IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE)
e-ISSN: 2348-019X, p-ISSN: 2348-0181, Volume 11, Issue 5 (Sep. – Oct. 2024), PP 19-28
www.iosrjournals.org

A study the effect of modifications in compact spinning machine on the yarn quality properties

Eman Y. Abd-Elkawe
Spinning Research Department, Cotton Research Institute, Agricultural Research Center, Giza, Egypt.
Corresponding author: dr.emansunny.230@gmail.com

Abstract
Rieter's company had added some modifications (The Q-Package)to compact spinning machine K44 in order to increase the machine efficiency and obtain the best yarn quality properties. Q-Package was presented for the first time at the ITMA 2015 in Milan. The Q-Package is the combination of new developments in the drafting system of K44 compact spinning machine. The new K 45 is modular in design, and the total machine concept offers maximum reliability and flexibility with up to 1632 spindles.The mill-proven Ri-Q-Draft drafting system with pneumatically loaded guide arm and the Ri-Q-Bridge provide a sound basis for high yarn quality. The core featureof K 45 is the compacting zone with the wear-resistant, perforated metal drum. This combination is crucial for uniform compact yarn quality. The aim of this paper is to present the effect of modifications in the frame of compressed spinning (K44& K45) on the physical and mechanical yarn properties. In this study, long staple cotton variety(Super Giza 94) was used, and it was spun on three yarn counts (50s' 60s' and 80s'). The results indicated that yarn counts (50s' 60s' and 80s') with the same twist multiplier 4.2. for the compact spinning system (K45) was better in evennessthin places, thick places, yarn hairiness, yarn strength and yarn elongation at break (%) than both of normal K44 and modified K44 as a result of the change in the settings and the evaluation of the responsible part of the compact spinning, such as the air suction, the perforated cylinder, and the path of the twisted fiber inside the suction group, which led to great control, and then improvement was observed.on the other hand, the irregularity innormal K44 and modified K44 compact spinning system higherin the readings of a thin places, thick places, neps, and yarn hairiness, than in K45compact spinning system.
Key words: *Compact spinning, yarn quality, K45.*

I. Introduction

The compact spinning system appeared at the ITMA exhibition in Paris in 1999, then it began to spread in the leading countries in the textile industry. The international modifications(Rieter, Suessen and Zinser) producing spinning machines showed different designs for compact spinning system. All designs agreed in the basic idea and differ in condensing unit Islam (2019).Compact spinning is a process where fiber strand drawn by drafting system is condensed before twisting it. Compact spinning system reduces the size of the spinning triangle to a minimum. This is achieved through a condensing of the fibers after the main draft by using a perforated roller in combination with a suction unit. The hairiness of the yarn is thus reduced, and the tenacity is higher when compared to ring-spun yarns. The yarn evenness is also improved. The compact was described as a modification of the ring spinning. A lot of studies conducted on compact spinning to offer advantages and improved quality.Kumar et al (2003) reported that Compact spinning achieved great improvement in yarn qualityproperties and yarn structure compared to the ring spinning,Krifa and Ethridge **(2003)** reported that compact spinning made it possible to produce a 50 ne carded yarn having tensile properties comparable to those of a combed yarn spun on the conventional frame. Thisimportant potential has also been raised. Jackowski *et al*. (2003) reported that low hairiness of compact yarns compared to conventional yarns has raised again the issue of measuring hairiness and the proper interpretation of the measured values. The general consensus of opinion is that short hairs aredesirable while long hairs are not. Celik andKadoglu(2004**)** result showed that Compact spinning was superior to the ring spinning system in both of yarn strength and yarn elongation at the same twist multiplier.In addition to, compact spinning had produced high strength and elongation yarns with low twist factor, which had enabled an increase in production rates. El-Sayed and Sanad (2007) showed that it is possible to use low quality cotton while maintaining yarn strength equal to that of conventional ring spun yarn with the same twist level. It is interesting to note that the improvements in yarn strength appear to be greater for long-staple coarse yarn count than for the extra-long staple, especially in the extra-fine count. Rashid et al (2011)showed thatcompact spinning as some advantages suchas higher yarn strength and elongation percentage, lowerhairiness and imperfectionscompared to conventional ring yarns**.**El Banna et al (2013). reported that Compact spun yarns had better yarn hairiness, yarn elongation percentage and yarn strength than conventional spun yarns due to compact spinning was minimized or eliminated of spinning triangle by using air section to condense all fibers in yarn formationyarn count and spinning system beside the yarn quality play an important role in the efficiency and performance of spinning process.Almetwally et al(2015).in compact spinning all fibers were incorporated into yarn body thus, compact spinning was almost eliminated spinning triangle in ring spinning to improve yarn quality properties such as increasing yarn strength, elongation percentage, reducing yarn hairiness and imperfections.The aim of this study to compare the physical and mechanical yarn quality properties produced with Normalcompact,modified compact spinning frame (k44) and K 45 compact frame.

