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Weaving performance of polyester blended sized yarns : Roles of size recipe and high squeeze pressure

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Weaving performance of polyester-cotton (67:33) and polyester-viscose (48:52) yarns sized with starch and starch plus PVA at low and high squeeze pressures on a laboratory sizing machine has been studied. It is observed that the size recipe comprising starch and PVA significantly improves the weavability of polyester blended yarns. High pressure squeezing further improves the weavability of polyester blended yarns, irrespective of the size recipe. Both the size recipe and squeeze pressure have no significant effect on the tensile strength of these yarns.

Keywords : Polyester-cotton yarn, Polyester-viscose yarn, Polyvinyl alcohol, Sizing, Tensile strength, Weavability

1 Introduction

High squeeze pressure causes more size penetration to the yarn body and helps in improving the weavability of the cotton yarn[1]. However, the polyester blended yarns are more vulnerable to (i) the plucking out of the fibres (poor surface integrity), and (ii) inter-fibre slippage during abrasion due to the smooth and round structure of the fibres and greater bulk of the yarn. In order to improve the surface integrity, and therefore the weavability of the blended yarns, it is necessary to improve fibre-to-fibre interaction and fibre-to-size anchorage. The anchoring of the size coat with surface fibres and annulus of size inside the yarn can be improved by (i) using suitable size recipe, and (ii) improving the size-fibre interaction by applying higher squeeze pressure in sizing.

The choice of sizing agent depends on its adhesion with the fibres. As such, different sizing agents are used for different fibres, depending on their chemical interaction with the fibre substrate. However, high pressure squeezing increases the penetration of the size in the yarn and thus improves the mechanical interlocking between the fibres and anchorage of size with the yarn.

In the present work, which was aimed at comparing the relative effectiveness of the mechanical interlocking by high squeeze pressure with the chemical interaction of the size material, the weaving performance of polyester-cotton and polyester-viscose yarns sized with starch and starch + PVA at low and high squeeze pressures has been evaluated.

2 Materials and Methods

45 Ne polyester-cotton (67:33) yarn and 40 Ne polyester-viscose (48:52) yarn were used for sizing.

2.1 Sizing

Sizing was carried out under controlled conditions on the Laboratory Zell High Pressure Sizing Machine. The sizing agents, squeeze pressure, and sizing add-on employed were as follows:

Sizing agent: Thin boiling starch
Thin boiling starch + partially hydrolyzed polyvinyl alcohol (85:15)

Squeeze pressure: 22 daN/cm^2, Low squeeze pressure (LPS)
33.8 daN/cm^2, High squeeze pressure (HPS)

Size add-on: 15.3% for polyester-cotton
15.8% for polyester-viscose

The size add-on for P/C and P/V yarns was kept almost constant at both LPS and HPS by varying the machine speed and size liquor concentration. P/V and P/C yarn samples were also treated with hot water under similar conditions on the sizing machine.

2.2 Tensile Testing

Yarn breaking strength/extension was obtained on the Instron tensile tester as per ASTM standard.

2.3 Weaving Performance

The relative weaving potential of the yarn was studied on the Web tester which simulates the most important stresses during weaving such as cyclic extension/bending and axial abrasion under constant tension. This experiment was conducted for unsized, water-treated and sized yarns. In a test, fifteen yarn samples were mounted on the tester and the number of cycles to break the first ten successive yarns was recorded. The average abrasion cycles of the ten repeats of the test was taken.

3 Results and Discussion

3.1 Tensile Properties

3.1.1 Breaking Strength

The breaking strength of unsized and low- and high-pressure sized yarns (for identical size add-on) is shown in Table 1. The results show insignificant change in the breaking strength of P/C and P/V yarns after sizing. Moreover, the increase in squeeze pressure has insignificant effect on the breaking strength of the sized yarn. This is in contradiction with the behaviour of cotton yarn[1] shown in Table 1.

