EFFECT OF SIZING ON WEAVABILITY OF DREF YARNS

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Abstract

The optimum-size add-on for corespun Dref yarns and 100% cotton Dref yarns was studied, and was found to be approximately 15%. A rich size recipe consisting of acrylic at high add-on further improves the weavability, although it fails to bring the weaving potential to a par with that of ring- and rotor-yarns sized with normal modified starch at low add-on.

Key words:

Corespun yarn, Dref spinning, sizing, weavability

1. Introduction

In the cases of ring and rotor yarns, the effect of sizing at various levels of add-on and its subsequent influence on weaving performance has been reported extensively by Aggarwal [1,2], Behera [3], Dolecki [4,5], Fassan [6], Hari [7,8], Heap [9], Slauson [10], Strauss [11], and Trauter [12]. However, literature regarding the sizing of friction spun yarn is scanty. Although Trauter [13] reported a technique for sizing Dref-2 yarns, he did not deal with the weavability of these yarns. It is desirable to develop a sizing weaving curve in order to investigate the optimum weavability conditions of sizing. Therefore, an attempt has been made here to see the effect of sizing in terms of change in size add-on, which is likely to alter the physical properties and surface properties of friction spun yarn caused by size penetration and encapsulation. Alterations in their properties and the nature of the surface are likely to influence the weaving potential of such yarns. This will also help to determine the desired level of size add-on, where the weaving performance will be better for friction spun yarns. Therefore, a sizing-weaving curve has been prepared for a normal recipe mainly consisting of modified starch, as is normally used in the industry.

Selecting an appropriate size mix is another important aspect in sizing. It is again a well-established fact that the size mix selection is mainly governed by fibre substrate. Since cotton is the only fibre used here, the sizing is also carried out by taking the best possible recipe consisting of a modified starch/acrylic blend, since many researchers (including Heap [9] and Moreau [14]) have already reported that the starch/acrylic size mix is the best one for cotton yarns. Therefore, an attempt has also been made to examine the effect of the best size recipe consisting of a modified starch/acrylic blend on the weavability of Dref yarns.

2. Materials and methods

2.1. Materials

2.1.1. Yarns

We used different core Dref yarns and 100% cotton Dref yarns as shown in Table 1 and Table 2 respectively; they were spun while maintaining constant the other Dref-3 machine parameters, such as a delivery speed of 100 m/min, drum speed of 5000 rpm, and a friction ratio of 7.07.

Table 1. Details of content of 49 tex (12 Ne) core Dref yarn

No.	Yarn code	Type of core in Dref yarn with cotton sheath	Tex of core	Core/Sheath content %
1	H2	Polyester, 34 filaments, 110 tpm, Z twist	16.67	34/66
2	H3	Polyester, 34 filaments, 200 tpm, Z twist	16.67	34/66
3	H4	Polyester, 34 filaments, 350 tpm, Z twist	16.67	34/66
4	H5	Polyester, 34 filaments, false twist textured	16.67	34/66
5	H6	Polyester, 34 filaments, air textured	16.67	34/66

Table 2. Details of content of 100% cotton Dref yarn

Yarn code	Type	Tex	Core/Sheath Content %
H7	Dref yarn with core of 100% cotton yarn, 715 tpm, Z twist, and cotton sheath	49	60/40
E7	Dref-2 cotton yarn	74	-
C1	Dref-3 cotton yarn	74	50/50
D1	Dref-3 cotton yarn	49	70/30

2.1.2. Size materials

The following size materials were used;
- i) modified maize starch
- ii) commercial mutton tallow
- iii) acrylic size

2.2. Methods

2.2.1. Yarn preparation

The yarns were wound on a mini warper's beam, and were subsequently sized with 12% size solution on a laboratory sizing machine by using a single pair of squeeze rollers, as suggested by Trauter [13], at a delivery speed within the range of 5-30 m/min, a squeeze load of 90 daN on a 180 mm-wide warp sheet, a sow box temperature of 85^0C and a drying cylinder temperature of 110^0C.
For a normal size recipe, modified starch and mutton tallow were used in the ratio of 97:03. For the rich size recipe; modified starch, acrylic size and mutton tallow were used in the ratio of 60:37:03, and the machine was run at 10 m/min.

