A study of the Quality of Kenyan Cotton rotor Spun Yarn

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Abstract: The textile industry has been identified as one of the key industries which could spur industrial growth in Kenya. Efforts are being made by the Kenyan government and other institutions to revive the textile industry. One area which could contribute towards the revival of the Kenyan Textile industry could be the optimization of the cotton processing in Kenya. Cotton processing includes ginning, spinning, weaving and wet processing. In cotton spinning, the Kenyan industry uses ring and rotor spinning technologies. While ring spinning is the traditional spinning process, rotor spinning has established itself as a great competitor especially when dealing with course counts. This paper looks at the quality of cotton rotor spun yarns, in comparison with the USTER standards. While the Kenyan cotton lint reported good quality characteristics when compared to USTER standards, the quality of the rotor spun yarn was poor especially for yarn evenness and hairiness. It is therefore recommended that the rotor spinning process adapted to spin the Kenyan yarn should be carefully evaluated so as to unearth the sources of the shortfall in yarn quality.

Keywords: cotton, rotor spinning, quality, fiber

1. INTRODUCTION

The garment and textile industry in Kenya dates from the colonial period and has been regarded as one of the key sectors that could spur rapid industrialization in Kenya. After independence in 1963, the Kenyan Government invested heavily in the garment and Textile industrial sector and it was regarded as one of the key employers (World Bank, 2011). The government also enacted policies which shielded the local industries from international competition. The environment attracted private investors and many textile and garment factories were established. Unfortunately, the textile and garment industry slowly moved into a state of complacency. It failed to create strong vertical and horizontal linkages with other sectors, which, left them vulnerable when the protectionist policies were abandoned. Coupled with other difficulties which includes poor infrastructure, high energy cost, changes in world trade policies and aging machineries the textile sub-sector has continued to report a negative growth in the last two decades.

The ailing textile sub-sector has adversely affected the Kenyan economy and there is need to look into possible ways of reviving the industry. Some of the cost factors in the textile industry include the raw material, technology and labor. Other factors like energy, infrastructure, cost of borrowing finance, government policies and the world market will also have a bearing to the profitability of the textile industry.

2. COTTON SPINNING

2.1. Raw Material and Technology

Raw material (fiber) is one of the most important factors influencing yarn quality. The main fiber characteristics that influence the spinnability of cotton include: fiber length, length uniformity, fineness (micronaire), maturity, strength, color, elongation, trash and short fiber content (Klein 1987: Lawrence, 2003). Given that the raw material accounts for a major portion of the production cost of cotton yarn, considerable effort has been devoted to the measurement of cotton fiber quality characteristics. One of the internationally accepted systems for measuring cotton fiber characteristics is the High-Volume Instrument (HVI). A complete unit may include any combination of the following measuring modules: color and trash, length and strength, micronaire and moisture (Ghorashi 1999; USTER, 2007). The measurements and calculations done by the system include: fiber length, length uniformity index, strength, elongation at break (elongation), micronaire, color, short fiber index (SFI) and trash measurements. The quality of the cotton lint can be affected by the cotton growing conditions. Cotton neps can be caused by the growing season and conditions. (Mangialardi, et al., 1987), has reported that growing conditions within a location affects the number of neps and other imperfections for ginned lint, yarn and fabrics. This is due to the fact that even within a particular field cotton balls matures at different times. The higher the variation of cotton maturity period within a field the higher the percentage of immature fibers. This will also lead to higherneps in the cotton lint, yarn and fabrics (Frydrych et al., 2001). Cotton maturity can be a measure of the optimization of the cotton growing conditions.

Apart from the raw material which in our case is cotton lint, the technology used in the manufacture of cotton yarn is an important factor, which affects the cost and quality of the yarn. In Kenya yarn manufacturing is done using several methods. Ring and rotor spinning account for most of the cotton yarn manufactured. While ring spinning is the traditional spinning process, rotor spinning has established itself as a great competitor especially when dealing with course counts. The spinning process (ring and rotor spinning) processes can be summarized using Fig. 1 (Lord, 2003; McCreight et al., 1997). Ring spinning is the oldest and one of the most important cotton yarn manufacturing technology. The spinning process can be summarized into the following stages: cotton mixing, blowroom, carding, drawing, speedframe and ringframe. From the mixing to carding stages the cotton bales received from the ginnery undergo a series of processes which involve opening, cleaning and fiber individualization. The cotton material is then gradually drafted (reduction in the diameter) in drawframe. The ring spun yarn goes through one more drafting stage called speedframe, while the material from the drawframe can be taken straight to rotor spinning. Rotor spinning is sensitive to dust, so the opening stage is very critical, and should eliminate micro-dust.

