Industrial Crops and Products 87 (2016) 27–32

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

Value-added waste cotton yarn: Optimization of recycling process and spinning of reclaimed fibers

Béchir Wanassi[a,*], Béchir Azzouz[a], Mohamed Ben Hassen[a,b]

[a] Textile Laboratory Engeneering 'LGTex', University of Monastir, 5078 Ksar Hellal, Tunisia
[b] College of Engineering, Industrial Engineering Department, Taiba University, Saudi Arabia

ARTICLE INFO

Article history:
Received 29 December 2015
Received in revised form 5 March 2016
Accepted 4 April 2016
Available online 12 April 2016

Keywords:
Blend yarn
Cotton wastes
DENIM waste
DOE
Mechanical recycling

ABSTRACT

In the spinning industry, waste yarns are generally forsaken or sale at low prices. The main purpose of this study is to give an added value to this waste and produce a new low cost yarn based on recycled yarn fibers. The first part of this study investigated the effect of the raw material and the recycling process taking into account the cut length (L) and the passage number (N) on the final quality of reclaimed fibers. The effect of different factors on the count of Neps (Neps), mean length (L), short fiber content (SFC), Upper Quartile Length (UQL), and weight yield (R) were examined by using design of experimental method. In the second part of this work, the highest quality fibers (Neps = 260Cnt/g, SFC = 26%, UQL = 23.9 mm, L = 18 mm and R = 61.20%) were selected for this project. They were spun with a ratio cotton/recycling cotton 50/50 into a three account (Ne 10, Ne 15 and Ne 20). Comparing with the 100% cotton yarn, the blended yarn has similar physical and mechanical properties and it has a lower cost yarn since we can increase the total value of the yarn more than 33.5%.

1. Introduction

In recent years, the global annual textile fiber production exceeded 82 million tons, of which around 40% consisted of cellulosic materials (Andreas, 2012). Cotton with production of more than 27 million tons per year stands for about 1/3 of the market (Andreas, 2012). Rapid development and higher production capacity of cotton textile industries resulted in higher output of waste cotton fibers. Hence, in the context of economic issues and environmental protection, there is growing interest in developing recycling processes to produce valuable products from waste cotton fibers, (Meyabadi and Dadashian, 2012). The greater part of cotton wastes is abandoned in all countries over the world (Hanifi and Orhan, 2015).

Among the major sources of textile waste, is the municipal waste (Anne et al., 2006). The concept and practice of recycling fibers has been a well-established part of the textile industry since the first industrial revolution (Richard, 2000). Recycling of textile waste is a mindset and a culture that needs to be shared between industry and the public.

A lot of research work has been focused on the study of textile waste. This work was divided into two parts: the reclaiming of waste and its characterization. Jeihanipour et al. (2010); Jeihanipour and Taherzadeh. (2009), and Kuo et al. (2010) considers that the cotton-based waste textiles can be regarded as an alternative renewable biomass source for refining bio-ethanol, biogas or other bio-based products via various pretreatments and subsequent biological processes. Usarat et al. (2012) was successfully transformed a waste cotton fabric into modified cellulose by etherification using different types of fatty acid chloride. Wang (2010) consider only few parts of waste textile can be recycled, due to their complex component, and most of them have one of two destinations: disposed of in landfills or subjected to incineration.

Blending of different fibers is a very common practice in the spinning industries. The blending is primarily done to enhance the cost of raw material. The properties of blended yarns depend on the properties of the constituent fibers (Hamburger, 1949; Halimi et al., 2007).

The objective of this present study was to find the appropriate process to reclaim a 'good quality' of fiber before mechanical recycling of cotton waste yarn. The quality of reclaimed fiber will be identified according to fiber length parameters and the yield of weight. The fibers with the best quality will be selected for spinning a blend yarn with a ration of 50:50 recycling cotton/cotton.

* Corresponding author.
E-mail address: wanassi_b@yahoo.fr (B. Wanassi).
URL: http://null (B. Wanassi).

http://dx.doi.org/10.1016/j.indcrop.2016.04.020
0926-6690/

Table 1
Mechanical properties of waste yarn.

Property	Value	Unit
yarns count	82	Tex
the breaking force	13.34	N
elongation at break	5.96	%

Table 2
Levels factors.

Factors	Level 1	Level 2	Level 3	Level 4
Length of cut waste yarn (L)	5 cm	10 cm	∞	–
The number of passing the material (N)	1	2	3	4

Table 3
Design matrix and experiment design.

