

Comparative Study of Modified Starch (Esterified) and Conventional Starch (Thin-Boiling) for their Weaving Potential

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ABSTRACT: The process of sizing imparts the strength and increases the abrasion resistance of warp yarn in a weaving. Various methods were established for measuring size films and sized yarns to establish relationships that might be useful in forecasting weaving performance. Different types of natural and synthetic materials were applied to cotton yarn in a laboratory sizing apparatus, equipments and other available sources. Two critical factors to evaluate size material performance are: Size must form a tough but flexible film to protect the yarn from stress, strain and rubbing actions, and there must be good adhesion between size and yarn. Extensibility is correlated with tensile properties of films. The study was carried out on coarser and finer counts. Yarns sized with Modified starch (Esterified) gives better weaving performance being measured on MAG-SITRA Abra Tester.

KEYWORDS: Modified starch (Esterified), Conventional starch (Thin Boiling), Sized and Unsized yarn, Desizing, Size film, Abrasion resistance

I. INTRODUCTION

The sizing is a process affecting productivity of weave room. It imparts strength and improves abrasion resistance of warp yarn by coating a thin film of size ingredients so that it can withstand against several actions it is subjected to during weaving process i.e. cyclic strain, flexing abrasion at various loom parts and inter yarn friction. Selection of sizing chemicals (agent) is important because chemistry of sizing material with yarn decides in the degree of improvement in yarn strength. In modern times, weaving process has become highly sophisticated with loom speeds have increased ten-folds. The effectiveness of sizing depends not only on the adhesion between size and yarn but also on the film-forming properties of the size material, the properties of yarn themselves and machine variables. Even after sizing, size must be removed easily from the fabric after weaving without environmental and ecological damage. The selection of sizing ingredients is very critical and complex because the options available is in wide range [1,2,8].

The natural starch and its derivatives constitute almost share of 75% of sizing agents used. Many attempts have been made to evaluate the variables that affect size performance without expensive full-scale sizing and weaving trials [1]. The purpose of this study is to explore the suitability of different experimental approach at R & D Laboratory level (Anil Ltd., Ahmedabad) for evaluating sizes and sized yarn properties. In context of this we have compared two chemically modified starches i.e. Esterified starch and Thin-Boiling starch, for their various properties.

EXPERIMENTAL DETAILS

II. MATERIALS AND METHODS

A Sizing of yarn samples .

The baby cones of 9^s and 50^s unsized cotton yarns were obtained from Ashima limited for this study. The 12% w/w size solution used for sizing of yarn on padding mangle. The delivery speed was kept 13 m/min. with a top roller pressure of 1 kg./cm² for 9^s and 800 g/cm² for 50^s yarns with size box temp. 85°C±2°C.

The cotton yarn from baby cone impregnated in the size box, passing through the nip of padding mangle and sized yarn wound on wrap-reel at the back of the machine. The Thin boiling starch solution sized yarns of 9^s and 50^s were prepared one by one. of Thin Boiling starch was cooked in hot water bath at 100°C ± 2°C for 30 min. Agitator was used for proper mixing. The sizing was carried out on a laboratory single end sizing machine by They were conditioned in stability chamber for 24 hrs. at 20°C±2°C and 65% R.H. The same way cotton size yarns of 9^s and 50^s were prepared with 12% w/w Esterified starch solution.

B Tensile Properties of Yarns

The conditioned sized yarn samples tested on Instron tester for their tensile properties using the ASTM D-2256 standard test method with 250 mm gauge length and 300 mm/min. strain rate. 20 specimens of unsized and sized yarns

were tested.[1] [8]

C Hairiness of yarns

The hairiness of unsized sized yarns was tested on Uster Zweigle Hairiness Tester 5 following International standard test method.

Technical specifications

- Measuring principle:
Counting the number of projecting fibres at nine intervals (length zones)
1,2,3,4,6,8,10,12,15 mm

- Fibre length measuring range
1-15 mm

- Yarn testing speed
Standard 50m/min. fix.

- Yarn tension device
0-10 cN (standard test tension 5 cN) adjustable by yarn tension device.
For all the yarn tests, 5cN tension was kept.

During the test the number of fibres recorded in the different length zones are continuously totaled and displayed in numerical and diagram form on the monitor.[7]

D Determining Size Add-on(%) of Sized yarn samples

The amount of size that is added to a yarn affects its weaving performance, it is important to determine this quantity accurately.

