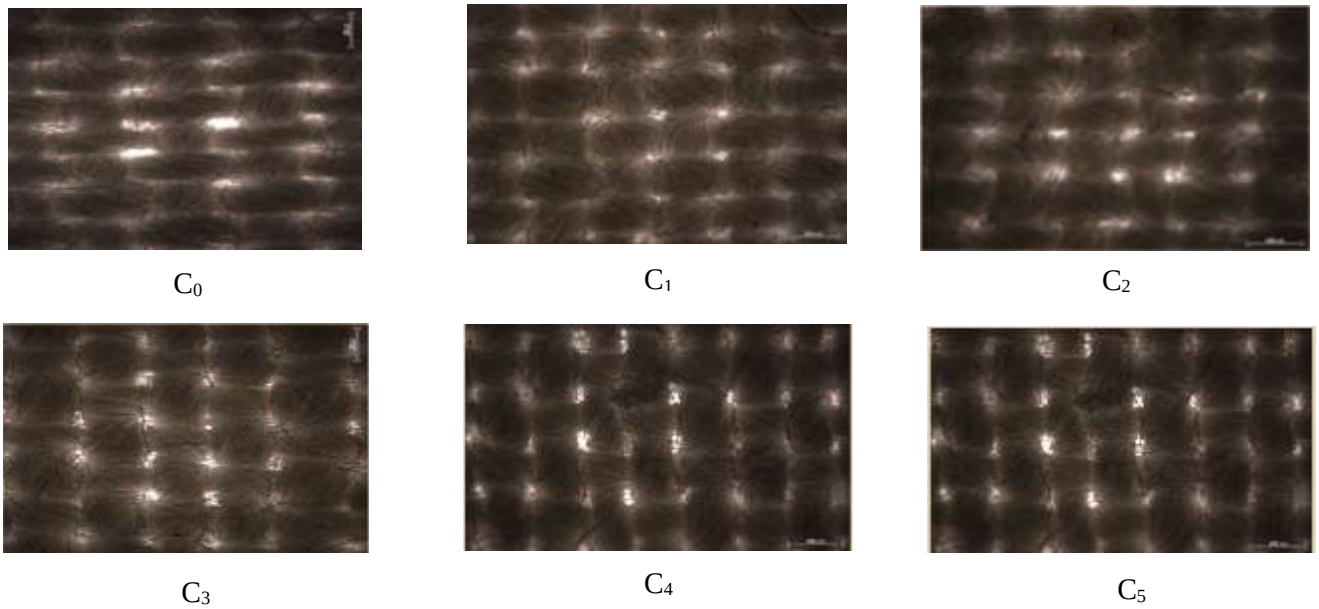

Fig.2 Photomicrographs of untreated and treated cotton fabrics

5. CONCLUSION:

Based on the experimental results, the sample fabrics treated with different compositions of hydrophobic solution can reduce their wettability in comparison with the untreated fabrics. Moreover, the contact angles of all treated fabrics are greater than 90° which show that good water repellency is obtained in all treatments. Therefore, the hydrophobic effect is generally achieved in all of the treated fabrics. Among them, the fabrics treated with 80-20% and 90-10% compositions give the best hydrophobic effect owing to their better results. Although the best hydrophobic effect is

obtained in these fabrics, the fabrics are stiffer than the other treated fabrics as the amount of polyurethane is used more than the other compositions. However, the surface morphology of all treated fabrics is unobtrusively changed as comparing the untreated fabrics according to the polarising microscopic results. And thus, it can be concluded that the cotton fabric is positively affected by treating with polyurethane and silicone oil in producing the hydrophobic fabrics.

6. RECOMMENDATIONS:

According to the observation, the handle of all treated fabrics is rigid although all treated fabrics attain the hydrophobic effect. In this research, washing test has not been investigated, it is suggested that the washing test should be carried out in order to study the durability of hydrophobic treated fabrics as for the future work.

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