	Coded variable		Real variables		Respense				
N	X1	X2	X1	X2	Neps[Cnt/g]	SFC[%]	UQL[mm]	L[mm]	R%
1	L_1	N_1	∞	1pass	302	35.6	18.5	12.9	42.60
2	L_2	N_1	5	1pass	274	27.7	23.3	17.6	22.10
3	L_3	N_1	10	1pass	467	48.1	19.9	14.2	87.60
4	L_1	N_2	∞	2pass	285	31.4	17.3	13.5	45.30
5	L_2	N_2	5	2pass	260	26.7	23.9	18.0	61.20
6	L_3	N_2	10	2pass	409	46.2	20.6	15.6	90.10
7	L_1	N_3	∞	3pass	345	42.7	18.9	14.3	71.76
8	L_2	N_3	5	3pass	319	45.0	18.9	14.1	80.00
9	L_3	N_3	10	3pass	293	26.4	23.8	17.9	48.30
10	L_1	N_4	∞	4pass	629	48.6	21.7	15.2	85.70
11	L_2	N_4	5	4pass	401	45.2	18.6	13.1	88.60
12	L_3	N_4	10	4pass	264	25.8	24.5	18.1	79.10

The physical and mechanical properties and the cost of blended yarn were compared with properties of 100% cotton yarns.

2. Materials and methods

The yarns wastes used in this study were the dyed yarns wastes of Society of Textile Industries (SITEX) which is a textile company from Tunisia. The mechanical properties of the waste yarn are indicated in Table 1 and the process used to produce this yarn was showing in Fig. 1.

All tests in this study are conducted in the laboratory of SITEX Company while respecting ISO 139 standard. This standard describe the conditions of ambient that are 20 ± 2C and 65% ± 4% air relative humidity (Gourlot et al., 2006). 24 h of conditioning of the material is carried out before each test.

2.1. Mechanical recycling machine

The machine used to recycling a waste of yarn is a Shirley Analyzer (Fig. 2). The operating principle of machine is as follow: The waste of yarns are placed on Table (1), then supplied to the taker-in (4) (filled with saw tooth) via two feed-roller (2) and (7). The flow of recycled fiber is projected onto a perforated Take-off (5).

The flow of the fibers is enhanced by an air stream whose speed is a function of the position of the adjustable knife (8) and the degree of sealing of the cover (3). The recycling fiber recovery is done from the box (6).

The machine settings were: Feed roller speed was 0.9 revolution/min, Taker-in speed was 700 revolutions/min, Perforated take-off speed was 300 revolutions/min, the distance between feed roller and taker-in was 0.7 mm and between separating edge and taker-in was 0.19 mm.

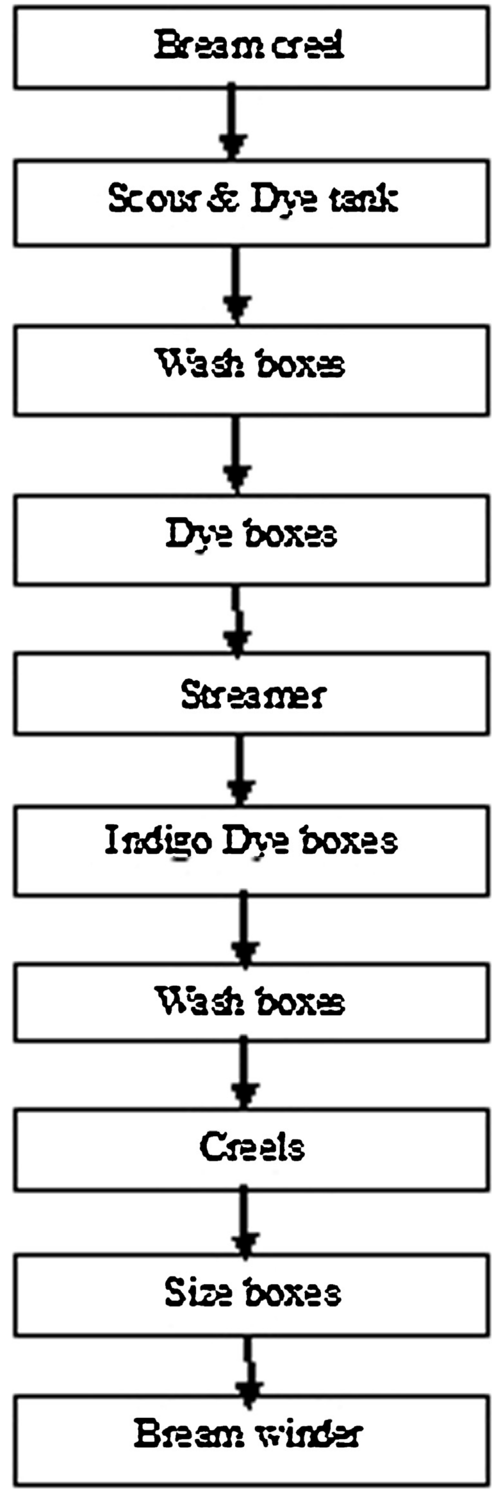

Fig. 1. A process to produce a DENIM yarns.

2.2. Recycled fibers testing

In this study, Advanced Fiber Information System (AFIS) from Uster Technologies was used to measure fiber length distribution. The AFIS provides a variety of length parameters: mean length by number L(n), and by weight L(w), upper quartile length by weight UQL(w), length CV% by weight and by number, short fiber content by weight SFC(w)% and by number SFC(n)%, and length upper percentiles by number L(n) 2.5% and L(n) 5%.