STUDIES ON THE PROPERTIES OF RING AND COMPACT SPUN MELANGE YARN

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ABSTRACT

Melange yarn is produced in combination with two or more fibres either of same &/or different generic nature and colour. These fancy yarns are widely produced in the textile industry & find their application primarily in the hosiery apparel sector. It also finds application in denim, upholstery and even in sophisticated fashion fabrics in the garment industry.

Though, melange yarn offers a great variety of shades, but its strength is inferior to normal grey yarn and the loss in strength increases with increase in the amount of coloured fibre. Much attention is generally paid to the aesthetics than to the strength of the yarn. However, attainment of minimum strength to sustain stress during post spinning operation and during use in given importance.

The present study primarily deals with a quantitative analysis of melange yarn produced with varying depth of coloured fibre using ring and compact spinning systems. The structural difference of two types of yarns necessitates the study of yarn properties. Effect of percentage of dyed fibre, spacer size & spinning system on yarn evenness, imperfection, tenacity, elongation, hairiness and frictional behaviour was studied. The compact yarn exhibited better mass uniformity, strength & elongation while the hairiness, coefficient of friction was low as compared to normal ring yarn.

Keyword: - *Ring spun melange yarn, Compact melange yarn, Imperfection, Hairiness, Coefficient of friction.*

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1. INTRODUCTION

The vast majority of the yarns produced commercially today are plain yarns– that is, they exhibit an evenness of colour and texture and a uniformity of structure throughout the yarn. Attaining a perfect regularity of colour and structure has been the aim of much of the technical research and innovation in textiles for many hundreds of years. However, at some point in the past, some designers realised that what seemed to be an imperfection in the yarn could, in some cases, create a pleasing effect in the fabric. As a result, research has also been undertaken to devise new ways of manufacturing yarns with these planned imperfections, or of making fabrics which demonstrate the textural variety that seems to be so appealing. These yarns are described as 'fancy yarns' or 'novelty yarns'. Fancy yarns are those in which some deliberate decorative discontinuity or interruptions are introduced, of either colour or form, or of both colour and form with the intention of producing an enhanced aesthetic effect [1-3].

Among the types of fancy yarns, melange yarn is known for its attractive colour and appearance. Melange yarn is a type of spun yarn made from two or more fibre groups with different colours or dye affinities. Mixing of fibres with different colours could be done either in the blow room at the start of spinning preparation or by feeding different dyed fibres to the draw frame. The wavy like effect and a wide range of colour tones due to different colour fibres blending makes it much popular and rich in look. Melange yarn has unique dyeing process, with different technological know-how as compare to yarn dyeing or fabric dyeing in terms of fibre dyes, colour matching and mixing of multiple coloured fibres. Dyeing the fibres before spinning can keep energy saving, emission reduction and environmental protection. Melange yarn can present multiple colours on one single yarn, which gives it rich colours, slenderness and tenderness. Textile made of melange yarn has a certain ambiguous cyclical effect. Studies show that scouring and dyeing process of cotton fibres lead to a greater entanglement and cohesion among them, decreasing of fibres strength and removal of a part of the wax present on the surface of cotton fibres. Further mechanical processes on the fibres lead to fibre damage and decreasing of their length parameter. These variations on fibres not only affect the efficiency of the spinning process, but also the mechanical and physical properties of the final yarn and fabric [4-6].

In conventional ring spinning, there is always a triangular bundle of fibres without twist, the so called spinning triangle, at the exit from the rollers, which represents the most critical part of ring spinning system. In this zone, the fibres assembly contains no twist. The edge fibres play out from this zone and make little or no contribution to the yarn properties like tenacity and hairiness [7]. In Elite compact spinning, the spinning triangle is almost eliminated and almost all fibres are incorporated into the yarn structure under the same tension. This leads to significant advantage such as increasing yarn tenacity and reducing yarn hairiness [8, 9].

