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# Development of Nonwoven Fabric from Recycled Fibers

**Sharma R[1]* and Goel A[2]**

[1]Department of Home Science, Dayalbagh Educational Institute Agra, Uttar Pradesh, India
[2]Department of Clothing and Textiles, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

## Abstract

"Nothing is waste until and unless we know how to use it".

Recycling is a way to process, the used materials (waste) into new products to prevent waste of potentially useful materials. Textile waste recycling becomes more important phenomenon; bearing in mind the limited availability of resources to produce natural fibers as well as fossil raw materials to make synthetic fibres. Recycled textile waste can be further converted in the form of fiber for filling, recycled yarn, recycled woven fabric, recycled nonwoven fabrics etc. Therefore the present study has been conducted to prepare nonwoven fabric by using recycled cotton and polyester fibers.

**Keywords:** Nonwoven; Recycling; Waste textiles;, Needle punching

## Introduction

Recycling is a way to process, the used materials (waste) into new products to prevent waste of potentially useful materials. It reduces the consumption of fresh raw materials, energy usage, air pollution created mainly from incineration, water pollution and land pollution mainly from land filling. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, Recycle and Recover" (4R's) waste hierarchy.

Cotton and polyester fibre have long been dominant fibres in the textile industry. Low quality grey fibres or low value textile wastes predominantly consist of cotton and polyester fibers. These fibres could not be used directly in the apparel industry but have a high potential in the manufacturing of recycled woven and nonwovens fabrics that are quite promising materials in the current market. Use of recovered synthetic fibrous waste is particularly attractive as the processing characteristics of properly recovered synthetic do not differ much from those of original synthetic staple and cut filaments [1-10].

Cotton and polyester fibers have long been dominant fibers in the textile industry. Low quality greige fabrics or low value textile wastes predominantly consist of cotton and polyester fibers. Saravanan [1] explained that the scope of the waste from cotton industry extends its products to upholstery cloth, cover cloths, blanket, towels, shirting, quilts, underwear, carpet, industrial roller cloth, electric cabling, hosiery and in the manufacture of asbestos yarn, paper, linoleum and regenerated fibres. It has been reported that, the total amount of waste generated in India is about 80,000 to 85,000 tons per annum and this obviously needs proper treatment apart from disposal as landfill. Similarly Claudio [2] reported that with the rise in production in the fashion industry, demand for man-made fibers, especially polyester, has nearly doubled in the last 15 years [3-5].

Hence visualizing the ready availability of recycled cotton fiber and recycled polyester fibers and their profusion, they were selected to be processed into nonwoven fabrics. A good quality nonwoven fabric can be formulated by using needle punching technique. The present study emphasis selection, testing, blending of recycled cotton and polyester fibers in various ratios for preparation of needle punched nonwoven fabric. This article prominence the analysis of best ratios for the preparation of blended nonwoven fabric by using recycled cotton fibers and recycled polyester fibers.

## Objectives of the Study

Major objective of the present research is to develop a nonwoven fabric made-up of recycled cotton fiber (RCF) and recycled polyester fiber (RPF) blend which gives a new approach of recycled fiber application. Another objective of the present paper is to test the various properties of developed nonwoven fabrics to analyze the best proportion.

## Material and Methods

The present invention provides nonwoven fabric prepared with recycled cotton and recycled polyester blended fibers with such a unique texture and properties which makes it suitable for preparing the various household and commercial products out of it [6-10].

a) **Raw material used for nonwoven fabric:** Two recycled fibers, cotton and polyester were selected for the preparation of nonwoven fabrics. Cotton and polyester both fibers were most widely used fiber in clothing and other textile industry, may be this was the reason that most of the textile waste comprised of these two fibers.

b) **Physical properties of recycled fibers**: In the present investigation, selected fibers were tested in terms of fiber length, tenacity, crimp, fineness, elongation, diameter, moisture content and microscopic appearance by using standard test procedures. Testing was necessary as the fiber properties directly affect the properties of developed nonwoven fabric. Before testing recycled cotton and recycled polyester, fibers were kept in standard conditions for 24 h i.e., 27°C temperature and 65% RH. It was done to avoid deviation in results.

