P: ISSN No. 0976-8602 RNI No.UPENG/2012/42622 VOL.-IV, ISSUE-IV, October-2015

E: ISSN No. 2349-9443 Asian Resonance

Optimisation of Wax Percentage for Photographic Analysis of Yarn Cross-Section Cutting Technique

Rajiv Kumar
Associate Professor & H.O.D.,
Deptt.of Textile Engineering,
M.L.V. Textile & Engineering College,
Bhilwara, Rajasthan

Abstract

Optimisation of blend percentage of bee wax and paraffin wax has been studied. Different blend percentages were tried. Bee wax: Parafin wax blends 80:20, 60:40, 50:50, 40:60, 20:80 were tried. It was found that higher percentage of bee wax leads to softer material and sharp cutting is not possible whereas higher content of paraffin wax is brittle and too hard to cut. A blend percentage of 50:50 was found to be optimum. It leads to easier cutting of cross-sections and clear photographs can be obtained. With this technique it is possible to cut cross-sections of yarn without microtome. This type of study is useful for finding distribution of fibres in yarn cross-section (radial and rotational distribution), migration behavior of fibres.

Keywords: Yarn Cross-Section Study, Migration of Fibres, Cutting of Yarn Cross-Section, Photograph of Yarn Cross-Section.

Introduction

Blending involves thorough mixing of two or more varieties of fibres to achieve uniformity in fibre properties and consistency in yarn qualities. In an ideal blend, some conditions must be fulfilled to ensure satisfactory quality of blended yarns. The constituent fibres should be randomly distributed in the yarn cross-section. The ratio of blend fibres in each cross section should not vary by more than random distribution. There should not be undue long, medium or short term irregularity in the blend ratio. All these conditions can be checked if we study cross-section of yarn.

It is necessary to study cross-section of yarn to explore the internal structure of yarn in detail. Several researches [1, 2] have studied the packing density of yarn spun on different spinning system and concluded that fibre distribution in the yarn cross-section significantly affects the yarn properties. While blending dissimilar fibres in spun yarn, it is necessary to study migrational behavior in yarn cross- section so as to find out whether there is uniform distribution of these fibres throughout the yarn cross-section or one fibre component congregate either towards the surface or in the core of yarn. The cross-section shape of the fibre also affect handle and comfort properties of fabrics [3,4].

The cross-sectional study requires microtome and cutting cross-sections is very tedious process. It is difficult to decide that which type of wax is to be used. This method is very sensitive to temperature and relative humidity of the department where the study is to be carried out. Blade of microtome will have to be sharpened again and again if we want clear picture of yarn cross-section. It is sensitive to type of wax, yarn surface treatment, yarn tension during wax pouring etc.

Hence it is necessary to develop a simple method of yarn cross-section cutting, which can be done easily and quickly. So we have tried to develop a method for cutting yarn cross-section without microtome in which all the above mentioned problems are overcome. For this purpose first the optimization of blend of wax has been done. Then feasibility of cutting yarn cross-section with the help of razor blade has been studied. We can get many useful informations from photographic analysis of yarn cross-sectional study and all these informations have also been compiled.

Materials and Methods

Wax is an essential and critical part of the present work and optimization of wax percentage is required to get yarn cross-sections without any problem. It will lead to clear photographs under microscope.

Wax is obtained from animal and vegetable sources. These are low melting mixture of organic compounds having high molecular weight, water repellency, smooth texture and non toxicity. They are combustible and soluble in most of the organic solvent but not in water. Beewax, lanolin and Shellac wax are obtained from animal sources. Sugarcane etc. provide vegetable waxes. Two types of waxes paraffin wax and bee wax, are easily available, hence used in this study

Parafin Wax

White translucent, tasteless, odourless, solid containing mixture of solid hydrocarbon of high molecular weight. Insoluble in water and acids. Melts in range 47- 65°C. Combustible but is non- toxic.

