

Research Article

A Study on Plasma Treated Flame Retardant Finish on Cotton Linen Blended Fabric

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Abstract

Cotton is the basic resource for thousands of consumer and industrial products manufactured in throughout the world, and the contribution made by cotton to the food and fiber industry continues to grow in importance. Cotton grown without the use of any synthetically compounded chemicals (i.e. pesticides, growth regulators, defoliants, etc.) and fertilizers is considered as 'Organic' cotton. Cotton is a white fibrous agricultural product that has a wide variety of uses, from textile production. Cotton and linen blended plain weave material is used, because cotton is very compatible with linen. Linen adds great strength and absorbency. The plasma technology is being introduction in textile in textile industry for many years. Plasma technology used in textile to change surface properties of the material by using oxygen gas. The aim of the study is to select cotton and linen blend in 50% each and give flame retardant finishing. There was a comparative study done between plasma treated and plasma untreated blended fabric.

Keywords: Cotton; Linen; Flame Retardant Finishing; Plasma Treatment

Introduction

Textile industry in India is the second largest employment generator after agriculture. It holds significant status in India as it provides one of the most fundamental necessities of people. The word textile can be defined as broad classification of cloths or fabrics made by different patterns. The Indian textile industry counts among the leading textile industries in the world. Textile is one of the oldest, largest and significant industrial sectors in India. Home textile is important, but there is also demand for processed fabrics says by Joshi (2014).

Over the past decade, there has been a growing interest in plasma processes, low temperature plasma as well as atmospheric pressure plasma for the modification of the surface properties of textile materials without changing the nature of the bulk of the substrate (Yang & Zhu, 2004).

The plasma coating is more durable than the traditional sprayed finishes because the coating is chemically bonded to the treated fabric says by Wafaa M, Raslan (2011). The challenge to confer wash-resistant flame retardant properties to textiles remains. This is even more relevant when textiles of natural origin like cotton or silk fabrics are concerned. Indeed, the flame retardant finishing could only be applied by surface modification technologies. Among all of them, the Plasma Induced Graft Polymerization (PIGP) process we have developed and refined in our laboratory over the last years has proven to be an efficient tool for that purpose by FHochart (2003).

The use of plasma surface treatment is one of the easiest and the most efficient ways to improve post-finishing of cotton fabrics. In general, the active species produced in plasma carry high energy to promote surface functionalisation reactions causing a sputtering or etching effect on cotton fabrics. The altered surface characteristics can still retain inherent advantages of cotton substrates and enhance material properties by incorporating with a large variety of

chemically active functional groups says Yin-Ling Lam (2012).

Methodology

Selection of Materials

The weave or construction of fabric is the main factor to apply plasma treatment through the fabric: the more closely woven fabric has high absorbency with plasma treatment. The 100% semi bleached plain weave cotton linen blend fabric (50:50), yarn count 17 tex, warp cotton yarn, weft linen. It is because it has good absorbency and soft hand feeling. However, cotton and linen fabric is easily ignited and burn out. In order to improve the flame retardant ability of cotton and linen blend fabric, flame retardant finishing was applied to provide flame resistant.

Pre-Treatment Process Bleaching

A suitable sequestering agent should also be added to the above recipe (0.5 to 1.0 g/liters) a treatment at 85°C is given for 45-60 minutes, hot wash at 80°C for 15 minutes. Treatment with 0.5% peroxide-killer at the pre-defined temperature the washed at 80°C for 15 minutes. Neutralize with 2gms/liter of acetic acid. The pH of the bleach both is checked it should be maintained 10.5-11.0. The quantity of the chemicals listed in below (Table 1.)

S. No	Chemicals	QUANTITY
1	Anionic wetting agent	0.5-0.75%
2	Anti- crease lubricating agent	0.3-0.05%
3	Soda ash	0.5-1.0%
4	Hydrogen peroxide	2.0-4.0gms/liters
5	Peroxide stabilizer	0.5-1.0gms/liters
6	Caustic soda flakes	0.7-1.0%

Table 1: Bleaching Recipes

Application of Plasma Treatment

Plasma of cotton linen blended fabric was carried out by Load the 40cm×50cm material and fix the substrate on the work holder. Close the chamber door after fixing the selected fabric. Then switch on the mainandrotary vaccum pump and pirani gauge. After switch on turn on the vacuum valve. It can be viewed that the pressure falls steadily to less than 100m.bar. Allow the cooling water supply to flow in anode and cathode electrode. Provide the required amount of power supply to the machine and switch on plasma on CB. Increase the variance control slowly. Measure the plasma current of on the meter. Set the voltage for required cleaning time. Do not allow the vacuum pressure, i.e. in GH-1 to exceed 0.020 m.bar at any time. Using the needle valve can control the pressure in the chamber. Glow discharge time depends upon the type of sample. For normal application 5 to 7 minute is sufficient. On completion of plasma cleaning bring the variance control to zero position, switch off H.T CB and close the needle valve. After the process is completed make the variance control as zero and

switch off the plasma CB. Open the air admittance valve till air-flow cease and the remove the chamber. The plasma treatments repeat for each sample if necessary the parameters and values of plasma treatment were listed in below (Table 2).

S. No	Parameter	Values
1	System frequency	60KHZ
2	Electrode type	Aluminium
3	Electrode gap	7.5 cm
4	Power	3000 volts 50m.amp
5	Pressure	5×10 ⁻² m.bar
6	Gas used	Oxygen
7	Temperature	Room temp
8	Motor capacity	500 ters/min

Table 2: Plasma Treatment Technical Details.