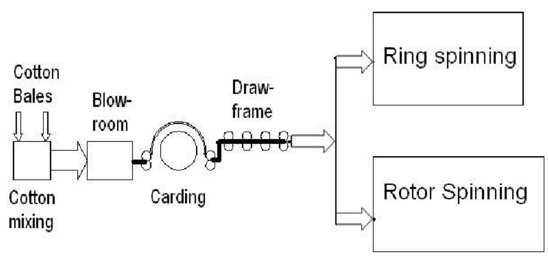

Figure 1 Typical cotton spinning process in Kenya

3. QUALITY CONTROL

The control of manufacturing factors is important so as to ensure that the quality and cost of cotton yarn is optimized. Quality control is one method used to monitor and hence control the quality of yarn. In the cotton spinning process quality control involves the inspection of the; raw materials prior to entering the production line, products at every stage in the spinning process, and final product (yarn) prior to dispatch. In this research paper we have concentrated our efforts on the study of the final product of the cotton yarn spinning process, which is the yarn. Some of the important yarn quality characteristics measured to check the quality of a rotor spun yarn include: yarn count, tensile properties, evenness and imperfections (Klein, 1987; Saville & Manchester, 1999). A study carried out by Moghassem and Bahramzadeh (Moghassem & Bahramzadeh, 2010) reported that knitting machine efficiency is affected by yarn tenacity and hairiness, followed by evenness, imperfections, and elongation. Therefore, a study of the aforementioned yarn characteristics cannot be overemphasized.

A case study of the Egyptian cotton spinning industry revealed that the main reason for quality problems were: Unsuitable quality levels, large quality variations and unexplained quality exceptions (Azzam & Mohamed, 2005). Unsuitable quality levels arise due to individual factories coming up with their own quality standards. This makes it difficult to compare products from different factories. This problem can however be solved by adapting internationally acceptable standards like Uster quality standards (Uster, 2007), which contains Uster statistics. Uster Statistics are quality reference figures which permit a classification of the quality of fibers, slivers, rovings and yarns with regard to worldwide production. Uster standards can be used for quality benchmarking, product specification and comparison of spinning factories and products. All the data obtained during the measurement of cotton lint and yarn samples in this research work were compared to Uster standards.

4. MATERIAL AND METHODS

The cotton fiber and yarn samples were collected from a textile firm in Kenya. The cotton lint was tested using High Volume Instrument (HVI) for quality parameters which included; Fiber length, micronaire (Mic), Uniformity

Index (UI), strength (str), reflectance (Rd), yellowness (+b), trash area (TrA) and trash count on the surface (TrC) (Ghorashi, 1999). The manufacturing process, included; blowroom, carding, drawframe (two passages) and finally rotor spinning. Yarn counts of Ne 8, 13 and 27 were spun. These are some of the popular counts spun in Kenyan factories. The rotor spinning machine parameters used in this research work are given in Table 1. The yarn samples were tested for yarn count, strength, evenness imperfections and hairiness (Nawaz et al., 2002). All the yarn characteristics were compared to Uster standards.

Table 1 Rotor machine parameters

Count (Ne)	8	13	27
Rotor speed (Rpm)	57000	68000	68000
Opening rollers speed (Rpm)	7700	8300	8800
Rotor diameter(mm)	46	40	36
Draft	58	96	207
Twist per inch (TPI)	12.4	16.6	28

5. RESULTS AND DISCUSSIONS

5.1. Quality of Kenyan Cotton lint

The quality of the Kenyan cotton lint was measured using HVI instrument. The cotton lint characteristics were compared to Uster Standards (Uster, 2007) and the results are given in Fig. 2. The uster level for the Kenyan cotton lint was at 50% for micronaire and Uniformity Index, 25% for fiber strength, reflectance, trash cent and trash surface area. Only fiber yellowness was at 95%.

An Uster level of 25% implies that the Kenyan cotton lint was among the 25% good cotton lint world-wide. Therefore the Kenyan cotton lint is among the upper 25% in its class (based on staple length) as concerning strength, reflectance and trash.