c) **Preparation of nonwoven fabric by recycled fiber:** Nonwoven fabrics were prepared in three ratios (70:30, 50:50 and 70:30) of recycled cotton and recycled polyester fibers by using needle punching method. The needle punch nonwoven blended recycled

***Corresponding author:** Sharma R, Assistant Professor, Department of Home Science, Dayalbagh Educational Institute Agra,Uttar Pradesh, India; Tel: 05622801545; E-mail: dr.rachnasharma12@gmail.com

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cotton and recycled polyester was prepared by passing through the various steps are discussed below.

## Blending

Recycled cotton and recycled polyester fibers were blended manually in three different ratios to prepare web for nonwoven fabrics. Blending ratios are of 30:70, 50:50 and 70:30 i.e., in first ratio 30% recycled cotton and 70% recycled polyester then equal amount of each fiber 50% recycled cotton and 50% recycled polyester. Another ratio comprises 30% recycled polyester and 70% recycled cotton [11-15].

## Carding

Carding machine, Vijay Textiles (M/C AQQ1Q4) was employed in the present research work. It consists of seven rollers covered with iron spikes of different length and thickness in each roller. Fiber mass was placed evenly on lattice of carding machine. This machine worked as to make web of fibers and also it removes dust and other impurities. Carding machine helped in straightening and parallelization of the fibers into thin web known as lap. To make a good quality non-woven fabric, this is very essential to card fibers properly to prepare even web.

## Web feeding

Layers of recycled cotton and recycled polyester web were feed into the needle punching machine by means of web feeder. Web feeder prevents the layers to get deformed.

## Pre needling punching loom

The fluffy layers of fiber web were then fed through a series of needle punching machine to interlace various layers using low needle density. It was a preliminary 3D interlacing to entangle fibers. Through this process the fluffy mass of fibers web get slightly compact.

## Needle punching

The pre punched layered web of blended fibers (each separately) was delivered by means of conveyer belt and rollers through two needle punching looms placed back to back. Fabric passed from first loom to second loom where the web gets needle punched successively to get the middle density nonwoven fabric of recycled fibers. In this process of needle punching the fiber web is passed through there needle punching looms, so that the more compressed nonwoven fabric can be developed [16-18].

## Calendaring

Calendering is a finishing process used on nonwoven where fabric is passed under hot rollers at high temperatures and pressures. The fabric runs through rollers that polish the surface and make the fabric smoother and more lustrous. High temperatures and pressure are used as well. Fabrics that go through the calendering process feel thin, glossy and papery. For the present study 180°C temperature was kept for upper roller and 170°C was kept for lower roller. The needle punching and calendering process was carried out separately for each kind of recycled blended fiber samples.

## Physical properties of blended nonwoven fabrics

The physical properties of all the developed fabrics were tested. Tests were carried out to evaluate fabric weight (g/m$^2$), fabric thickness (mm), bending length, abrasion loss (per cent), tensile strength (g/cm$^2$), elongation (per cent) of the prepared non-woven samples, as per their applicability.

# Result and Discussion

### a) Physical properties of experimental fibers

The results of the comparable physical properties of experimental fibers are presented in Table 1.

**b) Physical properties of blended nonwoven fabrics:** The physical properties of all the developed fabrics were tested. Results are discussed characteristic wise as under fabric weight as it is apparent from Table 2 that the fabric weight for blend of cotton and polyester nonwoven fabric 30:70, 50:50, 70:30 was 188, 200, 190 g/m$^2$ respectively.

**i. Fabric thickness**: Thickness of blended nonwoven fabrics in all

| Sl. No. | Properties | RCF | RPF |
|---|---|---|---|
| **1** | Length (mm) | 21.50 | 66.80 |
| **2** | Tenacity (g/denier) | 2.73 | 4.46 |
| **3** | Elongation (%) | 6.3 | 19.41 |
| **4** | Fiber fineness/count (dtex) | 1.577 | 3.92 |
| **5** | Crimp No/inch | 2/inch | 6/inch |
| **6** | Diameter (microns) | 16.75 | 24.29 |

RCF: Recycled Cotton Fiber; RPF: Recycled Polyester Fiber.