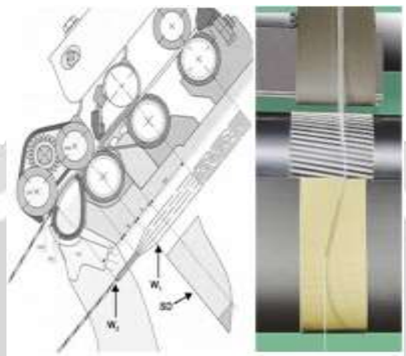

Fig 1:- The Elite Compacting System [9]

The distance between the top and bottom aprons is determines the intensity of pressure applied to the fibres to be under control. This distance, which is introduced by means of the special device, is called spinning spacer. With widened apron spacing, a progressive deterioration in regularity and strength of yarn was noticed [10].

The present study attempts to analyse the properties of melange yarn from the point of its functional performance.

2. MATERIALS AND METHODS

2.1 Materials

For the present study cotton fibres was used to produce homogeneous yarn. The specification of the fibre is given below:

Table 1 Specifications of Fibre

Fibre Name	**Fineness**	**Fibre Length(mm)**
Cotton (MCU-5, 100%)	4.2 Mic	30

In order to produce melange yarn the blending of dyed combed cotton fleece with grey cotton was done at the blow room stage. The compact melange yarns were produced on compact set ring frame (Model LR6/AX) of Suessen. Ring yarns were produced in Lakshmi short staple spinning line. The spindle speed 17,500 rpm were kept unchanged in both the system to produce the yarns. The design plan of an experiment is given in Table 2. A total of 8 yarns were produced for the study.

Table 2 Design Plan of Experiment

Sr. No.	Factor	Level	
1	Spinning System	Normal Ring yarn	Compact Ring yarn
2	Dyed Fibre	**30%**	**60%**
3	Spacer size	3.0 mm	3.5 mm

2.2 Testing Methods

The yarns were conditioned at a standard tropical atmospheric condition of 65±2% RH and 22±2^{o}C temperature for 24 hours. The number of test for each parameter was taken to ensure the result to remain 95% confidence limit.

2.2.1 Unevenness, Imperfection and hairiness

The evenness was measured on Uster Evenness Tester-5, which simultaneously measures the hairiness and imperfections.

2.2.2 Tensile Testing of Yarn

Uster tenso rapid 4 was used to measure the tensile properties. The yarns were tested at 5000mm/min extension rate using a gauge length of 250 mm (ASTM D 2256). At least 30 readings were taken for each sample to get the at 95% confidence level.

2.2.3 Coefficient of Friction

Uster Zweigle Friction Tester 5 was used to measure the fibre to metal friction. The instrument uses classical friction measurement principle and is based on the force required to move a yarn horizontally through a disc tensioner. A constant force is applied to the upper disc while the yarn is passed through the disc plates which in turn produce a defined force on the yarn in the vertical direction (F_1) and F_2 being the force required to pull the yarn. The friction coefficient (μ) can be calculated using the formula $F_2 = \mu F_1$.

2.3 Process Flow in preparation

The preparation process for normal melange and compact melange yarn was almost same except that in case of compact melange yarn compact attachment was attached to ring frame. In the case of melange spun yarn, firstly 30% and 60 % of fibre are dyed and then mixed at blow-room stage with 70% and 40% grey fibre respectively.

3. RESULT &DISCUSSION

This paper embodies analysis of melange yarn with varying parameters. In this study parameters of melange yarn are assessed in terms of strength and elongation of yarn. Table 3 shows different yarn specimen and their parameters.

