Effect of Steaming on Stress-Strain Curves of Bulk Silk Yarns

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Abstract

The effect of steaming on stress-strain curves of acrylic-silk blended yarns have been studied. Yarns with different proportions of shrinkable acrylic and silk fibre have been prepared such as 100% shrinkable acrylic A10, 80% shrinkable acrylic 20% silk (A8S2), A6S4, A5S5, A4S6, A2S8 and 100% silk S10. Stress strain curves of acrylic, silk and cotton fibres were also studied. Stress strain curves of the yarns were checked on tensile testing machines before and after steaming. All the stress-strain curves incline towards strain axis after steaming. It has been found that tenacity of acrylic-silk blended yarns reduces whereas elongation increases after steaming operation. Change in stress strain curves was observed for acrylic silk blends whereas no change was observed for 100 % silk and 100% cotton yarn. These types of stress-strain curves are useful for deciding compatibility of different fibres for blending.

Keywords: Stress-Strain Curves, Bulk Silk, Acrylic-Silk Blend, Shrinkable Acrylic,

Introduction

When fabrics are made from binary blends, most important consideration in selection of blend constituents is compatibility of fibre properties, viz. length, fineness and tenacity. However it was realized that matching of these parameters alone is not sufficient. For optimum spinnability and maximum strength of yarn, it is necessary to study and match stress-strain curves of fibres. It will improve processing of fibres in spinning and affect properties of yarns and fabrics. It is well established that spinnability, yarn and fabric properties are dependent on fibre properties and shape of stress-strain curves. Hence while selection of constituent fibres for a blend, it is necessary that properties of fibres in the blend are fully compatible so as to avoid undesirable processing problems and consumer problems. In particular when synthetic fibres are blended with natural fibres as in our case acrylic and silk, it is necessary to study stress-strain curves of the constituent fibres. While blending different fibres and to get desired properties in the fabric, we blend different fibres in different proportions. Textile technologist is also interested to predict and know the properties of blended yarn. For this it is necessary to study fibre and yarn stress strain curves. In this study blend of shrinkable acrylic and silk fibre is used to produce bulk in acrylic-silk yarns. Acrylic-silk yarns were spun in different proportions and after spinning the yarns, the yarns are wound in hank form on reeling machine. Then steaming operation is done to produce bulk in the yarn. The shrinkable component shrinks whereas non- shrinkable doesn't undergo any change. This increases bulk in the yarn. Due to this, tensile behavior of the blended yarns changes after steaming.

There is change in the properties of shrinkable fibre after steaming. This results in change in the properties of blended yarn. Hence it is necessary to study the stress-strain curves of fibres and yarns before and after steaming.

Review of Literature

Choudhuri and Majumdar[1] has derived equations to predict strength of blended Dref yarn for different types of blend compositions and different combination of core-sheath components. They have tried to predict tenacity of blended Dref yarn and ring yarn from stress-strain curves of yarns. Patel and Kothari[2]have studied relationship between tensile properties offibres and nonwoven fabrics. The stress-strain behavior of constituents fibres has been studied and relation with structural parameters of nonwoven fabrics has been evaluated in case of heat setting of fabrics. Rao and Dweltz[3] have tried to find out polyester fibres compatible for blending with cotton in case of fabrics with the help of stress-strain curves. An attempt has been made to alter polyester fibre properties through physical modifications and heat setting operations with a view to produce a compatible fibre with property matched stress-strain curves for blending with cotton. Parathasarathy[4] has tried to find relationship between stress-strain parameters and fibre characteristics in wool with the help of regression equations. Parathasarthy et al[5] has studied stress-strain properties of Bharat Merino wool fibres, bundles and yarns so as to find relation between stress- strain values and tex. Tyagi G.K.et al[6] has studied variations in the characteristics of acrylic-cotton ring and open-end rotor yarns as a consequence of steam-relaxation treatment. They found that steam-relaxation treatment of acrylic rich yarns reduces their tenacity and abrasion resistance but increases extensibility and bulk. Kaushik R.C.D. et al[7] have studied effect of steam-relaxation treatment on characteristics of acrylic-viscose rotor spun yarns. Choudhuri et al[8] have studied tensile properties of different blend ratio of eri silk and acrylic by drawframe blending method.