Bee Wax

Wax from honeycomb of the bees, consists largely of myristyl palmitate (myristic alchol esterified with palmitic acid) acid and its esters and some higher alipathic hydrocarbons. Brown solid with faint odour, melting in the range of 60-65°C, insoluble in water and soluble in chloroform, ether and oils. It is combustible and non-toxic, used in the manufacture of wax emulsions.

Paraffin wax cannot be used alone as the wax material for yarn cross-section because, it is brittle and difficult to form thin film or sections. Bee wax also can't be taken alone since it is sticky, difficult to form films/section, sensitive to temperature and relative humidity. It is difficult to handle the cut section as it is very soft and chances of yarn slippage are high.

So to get optimum properties we must blend the waxes in suitable proportions. For this we prepared five different blend % of paraffin and bee waxes. They are 80:20, 60:40, 50:50, 40:60 and 20:80. These blends were taken on weight ratio.

Result and Discussion

A rectangular container (dimensions LxWxH 6cm x 3cm x 1.5cm) of iron sheet was prepared. We must use a certain kind of binder which is to be applied on the yarn surface in order to make the yarn surface hard, brittle. It will ensure smooth cutting of yarn cross-sections and also prevent fraying of surface fibres during the cross-section cutting. Care is to be taken that binder chosen must not disturb the internal arrangement of fibres as this will lead to misleading results. In this study polyester/silk yarn 50/50 blend was taken. The yarn was first coated with binder (Fevicol) and allowed to dry. Then the yarn was passed through the centre of container and kept under tension as shown in the Fig. 1. Then blend of paraffin wax and bee wax was poured in the container. When the wax solidifies then cake of wax was taken out from the container. Cake of wax was kept in refrigerator for 8 hours so as to make it hard. Then the cross-sections of the yarn were cut with the help of razor blade and observed under the microscope. A magnification of 250 was kept and photographs of the cross-sections were taken.

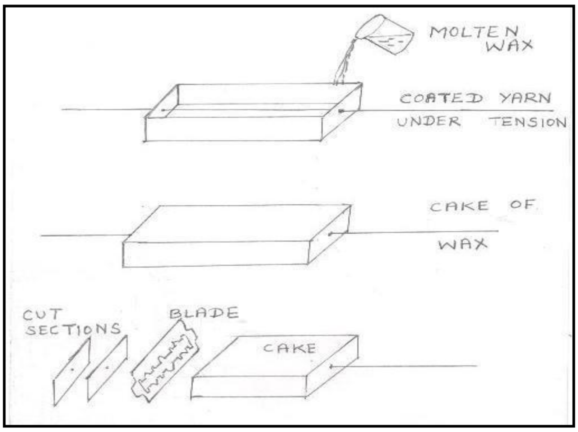
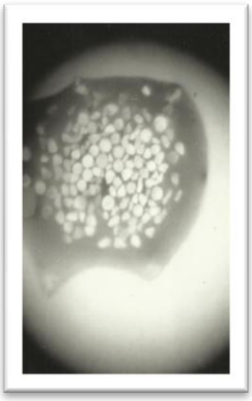


Fig. 1 - Preparation of Cake of Wax

Every time the yarn was coated with binder first, dried and put under tension in the container. Then blend of wax was poured. After drying and the cake of wax was taken out, kept in refrigerator for 8 hours and then cross-sections were cut with the razor blade. In this way same set of conditions were kept for different blends of wax. The observations during cutting of cross-sections were as follows

No.	Blend – Parafin wax : Bee wax	Observation
1.	80:20	Too brittle, slice very hard and difficult to cut.
2.	60:40	Thin slices can't be obtained, slightly brittle and hard to cut.
3.	50:50	Fine and even slices can be obtained. Non brittle. Non-sticky.
4.	40:60	Sensitive to ambient conditions. Thin slices cannot be obtained. Little bit sticky.
5.	20:80	Thin and even slices cannot be obtained. Very sticky. Very sensitive to ambient condition. Easily affected by temperature changes.