Table 3 Effect of spinning system, spacer size and dyed component on yarn properties

	Normal Melange Yarn				Compact melange yarn			
Spacer (mm)	3.0		3.5		3.0		3.5	
Dyed Component	30%	60%	30%	60%	30%	60%	30%	60%
Unevenness **(**U %)	11.2	11.71	11.35	11.93	10.45	11.38	10.94	11.74
Imperfection Index (IPI)	360	517	419	550	244	389	340	439
Hairiness(H)	4.44	4.8	4.41	5	3.17	3.41	3.27	3.77
RKM	15.74	14.98	15.71	14.6	18.45	16.7	18.2	16.69
Elongation%	3.96	3.91	3.85	3.82	4.66	4.43	4.41	4.39
Coefficient of Friction (μ)	0.21	0.2	0.21	0.2	0.19	0.18	0.19	0.18

3.1 Unevenness %

U% is defined as unevenness% in the yarn. It has been observed that U% of melange yarn was higher than that of compact melange yarn as seen from Table 3. These may be due to the difference in the system and presence of additional integrated fibre on the surface of the yarn.

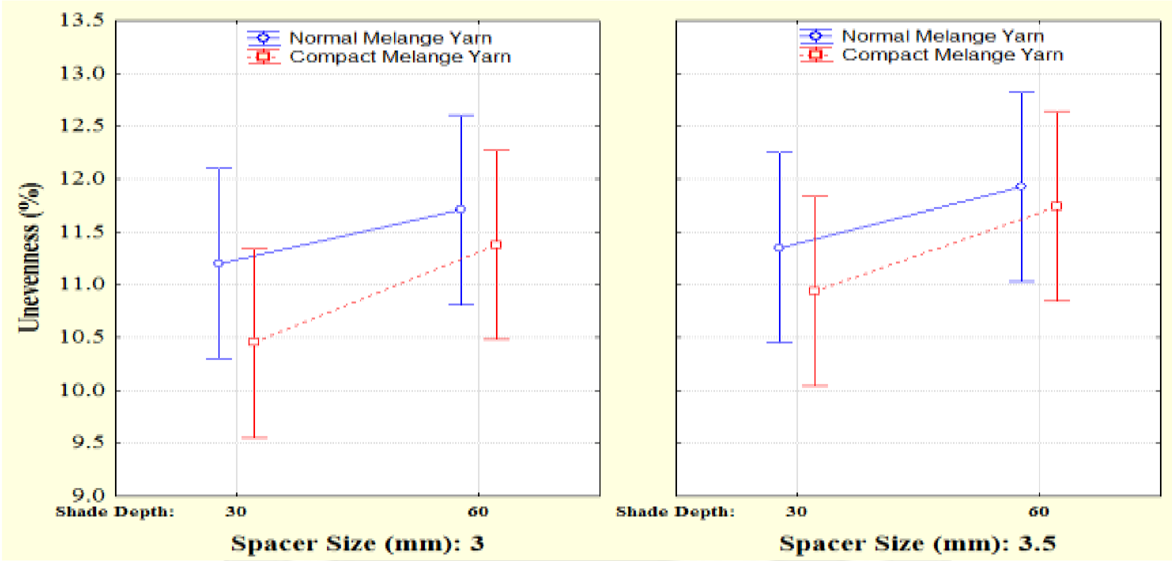

Fig- 2 Effect of spinning system and spacer size on the unevenness

It has been observed that U% increases with increase in shade depth for all combination as can be seen from Table 3. As it is known that the process of dyeing leads to a greater entanglement of fibres and lower staple length due to breakage. On the application of ANOVA, it was found that U% of compact melange yarn differs significantly with increase in shade depth. Further, it was observed that the U % increases with increasing the spacer size. The spacer size is directly related to the space between the drafting rollers. With the increase in spacer size, the drafting force will decrease on the fibre and which leads to increase entanglement in fibre.

3.2 Total Imperfection

The Imperfection Index (IPI) of spun yarn, is the description for thin, thick places and neps in the yarn. Yarn imperfections refer to the total number of thin places (-50%), thick places (+50%) and neps (+200%) present per 1000 metre of yarn. In the case of the ring-spun yarn, imperfections adversely affect the yarn fabric properties. Yarns with more imperfection will exhibits poor performance in a subsequent process, poor appearance grade and lower strength in the final product.