II. Materials And Methods

This study was conducted in Nile Company for fine Spinning and Waving. Rieter'sMachines were used in different spinning stages. All samples were spun on Rieter compact spinning frame K44, modified compact spinning (K44) and compact spinning frame K45 (Super Giza 94) was spun into three counts 50s',60s' and 80s' with the same twist multiplier 4.2.High Volume Instrument (HVI) was used to determine fiber properties according to (ASTM, D: 4605-1986). All fiber tests were carried out under controlled conditions of 65 ± 2% relative humidity and 21 ± 2∘C temperature. Fiber properties were presented in Table 1.Yarn strength (RKM) and yarn elongation (%) were measured on the UsterTensorapid 4 (according to ASTM., D2256-02).Uster Tester4 was used to measure Physical yarn propertieslike unevenness (CV%), Imperfection Index (thick/km, thin/km, neps/km) and hairiness according to (ASTM, D1425-96).

Table 1. Fiber parameters for Giza94

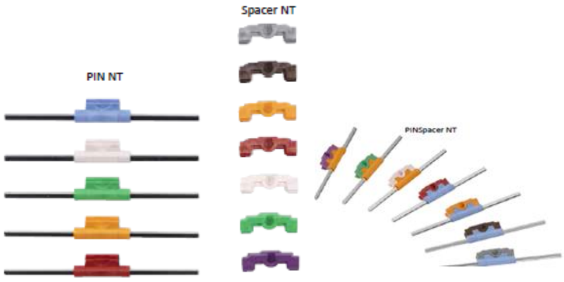
Fiber parameters	**Cotton varieties**
	Super Giza 94
Upper Half Mean "mm"	34.12
Uniformity Index "%"	87.21
Short Fiber Index "%"	5.57
Strength "g/tex"	42.5
Elongation "%"	6.29
Micronaire value	3.87
Maturity "%"	0.92
Reflectance (Rd)	78.63
Yellowness (+b)	9.10

The analysis of variance was determined by using a completely randomized design with four replications and analyzed as factorial experiment according to the method described by Gomez and Gomez (1984). All statistical procedures were conducted using the SPSS 20, statistical software package. Compact spinning (K44) is the development of the millennium, which changed the technology of ring spinning. There have been a lot of developments in ring spinning in the past but the development of compact spinning has changed all aspects of advancement. This is the development, whose advantages do not limit up to the extent of quality and productivity elevation; rather it is multidirectional and also covers the sphere of subsequent processes of weaving, Knitting & dyeing with tremendous and significant increase in productivity. Compact ring yarn is the best ring yarn ever spun with considerably reduced hairiness, hence numerous advantages in the downstream processes like better fiber utilization, better I. P. I.resulting in higher work capacity. It is spinable at lower twist than conventional ring spun yarn. The work relates to the correct selection of the apron distance clip or spacer, used in an apron drafting system for high draft spinning, to determine the extent of opening between the apron guide bar and the front edge of the cradle.nasir(2003).

K44 modified compact spinning system:

1. Application and compatibility

For the purpose of a correct apron nip and invariable positioning of the fiber guiding elements in the drafting plane, the SUESSEN PINSpacer NT (Fig.1-A) has been tailor- made for the SUESSEN Active Cradle.Therefore, the SUESSEN PIN Spacer NT (Fig. 1-B) is to be used exclusively in combination with the Original SUESSEN Active Cradles to guarantee premium yarn values with at the same time invariable running properties.Cradles of other manufacturers looking similar produce different apron nips and therefore wrong setting, what inevitably affects the yarn parameters negatively! In addition, the clip connection on products other than the original SUESSN Active cradle is notconsistently uniform, and in the worst case the position of the PIN Spacer can change during operation.Unlike the already known one-piece PIN space, the PIN Spacer NT is made up of two components. Basis is the spacer NT to set the apron nip, which is available with sizes from 2.25 to 5.0 mm . The correlation between spacer NT color and apron nip is the same as for the conventional SUESSEN cardle spacers Every PIN NT can be combined with any spacer NT.Thesuessen pinspacerNt was specially designed for active cradle in the drafting setting of k44 machine. SuessenpinspacerNt used exclusively in combination with the original suessen active cradlesto obtain high quality yarn properties.



(A) (B)

Fig.1. Pin Nt(1-A), spacer Nt(1-B).