Aim of the Study

In most of the studies yarn properties like tenacity, elongation etc have been studied but not much work has been done to study shape of the stress-strain curves after steaming. Hence aim of the study is

1. To study shape of stress-strain curves of acrylic, silk and cotton fibres before and after steaming.
2. To study the shape of stress-strain curves of acrylic-silk blended yarns before and after steaming.
3. To study effect of blend ratio on shape of stress-strain curves of acrylic-silk blended yarns before and after steaming.

Materials and Methods

Acrylic-silk yarns were spun in different proportions such as 100% shrinkable acrylic A10, 80% shrinkable acrylic 20% silk (A8S2), A6S4, A5S5, A4S6, A2S8 and 100% silk S10. Silk fibres were cut staple and then degummed using soap and soda method (Soap 6 g/litre, Sodium carbonate 1 g/litre, Temperature 90^{o} C, Time 90 minutes, Material : Liquor ratio 1:40). The degummed silk was opened. Shrinkable acrylic fibre of 64mm staple length and fineness 2.0 denier was selected for blending with silk as fine denier shrinkable acrylic fibres are not manufactured commercially. Blends of acrylic-silk were prepared in different proportions. The blended yarns were prepared by passing material on card, drawframe, simplex and ringframe. After spinning the yarns, the yarns were wound in hank form on reeling machine. Hanks of blended yarns were prepared by reeling machine. Yarn steaming was done in autoclave for 20 minutes and then hank rewinding was done. All these yarns are to be prepared for knitted fabric, hence the as spun count and twist levels were decided in such a way that after steaming and shrinkage, same count 30^{s} and 14.8 TPI (TM 2.7) may be achieved for all the yarns. Then steaming operation is done to produce bulk in the yarn. The shrinkable component shrinks whereas non-shrinkable doesn't undergo any change. This increases bulk in the yarn.

The stress-strain curves of silk and acrylic fibres before and after spinning, used in this study are shown in Fig 1. Cotton knitted fabrics are very popular, hence cotton fabric was also produced from H-4 cotton as a standard for comparison purpose. The stress-strain curves of these fibres are shown in Fig. 1. It was observed that there is no change in the properties of silk and cotton fibre after steaming whereas stress-strain behavior changes shrinkable acrylic changes after steaming.

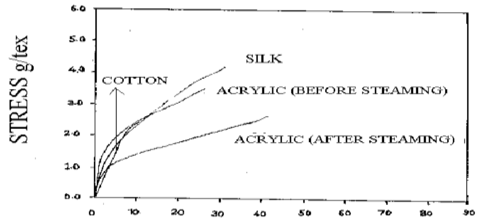

Fig 1 Stress-Strain curves of Silk , Acrylic and Cotton fibre (Before and After Steaming).

Table 1 Properties of Acrylic, Silk and Cotton Fibre.

	Acrylic (Beforesteaming)	**Acrylic (After steaming)**	**Silk**	**H-4 Cotton**
Tenacity (g/den)	3.5	2.7	4.1	2.2
	(17.9)	(19.0)	(12.0)	(12.4)
Elongation (%)	24.2	41.4	30.8	10.0
	(18.8)	(22.7)	(13.3)	(15.4)
Staple length (mm)	64.1	51.1	64	25.4 (2.5% span length)
	(18.5)	(20.8)	(28.5)	(28.4)
Fineness (den)	2.0	2.38	1.2	4.0 (micronaire)
	(14.8)	(17.0)	(17.4)	(20.4)

(Figures in parenthesis represent CV %)

Result and Discussion

The stress strain curves of 100% silk, acrylic and cotton yarn (before and after steaming) are shown in Fig. 2. No change was observed in the stress-strain curves of the 100% silk and cotton yarn after steaming whereas shape of the acrylic yarn has changed. This can be ascribed to the change in properties of the shrinkable acrylic fibre after steaming. The same trend was also observed in fibre stage. The stress strain curves of silk, cotton and acrylic fibre (before and after steaming) have already been shown in Fig.1 and properties of these fibres in Table 1. The properties of shrinkable fibre have changed after steaming treatment, hence a change in the properties of acrylic blended yarns is observed after steaming treatment.