The dried sized yarn was weighed on analytical balance, and then it was desized by enzymatic treatment. α -Amylase enzyme was used in proportion of 0.5ml/liter (distilled water) for desizing propose. The sized yarn sample was given enzymatic wash for 10 min. and two plain water washes of each 5 min. in hot water bath at $95^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

After desizing, yarn sample was dried and weighed on analytical balance having accuracy up to 0.01 mg. The amount of size on the entire four yarn sample was measured by the difference in dry weight before and after desizing.

E Yarn Abrasion Resistance Test on MAG-SITRA Abra Tester by RRI Index Test method

In tester, a cylinder oscillating in a straight line is covered with standard emery paper. The 20 yarn specimens held under constant tensile by weights are pressed against the cylinder under constant pressure and are abraded by the cylinder oscillating at constant speed until they break. At the end of every abrading cycle, the cylinder turns slightly so as to present a cleaned averaging surface. The average number of strokes at rupture is converted into Relative Resistance Index (RRI) by including the pretension applied at linear density of the yarn samples. With the help of this tester, it is possible to get the abrasion resistance of a yarn sample in terms of numbers of abrasion strokes to rupture the yarn. When comparing yarns of different linear densities, the interpretation of abrasion data becomes a little difficult as the number of strokes required to rupture certain yarns are small whereas others withstand a higher number of strokes. So, the accuracy of the results tends to be poor, if the mean value of the number of the strokes alone is taken as a criterion for the abrasion resistance of the yarns. In order to make the comparison more meaningful, the average number of strokes is converted in an index known as Relative Resistance Index by including the linear density of the yarn and the pretension applied to the sample. So this method proves that yarns of different linear densities can be best compared with the help of RRI rather than using the average number of strokes. The formula suggested for RRI is as follows:

$$\text{RRI} = \{ \text{Average number of Strokes} \times \text{Pretension (g.)} \} / \sqrt{\text{Linear Density (count)}}$$



Photograph : MAG-SITRA Abra Tester

The pretension was kept 20g. per thread for all the yarn samples. The 20 samples were tested of unsized and sized yarns of both the counts one after another on tester. The software package has a utility to calculate the minimum value, maximum value, average value, standard deviation, CV% and RRI from acquired results. [7] [8]

Technical Specifications during the test:

Number of Strokes/min. = 20
Pretension / thread = 20g.
Stroke length = 20cm. (200mm.)
Yarn Abrading length = 7cm (70mm.)
Emery paper = Water emery 320

F Presence of Starch Percentage in Desized Fabric by TEGEWA Scales

Tegewa Reagent was prepared by a standard method using Potassium Iodide (KI), Distilled water, Iodine and Ethanol. Desized fabric sample of Esterified starch at room temperature was first dipped in Tegewa Reagent for 30 sec and then in plain water for 1min. The change in colour of fabric sample matched on Tegewa scales which determines the presence of starch percentage. In the same way Thin-Boiling starch desized fabric was analysed on Tegewa Scales.

III. RESULTS AND DISCUSSION

A Sized and Unsized Yarn Testing

Results of Yarns: Tensile Properties

Tensile properties of unsized and sized yarns were tested on Instron tensile tester 3345 by following ASTM D-2256 standard method. The results are shown as under in the Table 1 and the graphs plotted from the results are shown in fig.1 and fig.2 of Tensile strength and Elongation respectively.

Table 1: Tensile strength and elongation of sized and unsized yarns

Yarn Detail	Load at Break (gf)	Tenacity (cN/tex)	Elongation, Tensile Strain (%)
9 ^s Unsized	943.1	23.11	16.19
SD	111.62	2.73	2.06
CV%	11.84	11.83	12.77
50 ^s Unsized	248.63	6.08	12.91
SD	16.36	0.40	0.81
CV%	6.58	6.6	6.27
9 ^s Sized Thin boiling	1178.01	28.87	15.66
SD	70.98	1.73	1.02
CV%	6.02	5.99	6.51
50 ^s Sized Thin boiling	313.87	7.68	10.00
SD	27.42	0.67	2.20
CV%	8.73	8.74	22.01
9 ^s Sized Esterified	991.09	24.26	14.75
SD	173.71	4.25	1.99

CV%	17.52	17.53	13.52
50 ^s Sized Esterified	258.90	6.34	11.70
SD	21.97	0.59	1.27
CV%	8.49	9.37	10.87

It is observed that strength of Thin boiling sized yarn is increased by 20% of both the counts 9s coarser and 50s finer counts, while 4-5% increased with yarn sized with Esterified starch. Elongation was decreased around 4-8% in 9s count sized with both the starches and 10-20% reduction in case of 50s count for the same.