The Pin NT which is available is different sizes, is just snapped on the spacer NT . the difference between the PIN NT variants is their immersion depth into the fiber strand for the variable deflection of the variable deflection of the fibers (Fig. 2) since the required intensity of fiber deflection by the PIN NT strongly depends on the roving to the spun, the fiber length, fiber martial, roving twist and other factors, the spinning mill can adjust the PIN NT precisely to the material to be spun, irrespective of the necessary cradle spacer.

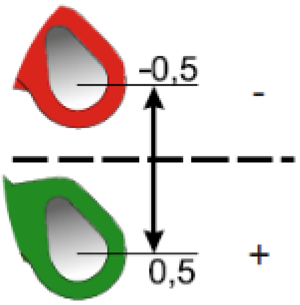


Fig. 2.The difference between the PIN NT.

So it is possible – in contrast with a one- piece PIN Spacer- to optimize yarn quality values and spinning stability indepndently of each other. In contrast to the one- piece PIN Spacer the PIN NT profile has been changedto ensure that the fibers are forced to run under the PIN and not- by mistake- over the same. This improves the operational reliability drastically.The correlation between Spacer NT colour and apron nip is the same as for the standard cradle Spacers.

2- Determination of Apron Nip and PIN immersion Depth

Since the PIN NT represents an additional deflection point for the fibers in the yarn path through the drafting system, the drafting process tends to be hampered, unlike using standard cradle spacer. We therefore suggest that you choose a spacer NT with an apron nip which is usually one step bigger than the standard cradle spacer and to combine them initially with the PIN NT (0.00). You may determine the optimum effect of the PIN NT on yarn quality values and running properties by spinning trials with the various PIN_s NT or by possibly existing empirical data.Rieter's company had added some modifications (The Q-Package)to compact spinning machine k44 in order to increase the machine efficiency and obtain the best yarn quality properties.Q-Package was presented for the first time at the ITMA in Milan.The Q-Package is the combination of new developments in the drafting system of k44 compact spinning machine,for example the standard cradle has been replaced by ACP cradle, the familiar Ri-Q-Bridge has been replaced by nose bar, the old distributor replaced by newdistributor,the old cradle spring with 43mm cradle replaced by new type cradle spring for Package (Fig. 3, 4, 5, 6and 7).

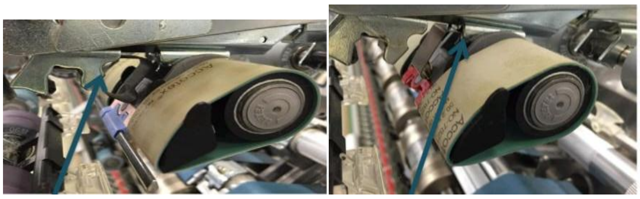
Fig.3. Active Cradle with roller, top apron, clip and pressure bar.

(A) **(B)**

Fig.4.Ri-Q-Bridge (A) and step-Nose Bar (B).

(A) (B)

Fig.5. Old distributor



(A) (B)

Fig.6. Old spring (A) and new spring (B).

(A) (B)

Fig.7. Old springs (A) and new spring (B).

And for correct setting of the nose bar and the cradle it is important that the plastic edge and the metal edge of both devices are in one line Figure 8.After setting the infeed roller this set position can be used to adjust the delivery roller by using the gauge.Raj **(**2020**)**

A) **(B)**

Fig.8. Correct setting of nose bar and cradle.

Take care that the distance between the bottom roller and pressure bar are min. 1mmFor further information see attached sheet of the manual from suessen company.Fig. 9.

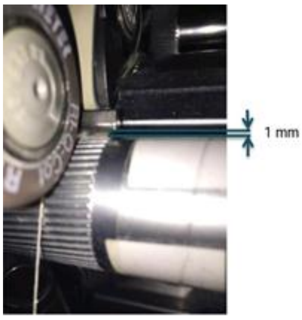


Fig.9. Correct setting of delivery roller and pressure bar.

K45 compact spinning system:

The K 45 Compact for spinning machine is derived from the basic G 35 machine and the extremely successful K 44 predecessor model with further optimization featuresand innovations. Customers benefit from a powerful, high-quality machine incorporating diverse additional solutions in the field of spinning technology. K 45 is modular in design, and the total machine concept offers maximum reliability and flexibility with up to1632 spindlesFig.10. The mill-proven Ri-Q-Draft drafting system with pneumatically loaded guide arm and the Ri-Q-Bridge provide a sound basis for high yarn quality. The core featureof K 45 is the compacting zone with the wear-resistant, perforated metal drum. This combination is crucial for uniform compact yarn quality.Cotton yarn market.