2.2.2. Determination of size add-on

Size add-on was calculated by taking the weights of the oven-dried sized and oven-dried unsized yarn samples of around 10 g, with 3 readings per sample.

2.2.3. Evaluation of weavability

The relative weaving potential of all the yarn samples was evaluated on a Reutilingen Web Tester, which enabled simulation of all weaving stresses measured on the loom.

3. Results and discussion

Determining the sizing-weaving curve has been a fundamental and most critical issue in sizing research. Optimising the size add-on for a given warp yarn helps us to establish not only the size add-on level for the best weaving performance, but also several essential factors for manufacturing fabric such as economics, ecology and identifying the potential of a size material. Therefore, it was decided in this research to investigate the sizing-weaving relationship by plotting size add-on vis-à-vis the weavability results as obtained on the web tester. It is once again worth mentioning that the size material obtained here is one of the richest size mix currently used in industrial practice for cotton yarn, keeping the cost of sizing affordable by industry.

3.1. Weavability of core spun Dref yarns

Figure 1 reveals that the weaving performance of Dref yarn with filament core shows a moderate relationship to size add-on (r=0.49 to 0.96). Weavability improves up to a certain increase in add-on, and thereafter with a further increase in add-on; the weaving performance of these yarns deteriorates. This might be ascribed to higher yarn bending rigidity and undesirable thicker coating, which causes a shedding of size material during abrasion. Considering the weaving performance at higher add-on, Dref yarns containing filaments core of higher twist perform better than those consisting of low twist filament in core. This higher performance might be due to better anchorage of the sheath with the core, as well as improvement in abrasion resistance.

It is observed that at high add-on, Dref yarns with textured filament core perform distinctly better than that of containing twisted filament in the core. This might be attributed to better cohesion as well as better penetration of size in the yarn body, which is similar to earlier observations in the case of a single level of size add-on. Nevertheless, the optimum size add-on seems to be within the range of 15-17% for Dref yarns consisting of filament yarn in the core. When we compare the weavability of Dref yarns containing different textured yarn in the core, it is observed that the Dref yarn containing an air-textured core shows higher weavability, initially up to an add-on of 15%. Beyond that, for higher add-on, the Dref yarn consisting of false twist-textured filament shows better performance than that containing air-textured filament in the core. This might be due to the greater anchorage initially provided by air-textured yarn. However, higher add-on might have resulted in making the yarn stiffer, thus causing poor performance. Thus, the optimum add-on range seems to be 16-18% for Dref yarns consisting of false twisted-textured core.