It was observed that higher content of paraffin wax resulted in brittle cake. It was difficult to cut thin cross-sections as the cake was brittle. Photographs were not clear. When the bee wax was 60 % or more, the resultant cake of wax was sticky. Curliness was observed at the edges and thin slices of cross-sections were difficult to obtain. This type of material was easily affected by temperature changes of the ambient conditions. When the blend % of paraffin wax and bee wax was 50:50, the resultant cake of material was neither brittle nor sticky. With the help of blade it was possible to cut fine, thin and even slices of yarn cross-sections. When these slices of wax were put under microscope, this resulted in clear photographs as shown below.



Round cross-section represents polyester fibre cross-section and rest are silk fibre cross-sections. These types of photographs are very useful for research in various fields

Applications of Photographic Analysis of Yarn-Cross-Sections

Ideally, the blend should be a perfect blend in which every fibre properties like length, denier and tenacity etc. is found in the same proportion within every unit cross-section of the yarn. However such a blend can never be achieved in practice. The best one can achieve, is the one in which the constituent fibres of the blend are randomly distributed across the cross-section along the length of the yarn. The blend homogeneity can be expressed either as the Degree of Mixing or the Index of Blend Irregularity [5].

Degree of Mixing

This is a statistical parameter which estimates the inherent intimacy of a blend. DeBarr and Walker [6] made a series of yarns from a blend of black and white fibres and examined their cross-section for the number of groups of fibres. They assumed that the fibre distribution in the yarn section would become random as the number of doubling approached α. If g is the number of groups of white fibres, the degree of mixing (¡) is given as g / g_α, where g represents the actual number of groups of white fibres and $g_\alpha = np(1-p)$ where n is the number of fibres in the average cross-section of the yarn and p is the average proportion of white fibres in the blend.

In practice, the number of groups of white fibres is less than this since the number of doublings in use never achieves perfect randomization. A value of 1 for ¡ shows a thorough random distribution of fibres. A value of less than 1 means less than random mixing and a value more than 1 means that the mixing is better than random. As this value increases, the blend approaches a perfect blend. In practice, the value of ¡ is less than 1 and tends to approach 1 as the number of doubling increases.

Index of Blend Irregularity (IBI)

This is another statistical measure used to assess the degree of randomness of fibre distribution. This index was evolved by Coplan and Klein [7] for variation in the blend proportion against the theoretical value for random mixing. The IBI can be calculated from the following expression:

$$IBI = \sqrt{\frac{1}{M}\sum\frac{(Tip - Wi)^2}{(Ti.p.q)}}$$

Where Ti is the total number of fibre in a given cross-section, Wi is the number of fibres of component W at that cross-section, p is the average fraction of component W for all cross section, q is equal to (1-p) and M is the number of cross-section examined. Obviously, this index is primarily a chi-square test. For complete randomness IBI has a value equal to unity. Values greater than unity indicate less homogeneity than complete randomness. The index would be zero for perfect blending.

According to Bogdon [8], the basis of evaluation in this method is the longitudinal variation in the ratio of the number of different fibres in the cross-section. Coplan and Bloch [9] expanded on the longitudinal variation method and developed two other methods of evaluation viz., radial distribution and rotational distribution of fibres.

Radial Distribution

This describes the fibre motion across the cross-section of the yarn. To estimate this, the yarn cross-section is divided into usually four, concentric circles of either area or thickness. Figure 2(a) shows circles of equal thickness along with the blend ratio plotted in the form of a bar diagram. Ideally, the blend ratio should be the same in all four zones from inside to outside.

Rotational Distribution

For estimating the variation in the rotational distribution, the yarn cross-section is divided in to four to six segments. The blend ratio is calculated and plotted as bar diagram shown in Fig - 2(b). Ideally the ratio should be the same for all the segments.