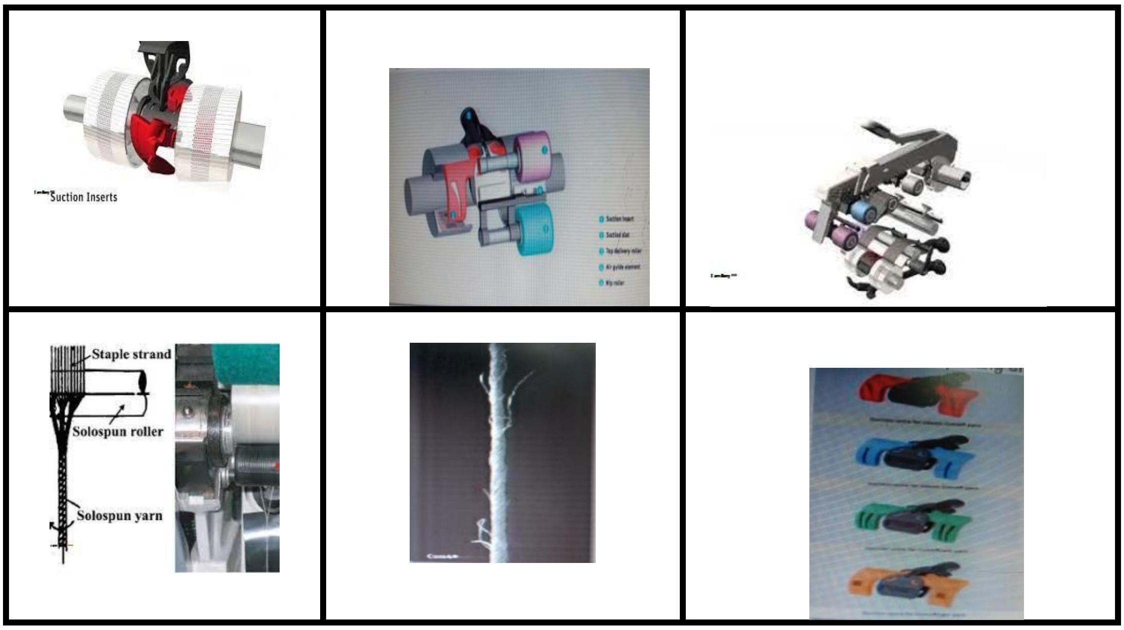


Fig. 10. K45 compact spinning frame

The purpose of this study is to present the effect of modifications in the frame of compact spinning (K44& K45) on the physical and mechanical yarn quality properties.

III. Results And Discussion

Effect of spininng system on yarn properties

Data in Table 2 and Fig.11 showed that compact spinning K45 had highly significanteffect on all yarn properties.K45 compact recorded better evenness (10.88), thin places (3), thick places (4), number of neps(14) yarn hairiness(2.11) Yarn strength (25.21RKM) and Yarn elongation (6.06%). than both K44 normal compact and K44 modify compact.while, the modified compact K44 spun yarn give higher yarn strength (25.02 RKM), yarn elongation (5.47%) and lower thick places(12),neps (24) and yarn hairiness (2.44) than the normal compact K44. The highestyarn unevenness (12.61), thick places (17), neps (32) and yarn hairiness (2.63), the lowest strength (22.91 RKM) and yarn elongation (5.31%) were recorded by normal K44. It noticed that K45 compact spun yarngave better yarn strength and yarn elongation percentage and imperfections as compared with normal compact and modify compact K44.

Table 2. Yarn quality properties normal compact, modified and K45

Compact spinning	CV %	Thin -50%	Thick +50%	Neps +200	Hairiness	Strength Rkm	Elongation %
Normal compact K44	12.61	4	17	32	2.63	22.91	5.31
modified compact yarn K44	12.31	6	12	24	2.44	25.02	5.47
K45	10.88	3	4	14	2.11	25.21	6.06
LSD at 5%	0.169	0.660	0.586	0.210	0.044	0.077	0.113

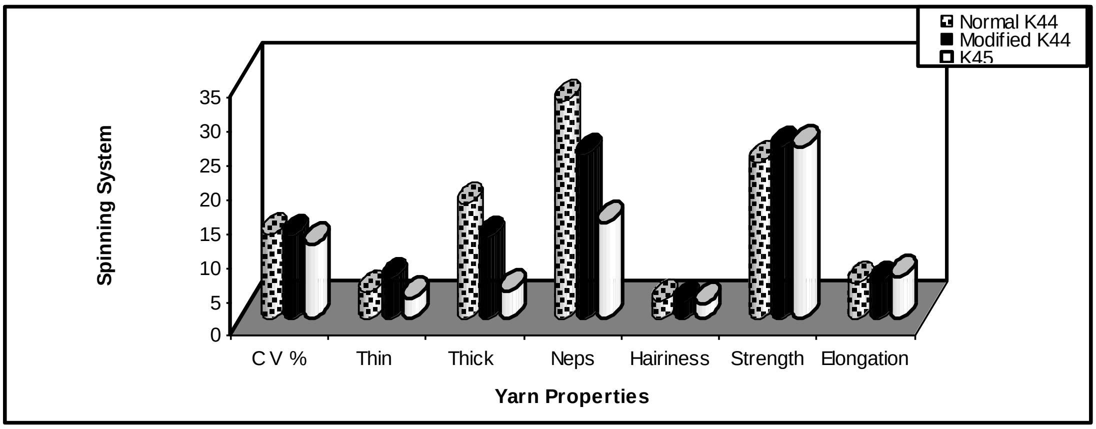


Fig.11 physical and mechanical yarn properties for normalK44, modified compact yarns and K45.