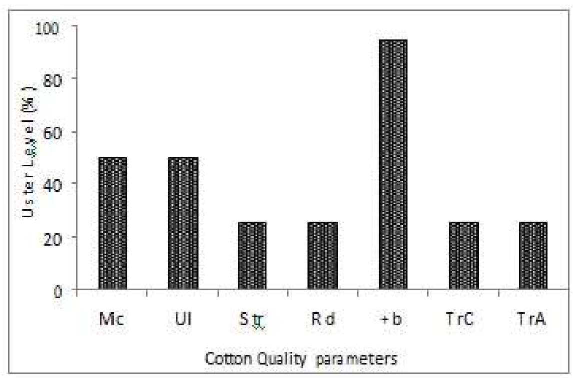

Figure 2 Uster levels for Kenyan cotton Lint

The trash measurement could be excellent because the Kenyan lint is hand-picked. Compared to machine picking, hand picking of cotton normally produce lint with less trash. Yellowness could be an indication of immature fibers. This could be due to the fact that the Kenyan cotton is rain fed, and not irrigated. Even in good rains the coming of the rains are uncontrolled and so rain fed cotton may have some traces of immature fibers.

The Quality of the Kenyan Rotor Spun Yarn

The quality parameters for the Kenyan rotor yarn were measured and compared with relevant Uster standards. The Uster standards levels are given in Table 2. The Uster levels for yarn CV of count, which is equivalent to the mass variation along the length of the yarn is poor. The best is at 75%. Poor CV% will lead to poorer efficiency in the subsequent processing (knitting and weaving) and poor fabric quality. The yarn hairiness also recorded a poor result. Higher levels in yarn hairiness will adversely affect the quality of the dyed/printed fabric.

Higher levels of unevenness and hairiness could be caused by machine or raw material related factors. For rotor spun yarn the selection of rotor diameter and navel size and types are the main rotor machine types which affect yarn evenness and hairiness (Nawaz et al., 2002).

Due to the higher levels of unevenness and hairiness in the Kenyan yarn there is need to optimize the selection of the rotor diameter and navel size and type. Yarn tension is also affected by the spinning tension which is affected by the rotor diameter, rotor speed and other rotor parameters.

Except for yarn elongation and hairiness the quality of the finer count (Ne 27) was mostly at the 95% level. These are poor results. The courser count (Ne 8), showed good results except for hairiness and CV of count. Yarn imperfections especially thick places and neps need to be checked. According to a report given by Rieter company (Rieter, 2011) one of the leading spinning machines manufactures, higher levels of imperfections could be due to raw material and machine related causes.

Table 2 Uster levels for Rotor Yarn Quality Parameters

Yarn Count	Uster 4 Levels (%)						
	CV of Count	CV of Hairiness	CV of Strength	CV of Elongation	Thick places	Thin places	Neps
8	75	95	25	25	50	5	25
13	75	95	50	25	50	5	95
27	95	75	95	25	95	95	95

Since the cotton lint reported good results the higher imperfections in the Kenyan yarn could be attributed to machine related causes. A higher level of thick places and neps could have been caused by defects in spinning elements or other fiber-guiding machine components. Bent, broken or notched clothing teeth on the opening roller in particular can cause steep increases in the numbers of neps and thick places. Wear or deposits in the fiber guide channel also result in fibers accumulating at these points. The accumulated fibers might be fed in uncontrolled manner to the rotor as larger or smaller clumps of fiber. Higher levels of neps and thick places could also have been caused by problems in the preparatory machines (carding and drawing). If the processing of the carding machine is not optimized it could lead to neps generation, which could lead to an increase in neps.

6. CONCLUSION AND RECOMMENDATIONS

Cotton rotor spun yarns were manufactured in a Kenyan factory were collected and tested. The cotton lint used to spin the yarns was also characterized. The quality characteristics of the cotton lint and yarns was compared to Uster standards. According to the results obtained in this research work, the cotton fiber showed good quality results. The rotor yarn spun from the fiber however showed poor uster results, especially for yarn evenness and hairiness. It is therefore recommended that the rotor spinning process adapted to spin the Kenyan yarn should be carefully evaluated so as to unearth the sources of the shortfall in yarn quality.

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