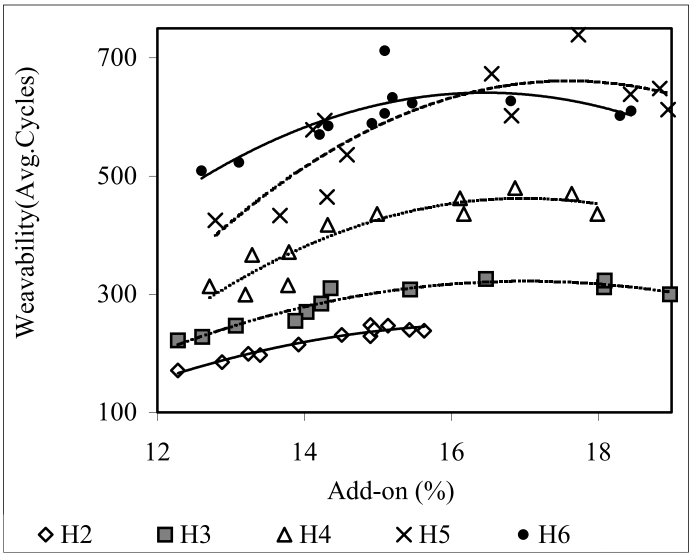

Figure 1. Effect of Add-on on Weavability of Dref yarns with Filament Core

3.2. Weavability of 100% cotton Dref yarns

It is observed from Figure 2 that the weaving performance of cotton Dref yarn shows a moderate relationship to size add-on (r=0.68 to 0.83), apart from that of Dref-2 yarns (r=0.24). The weaving performance of Dref-2 yarn at higher add-on is distinctly higher than that of Dref-3 yarn, which is similar to that observed at a single level of add-on. This might be ascribed to the lower bending rigidity of former yarns as compared to that of the latter. However, the optimum add-on in case of Dref-2 yarn seems to be around 14%, beyond which there is a drop in its performance. The initial rise in weavability with increasing add-on up to 14% might be attributed to higher coating, which in turn improves abrasion resistance.

In the case of Dref-3 yarn, the optimum add-on appears to be around 16%. Dref-3 yarn, which consists of 50% or more fibres in the core, are in an almost parallel form; they are held together by radial pressure applied by the sheath. Therefore, the longer the sheath remains intact, the better will be the survival of this yarn under weaving stresses. Higher add-on gives a better encapsulation for this yarn and thereby provides better abrasion resistance, which subsequently results in better performance at higher add-on.

At higher add-on, Dref yarn (H7) with a core of cotton ring yarn performs exceedingly well compared to the weavability of Dref-3 yarn (D1). This can be explained as follows. The bending rigidity of H7 is substantially lower than D1; H7 thus has less severe abrasion intensity compared to that involved in D1. In addition to this, in the case of H7, the stresses developed are comparatively low as compared to those developed in D1, on account of the higher extensibility of the former yarns. Moreover, in Dref yarns with cotton yarn in the core, the core remains intact to some extent, even though the sheath has been abraded and thereby a higher number of cycles is registered on the web tester. On the other hand, in the case of Dref-3 yarns, once the sheath is abraded, radial pressure on the core diminishes, resulting in an occurrence of inter-fibre slippage in the core, subsequently leading to failure of the core, and thereby that of the yarn. Further, it is observed that the optimum size add-on in both these

yarns appears to be close to 15%. The drop in weavability with further add-on can be explained as follows; as explained earlier, an increase in add-on increases the bending rigidity, which subsequently increases the severity of abrasion as the yarn becomes rigid. Since weavability has a moderately negative relationship to bending rigidity (r=-0.50 to -0.80), the yarn thus fails early.
However, it can be seen from Figure 3 that the weavability of the best ring and rotor yarns sized at single add-on of around 6-7% is much greater compared to that of friction yarns sized with high add-on by the normal recipe. However, it is important that at high add-on, friction yarns sustain a pre-tension of at least 2.5 cN/tex/thread to some extent, unlike the behaviour shown by unsized and sized yarn with a single add-on level (6%-7%), as earlier observed by Joshi [15].