Effect of yarn count on yarn properties

The data given in Table 3and Fig.12 showed that a highly significant effect of yarn count on yarn strength, yarnelongation, yarnunevenness (CV), thin places (-50%), thickplaces (+50%), no of neps /400m and yarn hairiness. The highest yarn count (80s') gave the highest yarn unevenness (12.35), thin places (6), thick places (20) and neps (32).while, the same count gave the lowest mean values of yarn strength (22.96Rkm), and yarn elongation (5.18%). The lowest yarn count (50s') gave the highest yarn strength (25.73 Rkm). On the other hand, the lowest mean values of yarn unevenness (11.32) and neps (14) and yarn hairiness (2.30) wererecorded by 50s' yarn count.Generally, yarn strength,yarn elongation and hairiness decrease when yarns become finer.Similar results were obtained by **Abdel-Ghaffar et al (2019**) who concluded that yarn strength, yarn elongation and yarn imperfections were significantly affected by yarn count. Also, yarn hairiness was decreased when yarn count increasing.

Table 3. Effect of yarn counts on yarn quality properties for super Giza94 long staple cotton

Count yarn	CV %	Thin -50%	Thick +50%	Neps +200	Hairiness	Strength Rkm	Elongation %
50s'	11.32	4	8	14	2.3	25.73	5.69
60s'	11.95	2	6	24	2.45	24.45	5.97
80s'	12.35	6	20	32	2.43	22.96	5.18
LSD at 5%	0.169	0.660	0.586	0.210	0.044	0.077	0.113

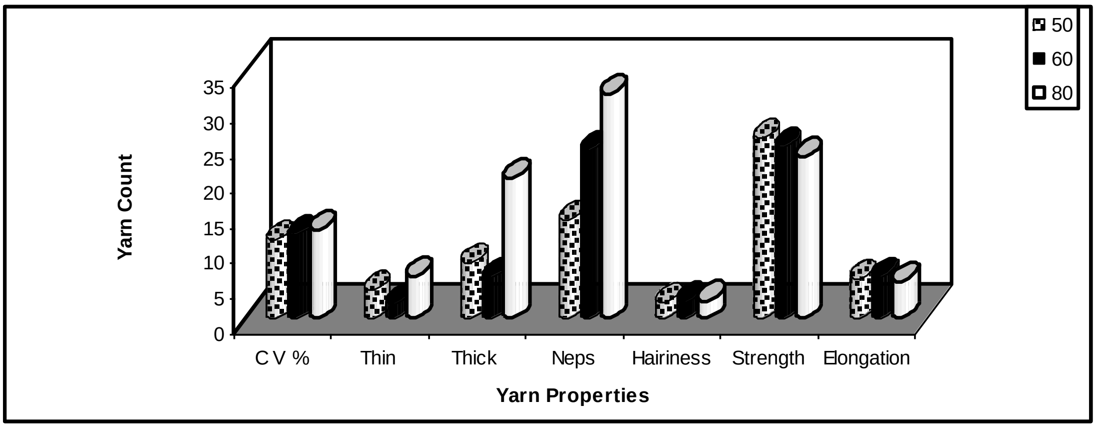


Fig.12 Yarn properties for Giza94 cotton variety at 50s, 60s, and 80s, yarn counts.

Data presented in Table 4 and Fig. 13showed the interaction between yarn count and compact spinning (CxS) had significant effect on allyarnproperties.The highest mean values of unevenness (13.26 and 13.24), thin places (9), thick places (29)andnumber of neps (48) were recorded by 80s yarn count fornormal compact. While, the same count recorded the lowest mean values of yarn strength (21.49 RKM) for normal compact and modified compact respectively.Yarn count 50s for K45compact recorded the lowest mean value of unevenness (10.51) and neps (10). While, the same countfor K45 compactrecorded the highest mean value of yarn elongation percentage (6.30%). Similar results were obtained by El Sayed (2002) and Sanad et al (2011) who reported that yarn elongation % and yarn strength (cN/tex) were decreased significantly with increasing yarn count. While, number of thin places,thick places and neps were increased with increasing yarn count. It noticed that fine yarns had a lower number of fibers in the cross section than coarser yarns.