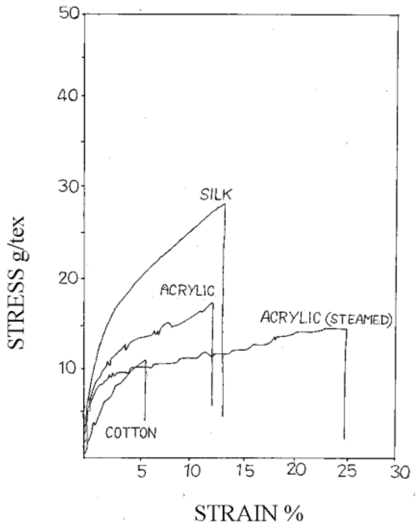

Fig. 2 - Stress-strain curves of 100% silk, cotton and acrylic yarns.

The stress strain curves of each acrylic-silk blended yarn before and after steaming is shown separately in Fig. 3,4,5,6,7 and 8 respectively. The properties of acrylic-silk blended yarns (before and after steaming) have been plotted in respective figures simultaneously, so as to observe the changes in yarn properties after steaming clearly.

All the curves incline towards strain axis after steaming. There is a reduction in tenacity and increase in elongation % at break after steaming for all the yarns.

Stress-strain curves of acrylic-silk blended yarns (before and after steaming).

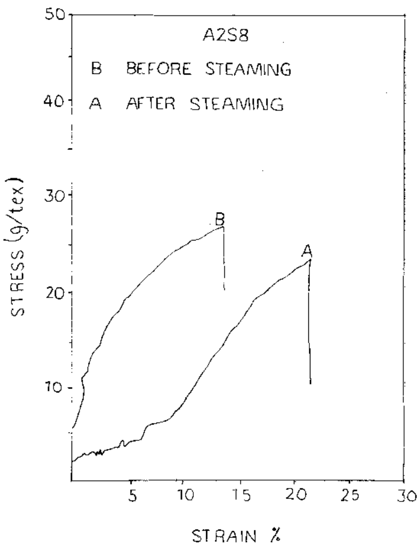

Fig. 3 – Acrylic-silk 20/80

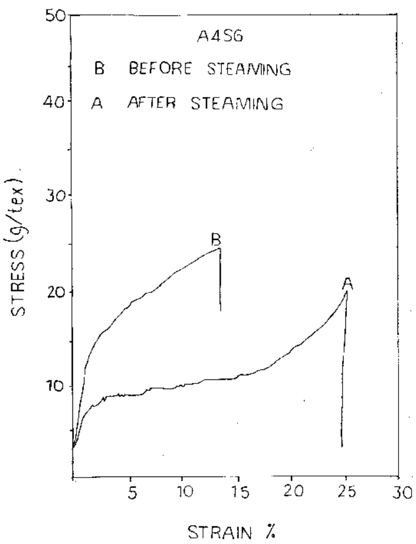

Fig. 4 – Acrylic/silk 40/60

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Remarking An Analisation

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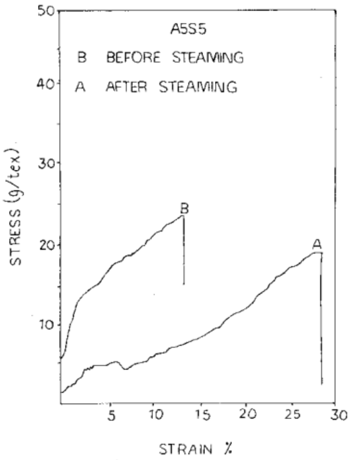