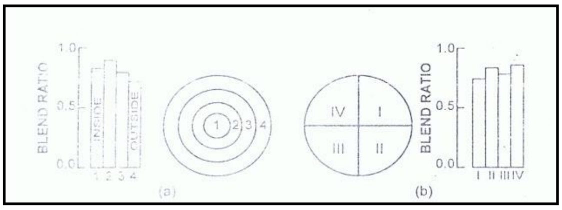


Fig 2 - Fibre Disribution in Zones and Segment

Migration

The segregation of components in a blend yarn is known as migration. A comprehensive understanding of this aspect of fibre behaviour is essential for the proper selection of fibres for a blend. It is known that in a blend yarn the fibres having higher modulus tend to occupy the inner zones of the yarn cross-section and those fibres having lower modulus, the outer zone. In general, longer, finer and higher-modulus fibres tend to migrate to the core of the yarn. The dyed fibres and non-crimped fibres also tend to migrate to the core of the yarn. With the help of cross-section analysis it is possible to ascertain actual position of fibres in the yarn.

Conclusion

1. A blend of Bee wax and Parafin wax 50:50 was found to optimum. The cross-sections cut with this blend resulted in clear photographs.

2. A thin film of binder should be applied on the yarn so that edge fibres also come clearly in the photograph.
3. The yarn should be under tension when the wax is poured.
4. The cake of wax should be kept in the refrigerator overnight and then yarn cross-section should be cut.
5. It is possible to cut cross-section with razor blade and analyze under microscope, take photographs.
6. This type of study is useful for finding degree of mixing, Index of blend irregularity (IBI), radial distribution and rotational distribution. It is also used to find blend ratio, packing coefficient of yarn, migration of fibres

Acknowledgement

The author is thankful to Sh. Surender Vyas for the useful suggestions given during this study.

References

1. Kilic, Musa; Buyukbayraktar, R Befru; (Dec 2014), Comparing the packing density of yarns spun by ring, compact and vortex spinning systems using image analysis method, *Indian Journal of Fibre & Texile Research*, Vol. 39**,** No.4, pp 351-357.
2. Hussain, U; Sarwar, A; (Dec. 2014), Effect of spinning variables on packing density of cotton yarn, *Indian Journal of Fibre & Texile Research*, Vol. 39**,** No.4, pp 434-436
3. Tyagi, G. K., Madhusoodhanan P, (Dec. 2006) Effect of fibre coss-sectional shape on handle characteristics of polyester-viscose and polyester cotton ring and MJS yarn fabric, *Indian Journal of Fibre & Texile Research*, Vol. 31**,** No.4, pp 496-500.
4. Jain, V., Contribution of fibre cross-sectional shape to the handle and thermal comfort characteristics of woven polyester viscose fabrics, (2004), M. Tech. Thesis, The Technological Institute of Textile & Sciences, Bhiwani.
5. Salhotra K.R., Spinning of Manmades and Blends on Cotton System, The Textile Association (India), Shivaji Park, Mumbai, 2004, p 68-74.
6. DeBarr, A.E., Walker, P.G., (1957), A measure of fibre distribution in blended yarns and its application to the determination of the degree of mixing achieved in different processes, *Journal of Textile Institute*, Vol 53, T 405
7. Coplan, M.J. and Klein, W.G. (1955), A study of blended woolen structures: Part I – Statistics of the ideal random blended yarn, *Textile Research Journal*, Vol 25, No. 9, pp 743–755.
8. Bogdan J. F., (1970), Measurement of fibre mixing in yarn, *Textile Research Journal*, Vol. 40, No. 5, pp 415-429.
9. Coplan M.J.; Bloch M.G.; (1955), A Study of Blended Woolen Structures: Part II: Blend Distribution in Some Wool-Nylon and Wool-Viscose Yarns, *Textile Research Journal,* Vol. 25, No. 11, pp-902-922.