Table 4. Effect of normal compact K44, modified compact K44 and compact K45 spun yarns on yarnquality properties for different yarn count.

Yarn counts	Compact spinning	CV %	Thin -50%	Thick +50%	Neps +200	Hairiness	Strength RKM	Elongation %
Count 50s	Normal compact K44	12.06	1	15	19	2.75	22.71	5.16
	Modified compact K44	11.38	7	6	12	2.36	23.00	5.60
	K 45	10.51	5	2	10	1.80	24.80	6.30
Count 60s	Normal compact K44	12.50	1	8	28	2.80	24.20	6.00
	Modified compact K44	12.31	3	7	25	2.65	24.12	6.10
	K 45	11.04	2	4	20	1.89	25.02	5.80
Count 80s	Normal compact K44	13.26	9	29	48	2.34	21.49	4.76
	Modified compact K44	13.24	7	24	36	2.30	21.60	4.70
	K 45	11.08	1	7	13	2.64	25.80	6.08
LSD at 5%		0.292	1.143	1.015	0.364	0.077	0.133	0.196

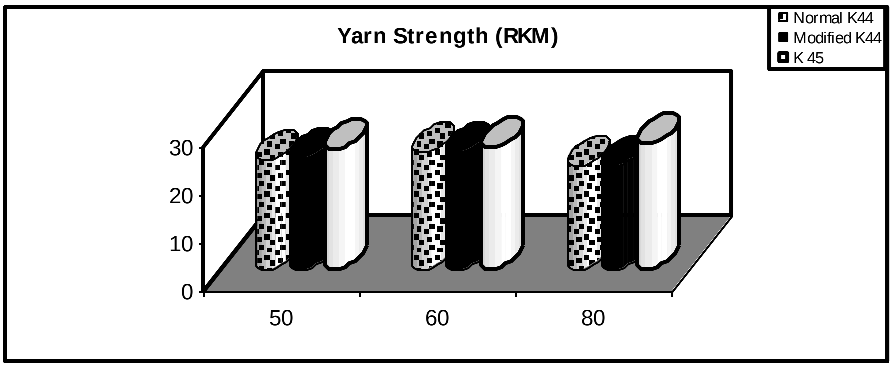


Fig.13- A. Effect of spinning system and yarn count on yarn Strength (RKM).

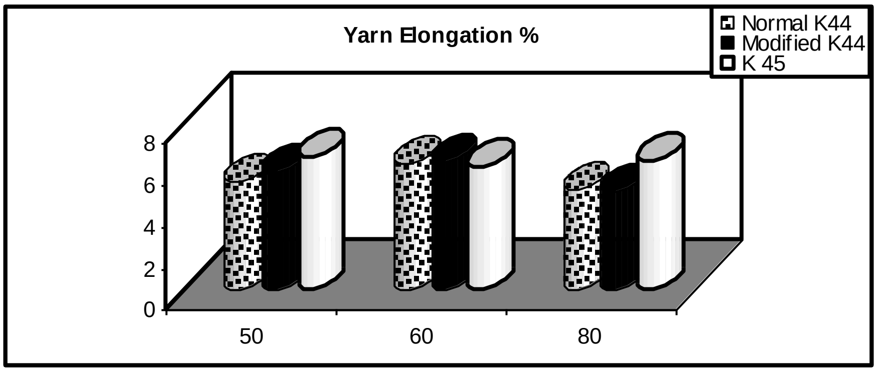


Fig.13- B. Effect of spinning system and yarn count on yarn Elongation %.

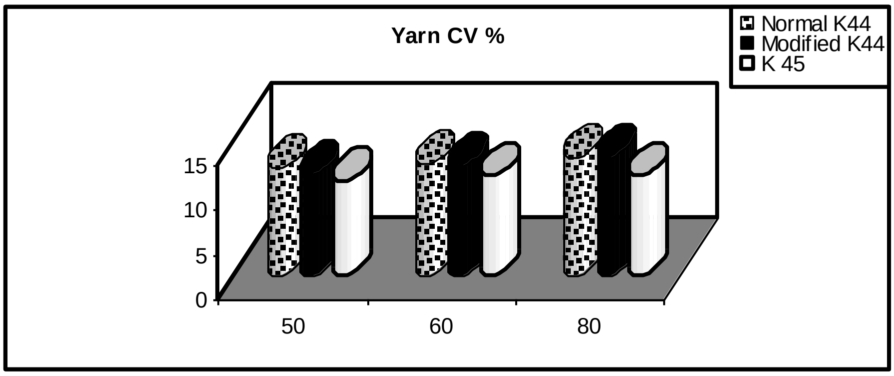


Fig.13- C. Effect of spinning system and yarn count on CV%.