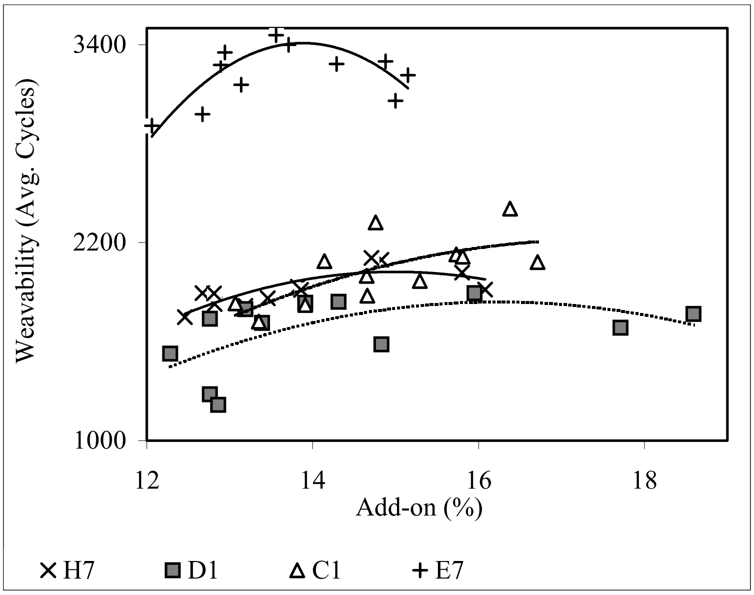

Figure 2. Effect of Add-on on Weavability of 100% Cotton Dref yarns

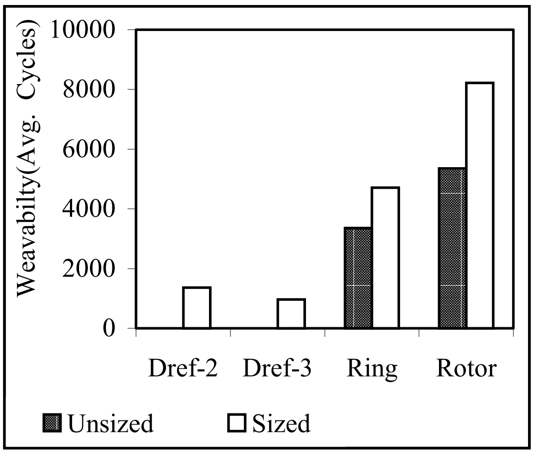

Figure 3. Effect of normal Starch Size on weavability of Dref-2 and Dref-3 yarns at High Add-on

This is obviously due to better encapsulation and anchorage of size to the yarn at higher add-on. As abrasion predominates over fatigue action during stresses on the loom, better encapsulation will result in more time taken to abrade the yarn surface, registering a higher number of failure cycles, and obviously a longer lifespan of the yarn under weaving stresses.

3.3. Effect of starch/acrylic size recipe on weavability

In order to observe the impact of the well-known rich size recipe, the friction yarns were sized at high add-on of 15% with 60:37:3 proportions of the modified starch, acrylic and mutton tallow size mix. It is observed that there is no significant change in the tensile properties of friction yarns, compared to that observed with the high add-on of the normal recipe containing modified starch.

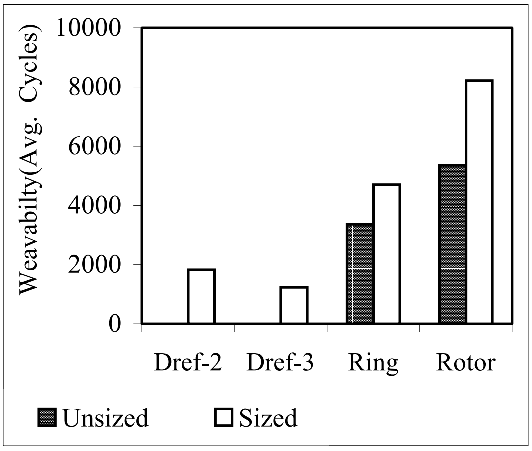

Figure 4. Effect of Starch/Acrylic Size on weavability of Dref-2 and Dref-3 yarns at High Add-on

The weavability results are shown in Figure 4. When the rich size recipe consisting acrylic is used, there are gains of 34% and 28% respectively in the weavability of 74 Tex Dref-2 and Dref-3 yarns as compared to the corresponding weavability of these yarns with the normal modified starch recipe. Nevertheless, their performance is lower than that of ring and rotor yarns sized with normal modified starch recipe at single add-on (6%-7%). Thus, we can observe that even a rich size recipe at high add-on cannot bring the weaving performance of friction yarns to a par with that of conventional yarns, although friction yarn can sustain a pre-tension of 2.5 cN/tex per thread. This exercise clearly suggests that Dref yarn behaves exactly the same as the ring and rotor yarns do as regard to the change in add-on level and the application of high-quality size mix. However, because of the inherent limitations of yarn structure, it does not reach exactly the same level of performance as conventional ring and rotor yarns offer. Therefore, another trial was undertaken to see whether plying yields any improvement in the weaving performance of Dref yarns.

4. Conclusions

Increasing size add-on increases the weaving performance of Dref yarns, and the optimum size add-on is found to be approximately 15%. The rich size recipe consisting acrylic at high add-on further improves the weavability, although it fails to bring the weaving potential up to a par with that of ring and rotor yarns sized with normal modified starch at low add-on.

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