P: ISSN No. 0976-8602 RNI No.UPENG/2012/42622 VOL.-V, ISSUE-III, July-2016
E: ISSN No. 2349-9443 Asian Resonance

# Study and Evaluation of Effect of Steaming on Bulk Silk Yarns

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**Abstract**

The effect of steaming on blends of shrinkable acrylic fibre and silk has been explored. 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.The yarn properties have been evaluated after steaming. It has been found that tenacity of acrylic-silk blended yarns reduces whereas elongation increases after steaming operation. Unevenness, total imperfections and hairiness increase after steaming. Abrasion resistance of the acrylic rich yarns increases after steaming whereas no change in abrasion resistance is observed for 100% silk and cotton yarn after steaming. Yarn diameter of acrylic-silk blended yarns increases after steaming. The increase in yarn diameter after steaming is maximum for acrylic-silk 50/50 blend.

**Keywords:** Bulk Silk, Acrylic-Silk, Blending, Shrinkable Acrylic,

**Introduction**

Combination of shrinkable acrylic and non-shrinkable acrylic fibre is used to produce bulk in acrylic yarns for knitwears. After spinning the yarns, the steaming operation is done in hank form to produce bulk in the yarn. This is very common practice in textile industry to produce bulk in acrylic yarn. In case of acrylic-silk bulk yarn, fibres of different shrinkable properties shrinkable acrylic and silk, are mixed together and steam relaxed in hank form after spinning operation. When steam is used as a medium, the strains imposed during spinning are released. The shrinkable acrylic fibre component shrinks whereas non- shrinkable fibre silk doesn't undergo any change. This increases bulk in the yarn. There is change in the properties of shrinkable acrylic fibre after steaming. This results in change in the properties of blended yarn. Bulk generates due to shrinkage or contraction of shrinkable acrylic. Studies on acrylic-silk blends are limited, hence it is necessary to study change in the properties of fibre and yarns. The effect of blend ratio on the properties of yarns after steaming will also be examined.

**Review of Literature**

Most of the work done earlier is related to research of molecular structure of acrylic [1], blending of shrinkable acrylic with jute, cotton, viscose and wool etc. and study of properties of knitted fabrics [2]. Few references are available on blending of shrinkable acrylic with silk. Sengupta S. has blended shrinkable acrylic for ternary blends [3]. Two types of jute based blended yarns have been developed from jute-shrinkable acrylic-hollow polyester and jute-polypropylene-holllow polyester. Yarn properties and dimensional stability of the fabrics have been evaluated. Tyagi G.K.et al.[4] 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 [5] have studied effect of steam-relaxation treatment on characteristics of acrylic-viscose rotor spun yarns. Sinha A.K. [6] has studied physical properties of jute acrylic blended bulked yarns. Three different methods of thermal treatments have been compared. In another study, silk noil was blended with acrylic fibre to produce bulk silk yarn processed on woolen set of machineries [7]. Tyagi [8] has studied bulk and related properties of acrylic-cotton jet-spun yarns. Jet-spun yarns produced with higher acrylic fibre content showed substantially higher bulk, abrasion resistance, flexural rigidity, tenacity and breaking elongation than the yarns spun with higher cotton content. Studies on the properties of Dref-spun acrylic yarns was also done [9]. It was observed that tenacity of core-spun acrylic yarns are higher than 100 % acrylic yarn. All the

properties of fibre [10,11] and yarn properties [12,13] were evaluated as per ASTM standards.

**Aim of the study**

There have been numerous studies on change in properties of acrylic blended yarns after steaming but work on acrylic-silk blends is very limited. Hence aim of the study is

1. To study change in properties of fibres before and after steaming.
2. To study the properties of yarns before and after steaming.
3. To study effect of blend ratio on the properties of acrylic-silk blended yarns after steam relaxation.

**Materials and Methods**

The silk hanks were cut to a staple length of 64 mm 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. Hanks of blended yarns were prepared by reeling machine. Yarn steaming was done in autoclave for 20 minutes and then hank rewinding was done.

The properties of silk and acrylic fibres used in this study (before and after steaming) are shown in Table 1. The properties of acrylic fibre have changed after steaming.It is revealed from Table 1 that tenacity of shrinkable acrylic fibres reduces whereas marginal increase in elongation % at break is observed after steaming treatment. The change in acrylic fibre properties is due to it's shrinkage during steaming. At the same time the denier has increased due to swelling of the shrinkable fibres. Length of the shrinkable acrylic fibre has reduced by 20% (64 to 51.12 mm) and denier has increased from 2.01 to 2.38.

**Table 1**
**Properties of Acrylic, Silk and Cotton Fibre.**

| | Acrylic (Before Steaming) | 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**

**Yarn Properties**

The properties of acrylic-silk blended yarns after steaming are shown in Table 2.