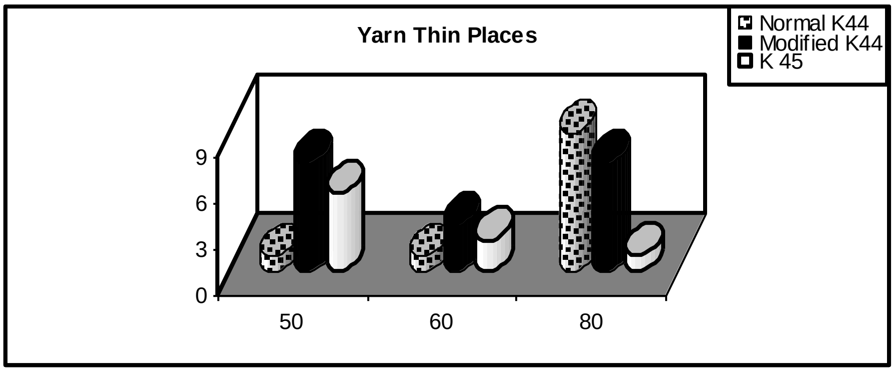


Fig.13- D. Effect of spinning system and yarn count on thin places.

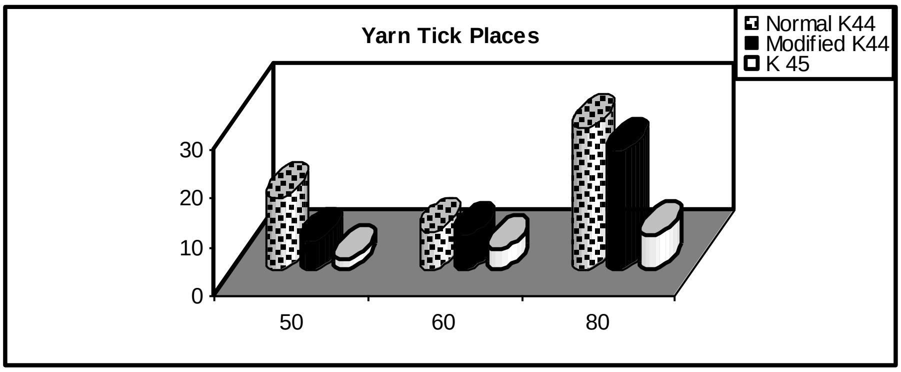


Fig.13- E. Effect of spinning system and yarn count on Thick places.

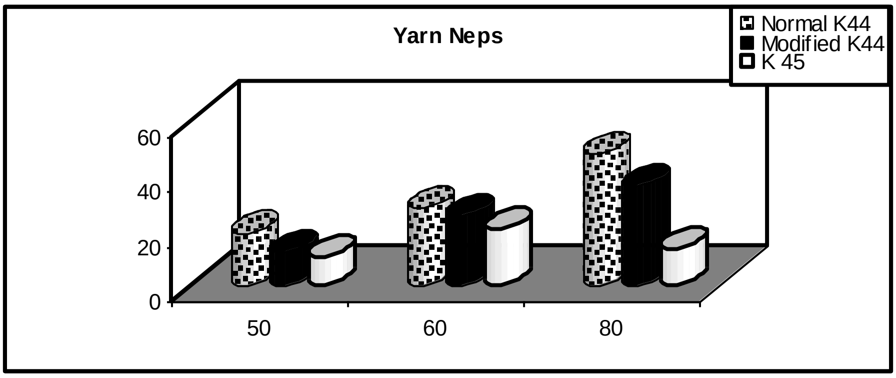


Fig.13- F. Effect of spinning system and yarn count on Neps.

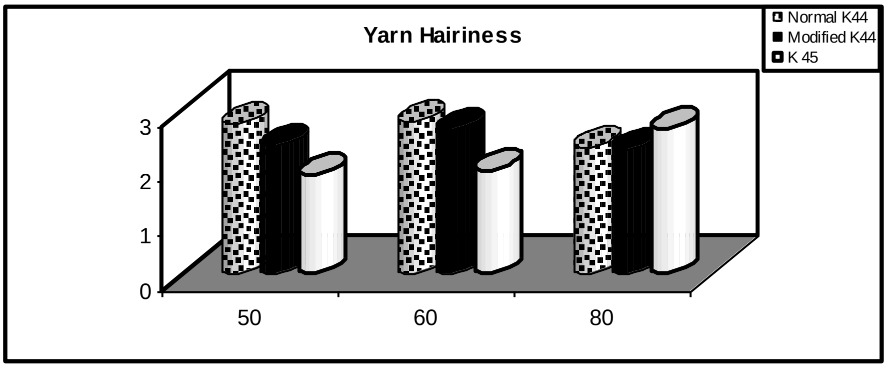


Fig.13- G. Effect of spinning system and yarn count on Hairiness.