**Table 1:** Physical properties of experimental fibers.

| Fabric properties | Fabric direction | Nonwoven fabric ratio | | |
|---|---|---|---|---|
| | | 30:70 (RC:RP) | 50:50 (RC:RP) | 70:30 (RC:RP) |
| Fabric weight g/m$^2$ | - | 188 | 200 | 190 |
| Fabric Thickness mm | - | 1.86 | 2.60 | 2.75 |
| Busting strength kg/cm$^2$ | - | 7.00 | 6.8 | 3.56 |
| Abrasion resistance (percent weight loss) | - | 1.42 | 0.52 | 0.34 |
| Tensile strength (kg/cm$^2$) | MD | 16.84 | 14.60 | 3.60 |
| | CD | 23.6 | 21.49 | 7.80 |
| Fabric elongation (%) | MD | 36 | 35.00 | 44.11 |
| | CD | 30 | 32 | 37 |
| Bending Length (cm) | MD | 4.10 | 4.50 | 3.50 |
| | CD | 6.90 | 5.3 | 5 |

RC: Recycled Cotton; RP: Recycled Polyester; MD: Machine Direction; CD: Cross Direction.

**Table 2:** Physical properties of developed nonwoven fabric samples.

three ratios i.e., 30:70 (C:P), 50:50, (C:P) 70:30 (C:P) was found to be 1.86 mm, 2.60 mm, 2.75 mm respectively.

**ii. Bursting strength**: Bursting strength was acquired as 7 kg/cm$^2$ in 30:70 cotton polyester blend, 6.80 kg/cm$^2$ in 50:50 cotton polyester ratios and 3.56 kg/cm$^2$ in 70:30 cotton polyester blend.

**iii. Abrasion resistance:** Abrasion loss of the fabric prepared from recycled cotton & recycled polyester blend having 30:70 (C:P), 50:50 (C:P), and 70:30 (C:P) ratio was recorded as 0.34%, 0.52% and 1.42% respectively.

**iv. Tensile strength:** Table 2 depicts that blended nonwoven fabric samples of recycled cotton with recycled polyester fiber were also tested for tensile strength and maximum tensile strength was observed in blended nonwoven fabric prepared with 30:70 ratio of cotton and polyester i.e., 16.84 kg/cm$^2$ in machine direction and 23.60 kg/cm$^2$ in cross direction followed by 50:50 ratio of cotton and polyester i.e., 14.60 kg/cm$^2$ in machine direction and 21.49 kg/cm$^2$ in cross direction and 70:30 ratio of cotton and polyester i.e., 3.60 kg/cm$^2$ in machine direction and in 7.80 g/cm$^2$ cross direction.

**v. Elongation:** Non-woven fabric blend in 30:70 ratio (recycled cotton with recycled polyester) shows 36% elongation in machine direction and 30% in cross direction followed by 50:50 and 70:30 ratio i.e., 35 and 32% & 44.11 and 37 in machine and cross directions respectively.

**vi. Bending length:** Values of bending length of cotton/polyester blended samples in 30:70, 50:50, 70:30 ratios was observed 4.10 cm, 4.50 cm and 3.50 cm in machine direction and 6.90 cm, 5.3 cm and 5 cm in cross direction respectively as shown in Table 2.

## Summary and Conclusion

Comparison of properties was done to obtain best blended nonwoven fabric among all ratios. It can be concluded that best proportion of nonwoven blended fabric on the basis of physical properties was 30:70 cotton and polyester blend. We claim this blended nonwoven fabric as best combination of recycled cotton and polyester fibers for the preparation of this fabric. Highest tensile strength and appropriate properties of this combination make it suitable ecofriendly fabric for use in various applications of textiles.

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