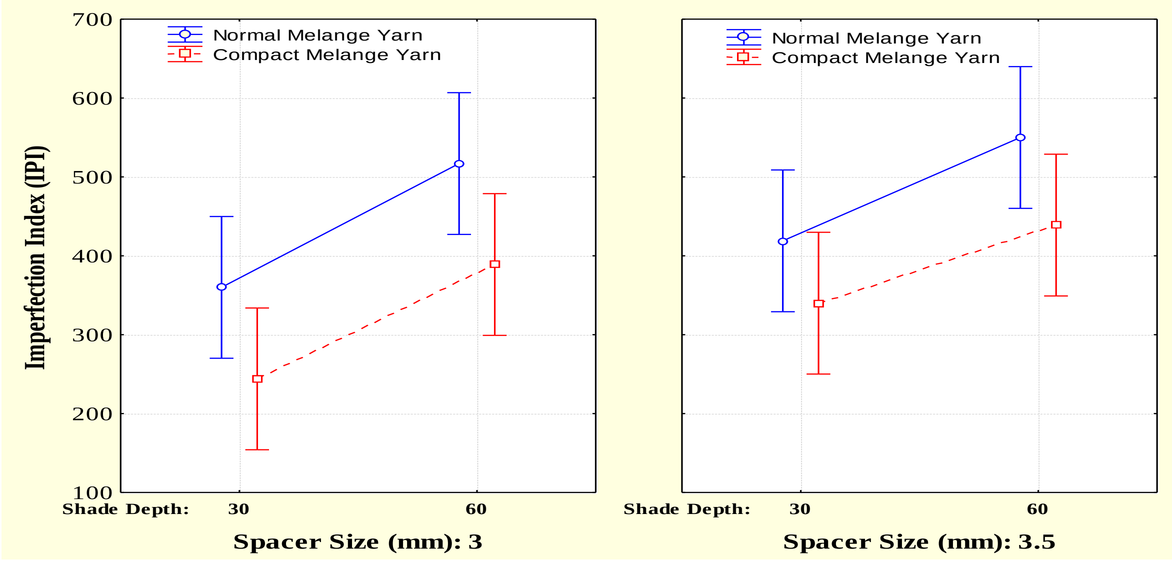

Fig 3 Effect of spinning system and spacer size on the imperfection index

The effect of types of spinning system on the imperfection index of the yarn is depicted in Fig 3. Based on the figure and statistical analysis, it is apparent that the spinning system and shade depth has a great influence on imperfection index of spun yarn. It has been observed that imperfection index of melange yarn was higher than that of compact melange yarn as seen from Table 3. In compact yarn spinning system, the condensing zone is assisted by suction which helps the protruding fibres to get integrated into yarn structure. Such additionally integrated fibres further improve the consolidation of yarn structure. This gives the yarn somewhat more compact, with a firmer body, than the usual normal yarn which helps to reduce the yarn imperfection index.
It was also observed from Fig 3 that the IPI increases with increase in shade depth for all combination. As it is known that the process of dyeing leads to a greater entanglement of fibres and sometimes neps are also generated due to water pressure thus increasing the imperfections. Further, it was observed that the IPI increases with an increase in the spacer size as, the cradle opening was increasing in ring frame. Wider the cradle opening, lesser will be the control of fibres between aprons leading to thin places in the yarn.

3.3 Hairiness

The hairiness of a yarn is the result of fibre protrusion from the yarn surface. Fig 4 is the graphical representation of the variation in yarn hairiness with spacer size and dyed % for two types of yarns.