IV. Conclusion

The aim of this investigation was to study the effect of modifications in the frame of compact spinning (K44) and k45 compact spinning frame on the physical and mechanical yarn quality properties. Results indicated that K45 compact spinning frame recorded higher yarn strength and yarn elongation than both of normal and modified k44 compact spinning for all yarn counts. While, it recorded lower unevenness, thin places, thick places, neps and yarn hairiness as compared with normal and modified k44 compact spinning for all yarn counts. Generally, compact spinning frame k45 improved mechanical and physical yarn properties due to some changes in this frame.

Reference

[1]. Abdel-Ghaffar, E.A.F., Hammam G.Y.M., El-Hosary A.A.A., El-Gedwy E.M.M. and Hassan A.A. Influence of some commercial blends between the imported cotton and the upper Egyptian varieties on technological properties. Annals of Agic. Sci.,Moshtohor, 57(1):31-38, (2019).

[2]. Ahmed, S.; M. Syduzzaman; Mohmud, S. andRahman, M.M.Comparative study on ring, rotor and jetring spun yarn. European. European Scientific Journal,Vol.(11): 411-424,(2015).

[3]. Almetwally, A.A.,Mourad,M.M. Hebeish, A.A.andRamadan, M.A.Comparison between physical properties of ring spun yarn and compact yarns spun from different pneumatic compacting systems. Indian Journal of Fiber &Textile Research. Pp. 40:43-50, (2015).

[4]. Altas, S and Kadoglu, H.Comparison of conventional ring, mechanical compact and pneumatic compact yarn spinning systems.Journal of Engineered Fibers and Fabrics, 7 (1): 87-100, (2012).
[5]. ASTM, American Society for Testing and Materials. Standards of Textile Testing and Materials. D1425-96, (1996).
[6]. ASTM, American Society for Testing and Materials. Standards of Textile Testing and Materials. D2256-02, (2002).
[7]. Celik,P and Kadoglu, H. A research on the compact spinning for long staple yarns. Fibers & Textiles in Eastern Europe. 4(48):27-31,(2004).
[8]. Cheng, K. P .S and Yu, C. A study of compact spun yarns. Textile Research Journal. 73(4):345-349, (2003).
[9]. El-Sayed, M.A. Egyptian cotton yarn quality. Cotton research institute. Giza, Egypt Paper presented. to ICAC, Cairo. Egypt. 20-25 Oct., (2002).
[10]. El Banna, M.N.,M.El- Sayed,A. M. Nassar, A. A. and El-Banna, A. A. A. Impact of ring and compact spinning systems on the quality of Egyptian cotton properties.2nd Alex. Int. Cotton, Fac. Agric. Saba Basha Alex. Univ. Egypt. Conf.10-11 April ,(2013).
[11]. Gomez, K.A and Gomez, A. A. Statistical procedures for agricultural research 2nd ed. john willey and sons, new York.USA.680, (1984).
[12]. Islam, Z. MD. Comparing quality parameters of yarn produced by ring, rotor and compact spinning system. European Scientific Journal. 15 (3), (2019).
[13]. Kampen, W. The advantages of condensed spinning. Melliand Textile berichte international Textile reports, 81(4):58-59, (2000).
[14]. Kumar, A., Ishtiaque, M. and Salhotra, K. Compact Spinning: A Critical Review. ASME International Mechanical Engineering Congress and Exposition. pp 16-21. (2003).
[15]. Mirzaei, M., Gharehaghaii. A. A. and Zarrebini, M. A new method of yarn hairiness reduction by air suction during carding. Textile Research Journal, 82 (20): 2128–2136,(2012).
[16]. Rashid, M. R., F. Ahmed, A.K. Azad, A.N.M .Ullah Comparative study on cotton yarn quality made from compact and conventional ring frame. J. Innov. Dev. Strategy. 5(3), 61-66, (2011).
[17]. Sanad, S.H. Mahmoud, H.E.M. and El-Sayed M.A.M. Production of carded compact cotton yarn of comparable quality to the combed conventional ring yarn. Egypt J Agric Res, 89 (1), 203-212, (2011).
[18]. Snedecor, G.W. and.Cochran, W. G. Statistical methods 7th ed. Iowa State Univ. Press Ames, Iowa, (1981).
[19]. Raj, M. (2020) Giza spinning -22130 –minutes of meeting
[20]. https://ptj.com.pk/web%202003/7-2003/pdf/nasir.pdf
[21]. http://www.cotttonyarnmarket.net/OASMTP/Rieter%20%20K%2045%20ComforSpin%20Machine.pdf