**Table 2**
**Properties of Acrylic-Silk Blended Yarns (After Steaming)**

| | Acrylic | A8S2 | A6S4 | A5S5 | A4S6 | A2S8 | Silk | Cotton |
|---|---|---|---|---|---|---|---|---|
| Yarn linear density (Tex) | 19.9 | 19.7 | 20.1 | 19.5 | 20.1 | 19.5 | 20.2 | 20.1 |
| | (3.1) | (2.5) | (3.3) | (2.7) | (2.1) | (2.6) | (3.8) | (3.6) |
| Tenacity(g/tex) | 14.7 | 15.3 | 16.1 | 18.9 | 20.3 | 23.5 | 28.1 | 11.2 |
| | (8.1) | (8.4) | (12.4) | (9.3) | (6.7) | (20.6) | (16.9) | (7.8) |
| Strain % at break | 24.9 | 26.1 | 28.1 | 28.3 | 24.9 | 21.1 | 13.1 | 5.3 |
| | (15.4) | (12.4) | (15.1) | (4.1) | (7.5) | (14.1) | (9.3) | (8.1) |
| Unevenness (U %) | 13.8 | 14.8 | 18.8 | 12.8 | 12.4 | 14.1 | 10.3 | 18.3 |
| Imperfections/250m | | | | | | | | |
| Thin place (-50%) | 30 | 19 | 8 | 6 | 6 | 14 | 3 | 92 |
| Thick place (+50%) | 15 | 30 | 34 | 9 | 38 | 48 | 10 | 106 |
| Neps (200%) | 47 | 68 | 75 | 52 | 16 | 68 | 18 | 216 |
| Total imperfections | 92 | 117 | 117 | 67 | 59 | 130 | 31 | 414 |
| Hairiness value S3 (Hairs>3mm/100m) | 4087 | 3860 | 3707 | 2667 | 2480 | 2462 | 2062 | 3055 |
| Flexural rigidity*$10^3$ (gm*$cm^2$) | 2.88 | 3.08 | 3.27 | 3.29 | 3.32 | 3.40 | 3.71 | 3.48 |
| | (6.1) | (8.1) | (9.1) | (8.1) | (9.1) | (9.8) | (10.4) | (9.4) |
| Abrasion resistance (cycles) | 290 | 334 | 456 | 460 | 492 | 507 | 587 | 110 |
| | (20.9) | (26.3) | (24.5) | (28.8) | (20.4) | (24.4) | (28.4) | (28.1) |
| Yarn diameter (mm) | 0.24 | 0.25 | 0.25 | 0.31 | 0.26 | 0.26 | 0.184 | 0.205 |
| | (22.0) | (22.1) | (23.0) | (16.8) | (20.4) | (22.1) | (7.9) | (16.1) |
| Yarn appearance grade | B | B | B | B | B | B | B | C |

(Figures in Parenthesis Represent CV %)

The tenacity of acrylic-silk blended yarns before and after steaming is also shown in Fig. 1. The tenacity increases with increase in silk fibre content in the blend.After steaming decrease in tenacity is observed in case of blended yarns containing shrinkable acrylic fibre. This reduction in strength after steaming is mainly due to reduction in fibre strength of shrinkable acrylic fibre.

An increase in strain % at break or breaking elongation is observed for acrylic-silk blended yarns after steaming (Fig 2). Higher breaking elongation value can be attributed to bending, buckling of silk, shrinkage of acrylic fibres and hence increase in yarn bulk after steaming.As the buckling of fibres increases with increased quantity of acrylic content, the breaking elongation of the yarn also increases. It ultimately results in loosening of the yarn structure followed by reduction in tenacity and increase in elongation % at break.

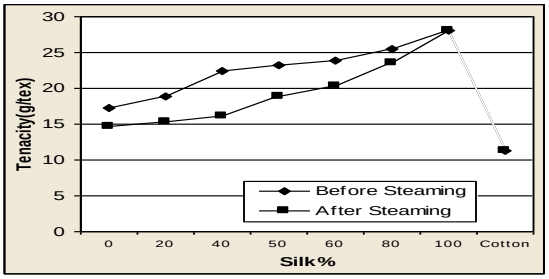


**Fig. 1 Tenacity of Acrylic-Silk Yarns**

Fig.3 shows that U% of the yarns have increased after steaming.This may be because of manhandling of the yarns during reeling, steaming and hank rewinding operations. Uniformity improves with the addition of silk, as the number of fibres in the cross-section also increases. Total imperfections remain fairly same as shown in Fig 4.