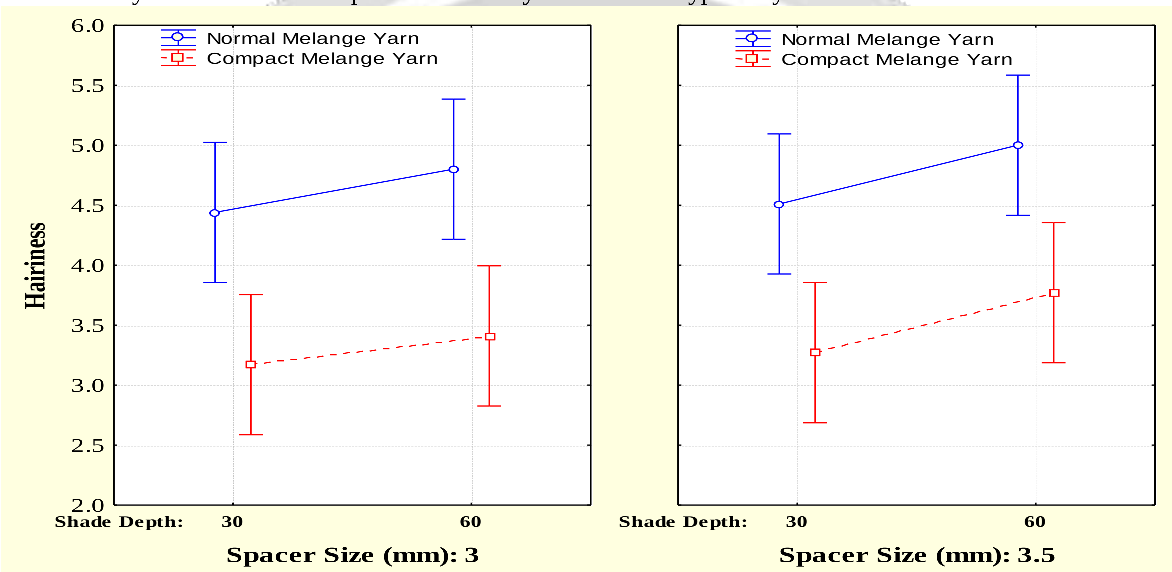

Fig- 4 Effect of spinning system and spacer size on the hairiness

It is observed from the figure that the spinning system has a significant influence on the level of hairiness. The hairiness of normal melange yarn was found to be higher than that of compact melange yarn. The ANOVA results also suggested that the hairiness of compact melange yarn differs significantly with normal melange yarn. In conventional ring spinning the strand width at the front roller nip is much wider than final yarn diameter and as a result, the twist does not flow right up to nip of front roller, hence the edge fibres do not get integrated into yarn structure. In the compact spinning system, due to the condensing the fibres in the strand are delivered in a straightened condition. Air drawn through inclined slot causes axial rotation of fibres, which contributes to the better integration of short fibres into the main strand. When the strand width is reduced, the twist can flow closer to front roller nip rendering to shortened spinning triangle, where the edge fibres can easily get integrated into the yarn reducing hairiness.
The yarn hairiness at various parameters is presented in Fig 4. It was determined that there is dramatically increase in hairiness with an increase in the shade depth. This hairiness is the result of shorter and coarser fibres present in the mixing, as they move to the outer surface of the yarn in the spinning triangle. As it is also known that the process of dyeing leads to a greater entanglement of fibres thus increasing the hairiness. Further, it was observed that the hairiness is increasing with increase the spacer size. With the increase in spacer size, the cradle opening is increasing in ring frame. Wider the cradle opening, lesser will be the control of fibres between aprons leading to thin places in the yarn.

3.4 Effect on RKM

The breaking strength of yarn is an important criterion in assessing yarn quality. The number of yarn breakages in spinning, weaving and knitting process largely depend on the strength. The effect of the spinning system on RKM of both yarn was depicted in Fig 5.