Fig. 5 – Acrylic/silk 50/50

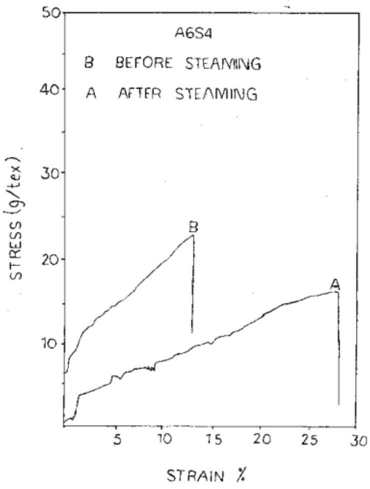


Fig. 6 – Acrylic/silk 60/40

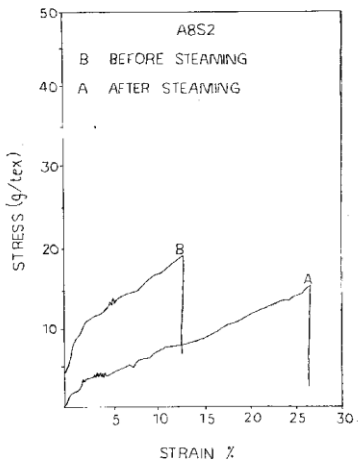


Fig. 7 -- Acrylic/silk 80/20

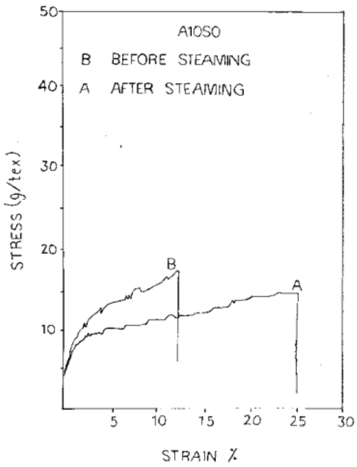
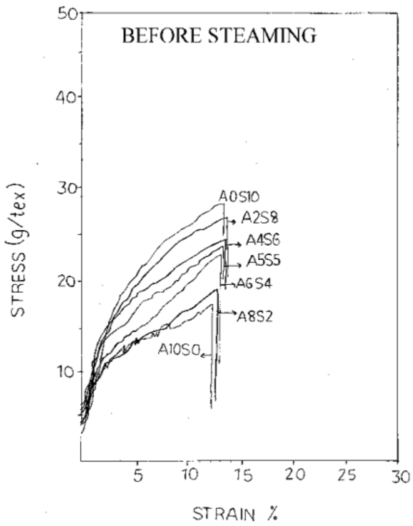
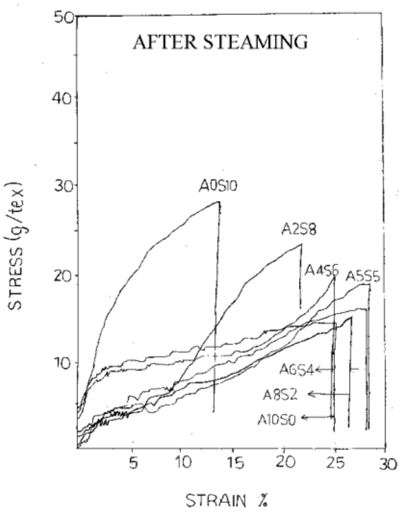


Fig. 8 – Acrylic 100%





Stress Strain Curves of Acrylic/Silk Blended Yarns

Fig. 9 Before steaming. **Fig. 10 After steaming**

If we superimpose all the curves in one diagram, then the change in stress-strain curves with the change in blend can easily be seen. The stress strain curves at various blend levels of acrylic/silk yarns before steaming are shown in Fig. 9. The change in shape of the curves after steaming treatment is shown in Fig. 10.

Conclusion

1. Stress-strain curves of acrylic/silk blended yarns incline towards strain axis after steaming.
2. No change in the shape of stress-strain curve was observed for 100% silk and 100% cotton yarn.
3. The stress-strain curves of acrylic rich blends incline more towards strain axis after steaming.
4. If we know the stress-strain curves of the fibres and blended yarn, this will help us to predict the compatibility of fibres and tensile behavior of blended yarns.

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