The increase in strength of the yarn after sizing is due to the (i) protruding fibres which are cemented with the yarn body, and (ii) decrease in inter-fibre slippage due to adhesive joints formed by the penetration of adhesive. In the blended yarn the above effect can be counterpoised due to the differential tensile behaviour of the component fibres. Above discussion shows that the tensile strength is not a sensitive criterion for assessing the contribution of sizing and squeeze pressure for polvester blended yarn unlike cotton.

3.1.2 Breaking Extension

Table 1 shows the well-known significant decrease in breaking extension of yarn on sizing. However, increase in squeeze pressure results in a marginal decrease in the breaking extension. This can be due to (i) size penetration which decreases inter-fibre slippage, and (ii) yarn stretch at the squeeze nip.

3.2 Weaving Performance

The relative weaving performance of the unsized and sized yarns is shown in Table 1 in terms of weavability cycles. It is observed that the weavability of P/C yarn deteriorates on sizing with thin boiling starch, though some improvement in the weavability of P/V is achieved. It is well known that starch is more suitable for cellulosic fibres like cotton and viscose than for polyester due to better chemical affinity for former. Improvement in the weavability[1] of cotton yarn sized with starch (Table 1) confirms the above observation. However, the addition of partially hydrolyzed polyvinyl alcohol (more suitable for polyester fibres) to starch gives significant improvement in the weavability of polyester-cotton and polyester-viscose yarns. This shows that more effective size recipe protects the yarn structure, mainly by the size coating, due to better chemical interaction with the surface fibres.

It is also observed from Table 1 that the increase in squeeze pressure increases the weavability of all the yarns, irrespective of the size material. These results show that the contribution of the size material is essential for improving the weavability. However, further improvement can be achieved by high squeeze pressure which causes more penetration of the size.

It appears that high pressure squeezing, by more penetration of the size, provides mechanical bonding between the fibres to retard inter-fibre slippage and thus delays yarn disintegration. In addition, the enormous benefits of thermal energy saving by the high pressure squeezing[2-4] cannot be under estimated.

3.3 Damage of Yarn due to High Squeeze Pressure

High squeeze pressure, by acting on an elemental length of the yarn, due to crushing might cause damage, particularly to the polyester fibres. This can lower the benefits achieved due to more size penetration during high pressure squeezing[5].

The damage due to high squeeze pressure is more for the yarn passed through hot water instead of size and squeezed under low/high pressure as for the sized yarn. Increase in squeeze pressure has insignificant

Table 1—Tensile properties and weaving performance of unsized and sized yarns

Yarn	Breaking strength,g			Breaking extension,%			Weavability cycles		
	Unsized	Sized		Unsized	Sized		Unsized	Sized	
		LPS	HPS		LPS	HPS		LPS	HPS
P/C(67:33)	267	270 (276)	270 (295)	10.0	5.2 (4.2)	4.9 (3.6)	1229	692 (2183)	880 (2823)
P/V(48:52)	254	276 (271)	280 (280)	10.8	7.6 (8.7)	7.0 (8.5)	608	886 (2338)	1030 (2961)
Cotton[a]	241	335	255	5.6	3.4	3.3	1030	1766	2411

[a]Values quoted from ref. 1

Values in parentheses relate to the yarns sized with rich sizing agent (starch + PVA)

Table 2—Tensile properties and weaving performance of water-treated yarns

Yarn	Breaking strength, g		Breaking extension, %		Weavability cycles	
	LPS	HPS	LPS	HPS	LPS	HPS
Cotton	219	214	2.72	2.83	320	298
P/C(67:33)	242	235	7.11	6.87	426	398
P/V(48:52)	219	215	7.37	7.35	284	281

effects on the tensile properties and weavability of water-treated yarn (Table 2). Therefore, the damage to the sized yarn by high squeeze pressure can be neglected.

4 Conclusions

4.1 Significant improvement in weavability can be achieved by using suitable sizing agent.

4.2 High pressure squeezing helps in further improving the weavability of the sized yarn.

4.3 The damage to the polyester blended yarns sized at high squeeze pressure is insignificant.

4.4 Both the size recipe and squeeze pressure have no significant effect on the tensile strength of polyester blended yarns.

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