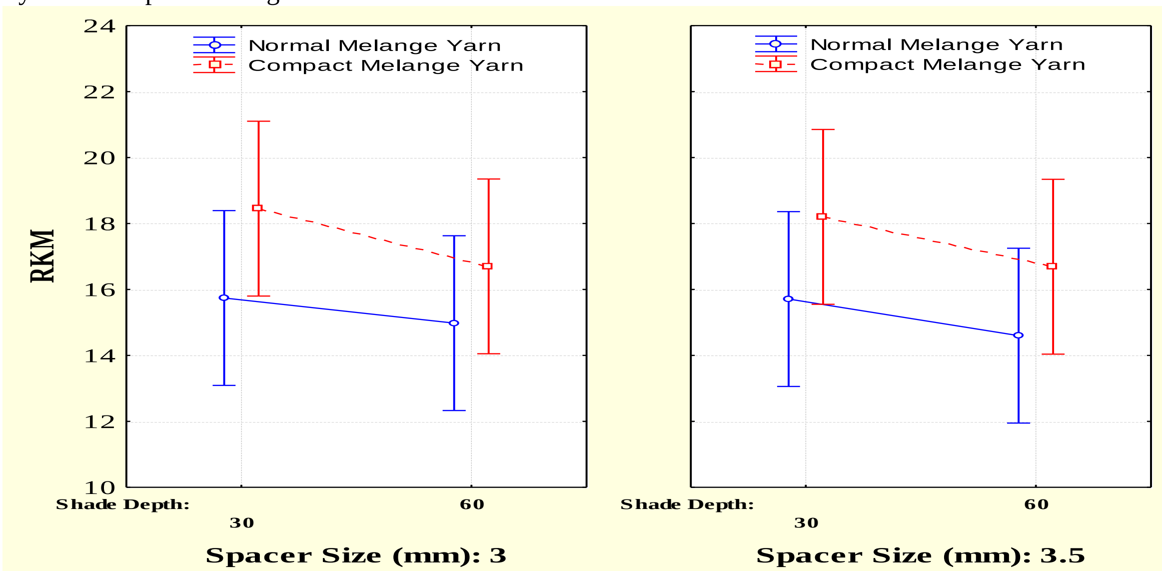

Fig- 5 Effect of spinning system and spacer size on the RKM

It has been observed from Figure 5 that the RKM of the compact melange yarn is more compared to normal melange ring spun yarn when the other parameters viz. shade depth and spacer size are kept unchanged. The ANOVA analysis shows the type of spinning system has a significant effect on RKM of spun yarn. The condensing zone is assisted by air suction which helps the protruding fibres to get integrated into yarn structure. Such additionally integrated fibres further improve the consolidation of yarn structure. This gives a yarn which is somewhat more compact, where the possibility of more contribution from individual fibre exists, as compared usual melange yarn. Hence compact melange yarn is stronger than melange yarn.

It has been also observed from Fig 5 that the RKM decreases with an increase in shade depth for all combination. Dyeing cotton fibres leads lesser strength, greater entanglement and cohesion. The average length of cotton fibres decreases with increase in shade depth which reduces the strength of yarn. Further, it is observed that the RKM is showing the significant increase with the decrease in the spacer size.

3.5 Breaking Elongation

The breaking elongation of the yarn under study is represented in Fig 6, when a load is applied to a yarn it is distributed among the constituent fibres. The breaking elongation of a yarn is basically related to fibre extension and the way fibres are arranged in its body.