Finishing

Selection of Chemicals

Plasma pre-treated cotton / linen sample were treated with below chemicals

- APYROL CEP
- APYROL MH

Method of Finishing

All fabric specimens were prepared by pad cure method. The fabric sample was finished with the flame retardant chemical according to the following recipe with 8% binder. The prepared volume for 10 pcs of fabrics was 147.5ml. The bath filled with 100ml water, 40g APYROL CEP flame retardant agent, 5g APYROL MH melamine resin. The specimens were dipped and padded until reaching a wet pick up percentage of 80% at room temperature. By changing the air pressure of the padding machine, the wet pick - up could be adjusted. Then the specimens dried in an oven at 110°C. Finally, the specimens were cured in the curing machine at 170°C for 1 minute. (Table 3)

Roller Width	450mm
Roller Diameter	125mm
Fabric Speed	10rpm
Content of Liquor Trough	Apprpx 1000cc

Table 3: Finishing Technical Details.

Flammability Test of Cotton/Linen Fabric

Flammability of all specimens was measured in accordance with ASTM D1230-94 standard using the 45° flammability test for apparel textiles (The Govmark Organization Inc). The specimens were tested after home laundering for 0, 1 and 5 normal machine cycles at (27 ± 3)°C and tumble dried, according to AATCC 135-

2004. The specimens were inserted in a frame and held in the flammability tester at an angle of 45°. A standardized flame, of 16 mm flame length, was applied to the fabric surface near the lower end for 4 s. Burning time (s), char length (cm) and burning speed (m/h) were then measured.

Result and Discussion

Flammability Test

The Flammability activity of 50% of cotton and 50% of linen blended woven fabric is treated with PT, UTF and PTF was tested according to ASTM-D_1230/94 standard. Flame extinguishment or flame prevention is a compulsory requirement for textile as most of the fabrics are combustible, especially fabrics made of cotton. Cotton is classified as a combustible textile that will ignite and burn easily when subjected to external sources of ignition. The present experiment measures the flammability characteristics of a material by two important factors: (1) ease of ignition; and (2) flame spread speed. According to ASTM D1230-94 standard, progressive burning of a fabric at a distance of 127 mm is recorded as “Fail” resistance to burning, and flame spread speed is the time taken by a flame on a burning material, away from the source of ignition, to travel a specified distance under specified conditions. From the above (Table 4) and (Figure 1) it is cleared that the fabric without plasma pre-treatment and flame-retardant treatment, is burnt to ashes vigorously that is UT is class II, PT is class II, UTF is class I, PTF is class I. The pre-treated plasma flame-resistant fabrics UTF and PTF showed class I that the specimens do not ignite and the flame is extinguished right after removal of the ignition source without flame spreading. It is clear found that pre-treated plasma flame-resistant fabrics have good flame retardant.

S. No	Fabric Test (Before Wash)	Flammability	
1	UT	Above 3.5 sec	Class II
2	PT	Above 3.5 sec	Class II
3	UTF	Did not ignite	Class I
4	PTF	Did not ignite	Class I

Table 4: Flammability Test Astm-D_1230/94.

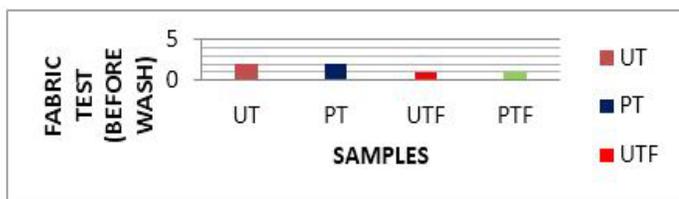


Figure 1: Flammability Test Astm-D_1230/94.

Durability Test

The Flammability activity of 50% cotton and 50% linen blended woven fabric is treated with UTF and PTF was tested according to ASTM-D_1230/94.

S. No	Fabric Test (After Wash)	Flammability	
1	UTF	DID NOT IGNITE	CLASS I
2	PTF	DID NOT IGNITE	CLASS I

Table 5: Durability Test Astm-D_1230/94.

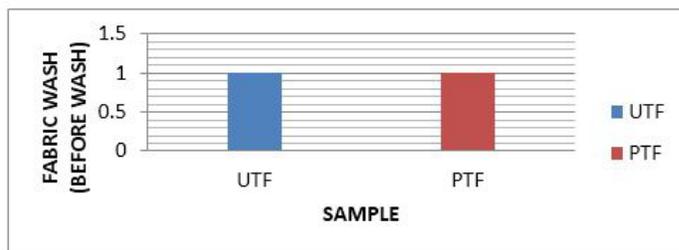


Figure 2: Durability Test ASTM-D_1230/94.

From the above (Table 5) and (Figure 2) it is observed that UTP is class I, PTF is class I. It is clear found that UTF and PTF have good durability.

Conclusion

Plasma technology is a growing technology in textile industry; It can replace the traditional wet processing so that the problem of pollution can be minimized. Much different kind of material can be modified by the plasma; therefore, there is still lot of space to be explored. Information about the effect of the plasma treatment on cotton fabric and other finishing is still lacking. Since plasma treatment has different interaction nature with the substrate, wide varieties of application modes could be used for textile finishing. Thus, this research helps address the important of plasma treatment for further textile modification development.

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