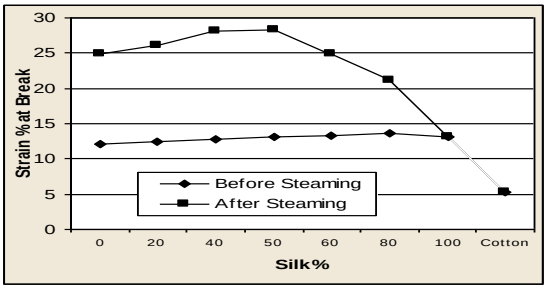


**Fig. 2 Strain% at Break of Acrylic-Silk Yarns**

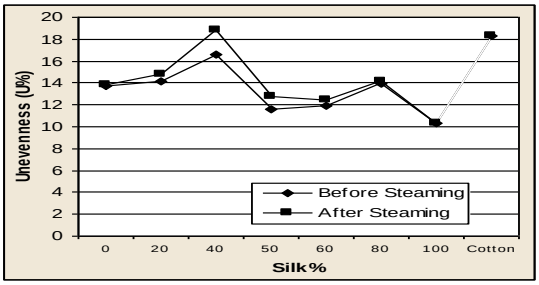


**Fig. 3 Unevenness of Acrylic-Silk Yarns**

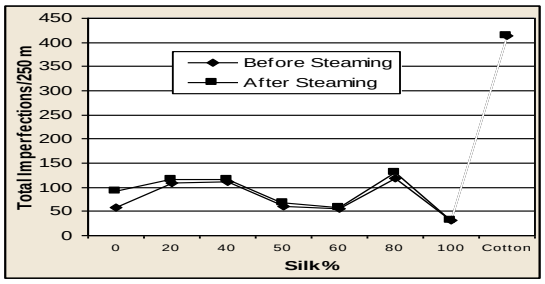


**Fig. 4 Total Imperfections of Acrylic-Silk Yarns**

A marginal increase in the hairiness of the yarns is observed in Fig. 5 due to repeatedly winding and rewinding. Flexural rigidity of yarns has increased after steaming operation (Fig. 6).The acrylic-silk yarns have become coarser after steaming operation, hence coarser yarn is expected to exhibit more yarn flexural rigidity.

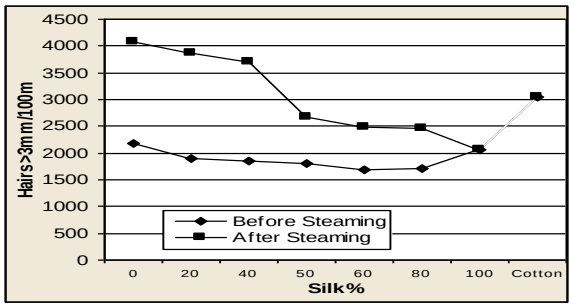


**Fig. 5 Hairiness of Acrylic-Silk Yarns**

Fig. 7 reveals poor values of abrasion resistance before steaming. The yarns were comparatively finer before steaming and hence are exhibiting lesser abrasion resistance. The diameter of the yarns as measured on the microscope is shown in Fig. 8. Each acrylic-silk blended yarn is showing a increasing trend in the yarn diameter after steaming operation, but increase in diameter of the yarn is found to be maximum in case of acrylic-silk 50:50 blend.

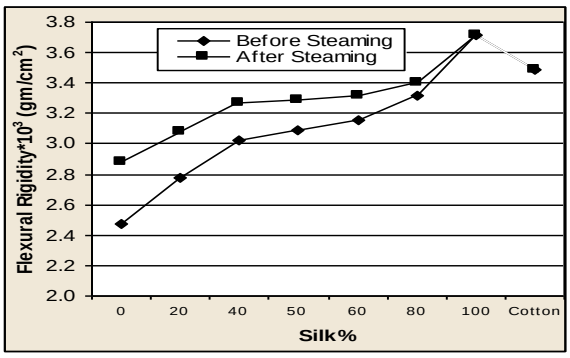


**Fig. 6 Flexural Rigidity of Acrylic-Silk Yarns**

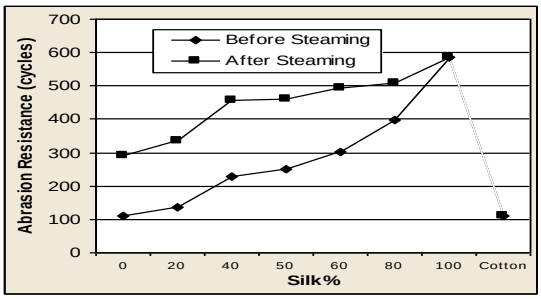


**Fig. 7 Abrasion resistance of acrylic-silk yarns**

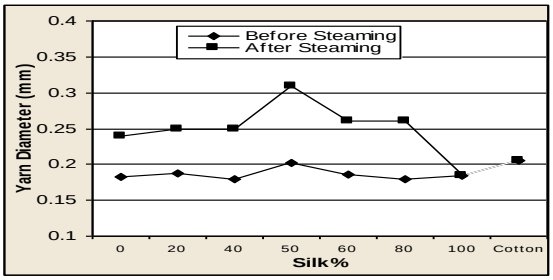


**Fig. 8 Yarn Diameter of Acrylic-Silk Yarns**

**Conclusion**

Tenacity of acrylic-silk blended yarns reduces whereas elongation increases after steaming operation. Unevenness, total imperfections and hairiness increase after steaming. Abrasion resistance of the acrylic rich yarns increases after steaming whereas no change in abrasion resistance is observed for 100% silk and cotton after steaming. Yarn diameter of acrylic-silk blended yarns increases after steaming. The increase in yarn diameter after steaming is maximum for acrylic-silk 50/50 blend.

**Acknowledgement**

The author is grateful to Late Prof. S. K. Sharma, Ex- Principal, M.L.V. Textile & Engineering College, Bhilwara for encouragement and thankful to Sh. Surender Vyas, Sh. Satyanarayan Parashar, Sh. Udailal Suthar, Sh. Mishrilal Sainee for co-operation during this study.

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