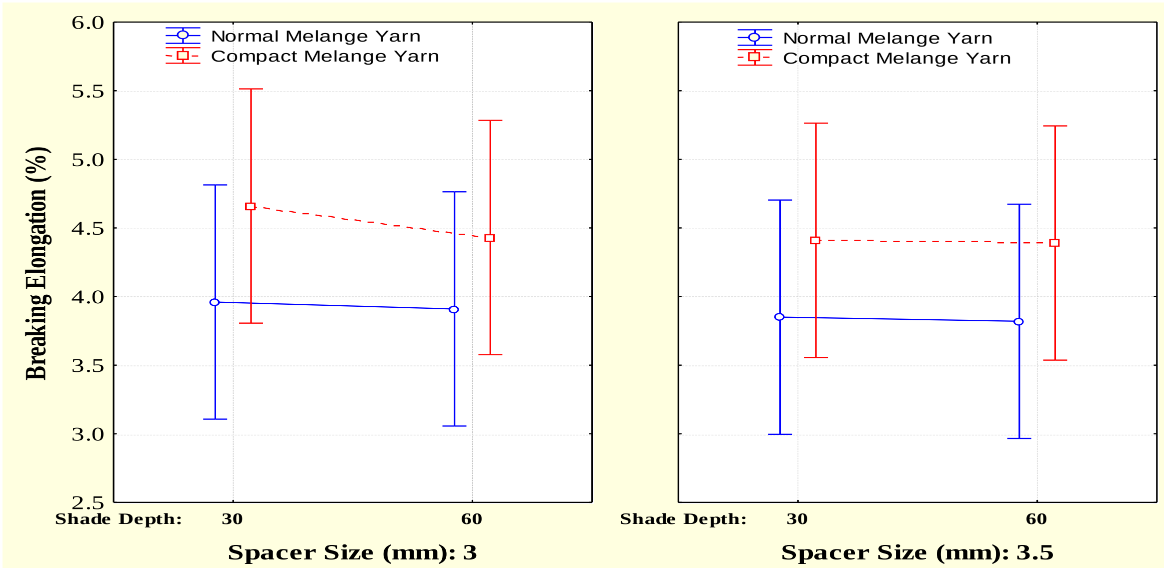

Fig- 6 Effect of spinning system and spacer size on the breaking elongation

From Fig 6 and the statistical analysis, it is clear that the breaking elongation of normal melange yarn and compact melange yarn differs significantly. The compact melange yarn exhibits higher breaking elongation in comparison with normal melange yarn. Breaking elongation of a compact melange yarn surpasses the normal melange yarn by 13%. Compact spun yarn characterised by better fibre integration and uniform fibre arrangement that leads to increased yarn elongation.

It has been observed from Fig 6 that the breaking elongation decreases with increase in shade depth. Dyeing cotton fibres leads to reduced strength of the yarn which influences the breaking elongation. Further, it was observed that the breaking elongation showed the significant decrease with an increase in the spacer size.

3.6 Coefficient of Friction of Yarn

Friction properties of yarn mainly depend on following:

- Area of contact: yarn diameter, the roundness of fibre, yarn compression.
- Wax/spin finish.

