Foolproof solutions to water proofing problems

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Abstract

In the current scenario of globalised trade, the need for speciality textiles is constantly growing, leading to more technical developments and innovations in advanced textiles for multi-functionalities. The enhancement of textile performances according to the consumer's demands includes a large array of properties with higher added value. To achieve this, the formulation and understanding of polymeric surfaces have progressed tremendously, allowing product developers to obtain systems with well-defined functionality. The use of coating for textiles is one of the possible ways to manufacture functional textile products.

TEXTILE COATING CAN be defined as the process of depositing a resin over a textile substrate, on one or two sides. The different characteristics of the substrate and the coating product are combined to produce a new structure that acquires the best properties of each component.

There are different procedures for the coating of textiles and not all are suitable for all products or substrates. One of the procedures most used is direct coating, which is based on the application of one or various layers of polyurethane, PVC, acrylic resins etc in paste form paste over the textile substrate, using a knife over air and knife over roll.

Polyurethane polymers are macromolecules made up of smaller, repeating units known as monomers. Generally, they consist of a primary long-chain backbone molecule with attached side groups. PU coatings are specifically preferred if abnormal impact and abrasion resistances are required, as well as for various outdoor and marine uses (due to their good weatherability). PU coatings are used to produce tents of different sizes, in upholstery and in waterproof protective clothing. Other examples include luggage, footwear, glove and waterproof mattress covers, as well as imitation leather.

Polyurethane resins are reaction products of a poly-isocyanate (materials containing more than one – NCO group) with at least one other species containing active hydrogen, often a polyol (materials containing more than one -OH group). Due to these two different groups, polyurethanes (PUs) consisting of alternating soft and hard segments are the most actively used polymers, with a unique combination of a wide range of physical and chemical properties such as abrasion resistance, water repellency, leather appearance, etc. These properties provided by PU coating on textile substrates are very attractive in many textile applications.

Sarex Chemicals has also developed a special PU-based coating, Fabcoat-WB. It is a ready-to-use coating compound, recommended for outdoor fabrics like Cordura, tents, luggage fabrics, etc. It forms a clear and tack-free film with high water column. To obtain a higher water column, two coatings of Fabcoat-WB are recommended.

Jackets Tents Furnishing fabric Luggage fabric

PU coatings have a variety of textile applications

Manufacturing of polyurethane

Synthetic polymers, such as polyurethane, are produced by reacting monomers in a reaction vessel. In order to produce polyurethane, a step—also known as condensation—reaction is performed.

In this type of chemical reaction, the monomers that are present contain reacting end groups. Specifically, a diisocyanate (OCN-RNCO) is reacted with a diol (HO-R-OH). The first step of this reaction results in the chemical linking of the two molecules, leaving a reactive alcohol (OH) on one side and a reactive isocyanate (NCO) on the other. These groups react further with other monomers to form a larger, longer molecule. This is a rapid process, which yields high-molecular-weight materials even at room temperature.

Materials and Method

Application process

Pre-impregnation of fabric with fluorocarbon is recommended before coating to avoid penetration of coating. A predetermined quantity of Fabcoat-WB was taken, depending on the add-on required, and was coated on the fluorocarbon treated fabric using a lab coater, with a knife on air technique. The samples were coated once or twice, depending on the add-on required, dried at 120°C for 2 min and cured at 160°C for 3 min. For double and triple coatings, drying was carried out after each application of the coating, while the curing was carried out at the end (ie, after drying the last coating).

Test methods

Water Resistance: Hydrostatic Pressure Test (Test Method: ISO 811:1981)

A specimen is subjected to a steadily increasing pressure of water on one face, under standard conditions, until penetration occurs in three places. The water pressure may be applied from below or from above the test specimen. The hydrostatic head supported by a fabric is a measure of the resistance to the passage of water through the fabric.

Moisture Vapour Transmission Rate (MVTR): Test Method (ASTM E96)

This test was conducted in a wind tunnel, which is housed in an environmental chamber. The air temperature in the chamber was 23±0.5°C, and the dew point temperature was 12±1°C (50% relative humidity). The air velocity in the wind tunnel is 2.8±0.25 m/s. Six circular specimens of 7.4cm diameter were cut from the fabric. Each specimen was placed on a 155ml aluminium cup that was filled with 100ml of distilled water, covered with a gasket, and then clamped. Coated fabrics were placed with the coated side facing the water in the cup. Each cup was first weighed to the nearest 0.001g and then placed inside the wind tunnel. Subsequent weighings were made at 3, 6, 9, 13, 23, 26, and 30 hours after placement in the chamber. The moisture vapour transmission rate (MVTR) was calculated using the following formula, where G = weight change (g), t = time during which G occurred, G/t = slope of the straight line for weight loss per unit time (g/h), and A = test area (m^2).

$$MVTR = \frac{\frac{G}{t}}{A}$$

Sr. No	Sample Code	Sample Description	Add-on (GSM)	Mean (cm water/min)	MVTR ($g/m^2/24hr$)
1	Untreated	White Nylon	-	34	1250
2	Treated	White Nylon	10	523.05	450
3	Untreated	Brown PET	-	0	1380
4	Treated	Brown PET	20	2005	212
5	Untreated	Black PET	-	0	1684
6	Treated	Black PET	15	1701.95	320
7	Untreated	Navy Blue Nylon	-	59.7	1303
8	Treated	Navy Blue Nylon	15	1827.85	257
9	Untreated	Grey PET	-	0	1312
10	Treated	Grey PET	18	1800.4	337

Table 1: Water resistance and MVTR test results of coated fabrics

Results and discussion

Treated samples were evaluated for water resistance by hydrostatic test and breathability by moisture vapour transport rate (MVTR) at the Wool Research Association, Mumbai, and the results are collated in Table 1.

From Table 1, it is evident that unfinished fabric does not show any resistance to water and allows the water to pass easily, while fabric treated with Fabcoat-WB shows higher water resistance as compared to unfinished fabric. Also, it is seen that, the higher the add-on, the better is the water resistance of the fabric.

The other parameter which is tested here is breathability. 'Breathability' is the measurement of the amount of moisture vapour transported through the fabric, into the atmosphere.

From the above results it is also clear that the higher the add-on of the polymer, the lower is the breathability of the fabric, which can be seen in the above table. The unfinished fabric shows higher MVTR while the coated fabric shows lower MVTR. This is because, on coating, the pores of the fabrics get blocked and thus do not allow the air or moisture to pass through it.