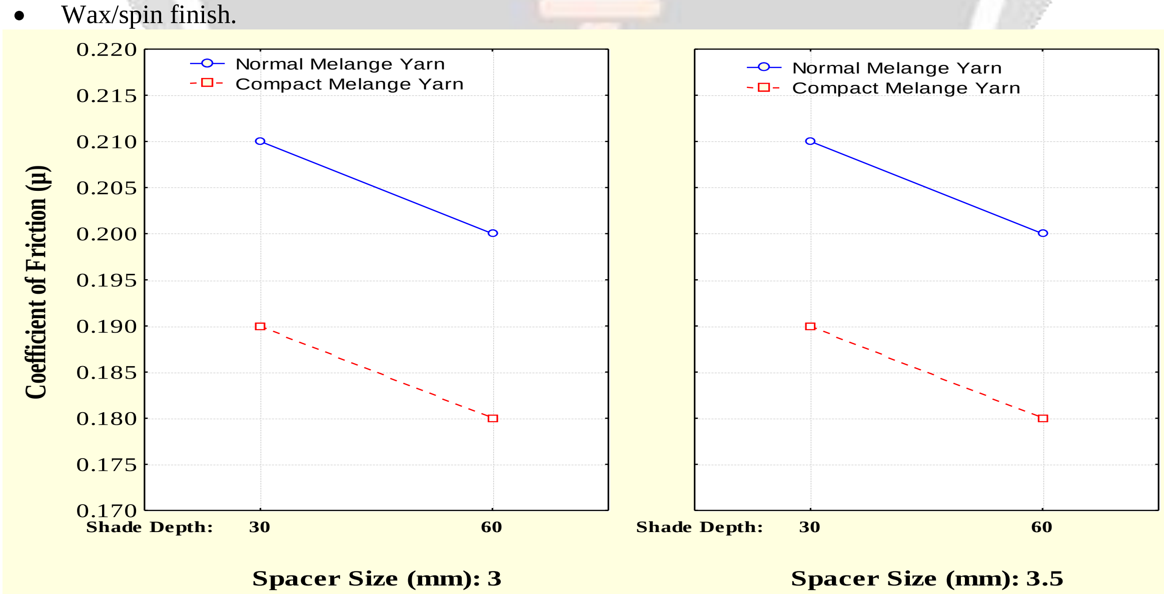

Fig- 7 Effect of spinning system and spacer size on the coefficient of friction

The dependence of frictional behaviour of different yarns is shown in Figure 7. The coefficient of friction of compact melange yarn is less than that of normal melange ring yarn. The compact melange yarn is compacted structure, hence ultimate strand twist and additional integration of surface fibre, so the scope of flatting is less when passed over any surface. The diameter of compact melange yarn is less compare to the normal melange yarn so the area of contact is also less in the case of compact melange yarn. The coefficient of friction decreases with increase in shade depth.

4. CONCLUSIONS

From the results, it can be concluded that dyed fibre component and spacer height impact directly on the parameters of yarn. Dyed fibre component % in yarn has a greater effect on normal ring spun melange yarn as compare to ring compact spinning melange yarn. It was investigated that when there was reduction in the dyed component by 50%, 30% IPI also reduced, RKM increases, and 10% Uster% decreases in normal melange yarn. In compact melange yarn contribution on the yarn properties of dyed fibre was lesser. It was found that compact spinning system overcomes deterioration of yarn properties due to dyed components.

The compact spinning system in melange also shows better properties like as U%, IPI, RKM, Hairiness and friction over the normal spinning system. Compact melange yarn also shows very high elongation as compare to normal melange yarn which is an essential property for knitting.

5. REFERENCES

[1]. Hatch, Kathryn L. Textile Science. Minneapolis/St. Paul: West Information Publishing Group, (1993).

[2]. Oxenham, William. Fancy Yarns: Yarns which are “novel” with respect to color, texture, composition and properties.” North Carolina State University,College of Textiles class notes. TT 521 001, Nov. (2002).

[3]. Karim, S. K., Gharehaghaji, A. A., &Tavanaie, H. A Study of the Damage Caused to Dyed Cotton Fibres and its Effects on the Properties of Rotor- and Ring-Spun Melange Yarns. Fibres & Textiles in Eastern Europe, 15(3), 63–67 (2007).

[4]. Cao Ying gang, ShenJiajia, Chen Weiguo, Study on Tolerance of Homogeneous Effect of Cotton Melange Yarn, Advanced Textile Technology, 5-12, (2013).

[5]. Watson, William. “Textile Design and Colour: elementary weaves and figured fabrics, Sixth Edition.” London: Longmans, (1954).

[6]. Almetwally, A. A., Mourad, M. M., Hebeish, A. A., & Ramadan, M. A. Comparison between physical properties of ring-spun yarn and compact yarns spun from different pneumatic compacting systems. Indian Journal of Fibre & Textile Research, 40(March), 43–50, (2015).

[7]. Mathew, J. Elite Compact Spinning. Spinnovation, 5(26), 14–16, (2012).

[8]. Soltani, P., & Johari, M. S. A study on siro- , solo- , compact- , and conventional ring-spun yarns. Part II : yarn strength with relation to physical and structural properties of yarns. Journal of the Textile Institute, 13(1), 110–117 (2012). https://doi.org/10.1080/00405000.2011.628117

[9]. Brunk N., EliTwist–Three Years after Market Introduction, Spinnovation, No.22, pp.10-16 (2006).

[10]. K Buvanesh Kumar, R Vasantha Kumar, and Dr G Thilagavathi Effect of spacers & shore hardness on yarn quality, Indian Textile Journal, December (2006).

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