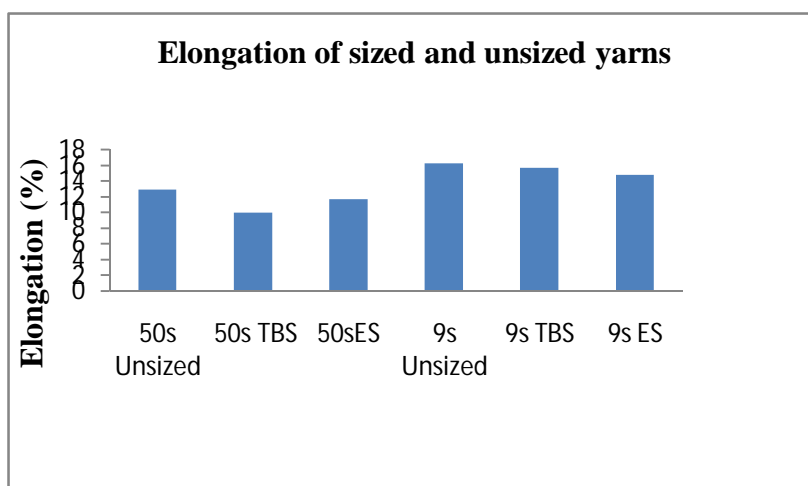


Fig 1:Elongation of sized and unsized yarn

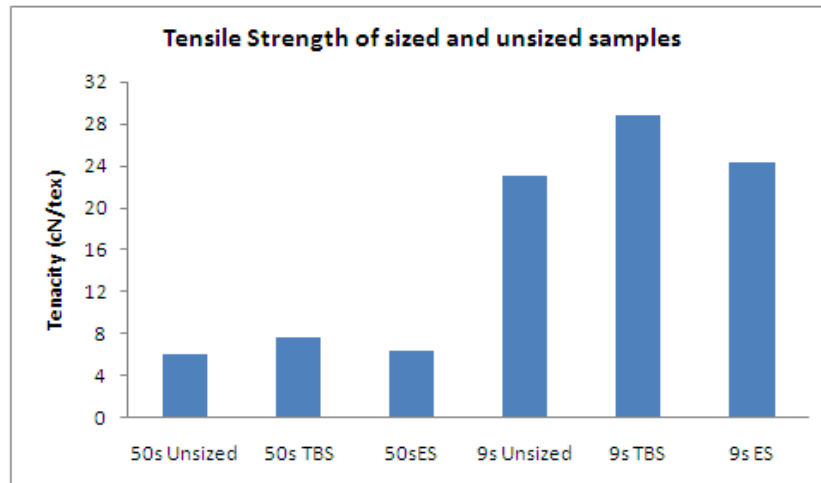


Fig 2:Elongation of sized and unsized yarn

Elongation is decreasing with increase in tensile strength of yarn, due to penetration of size material into yarn body and makes them stiff. Adhesivity of size material with fiber improves yarn strength, makes it compact and reduces the elongation.

B Results of Hairiness of Sized and Unsized Yarns

The hairiness value **S3** (protruding fibers in the range of 3 to 15mm.) tested on **USTER ZWEIGLE HAIRINESS TESTER 5** by standard test method. **S3** value gives the number of protruding fibers in range of **3 to 15mm.** length in **100 meter length** of yarn. The results are given in the table 2 as under.

Table 2: Uster Zweigle Hairiness Test Results

Fibre length (mm)	9s Unsized	50s Unsized	9s sized Thin boiling	50s sized Thin boiling	9s sized Esterified	50s sized Esterified
1mm	40479	10652	4400	2380	1559	2183
2mm	9095	1477	552	216	166	218
3mm	3270	385	144	80	112	96
4mm	1317	134	32	18	48	9
6mm	181	16	4	4	34	0
8mm	57	1	8	0	21	0
10mm	14	0	4	0	3	0
12mm	2	0	0	0	0	0
15mm	1	0	0	0	0	0
S1+2	49574	12129	4952	2596	1724	2401
S3	4852	536	192	102	218	105

The hairiness found substantially reduced by 80-90% in all sized yarn than unsized yarn.

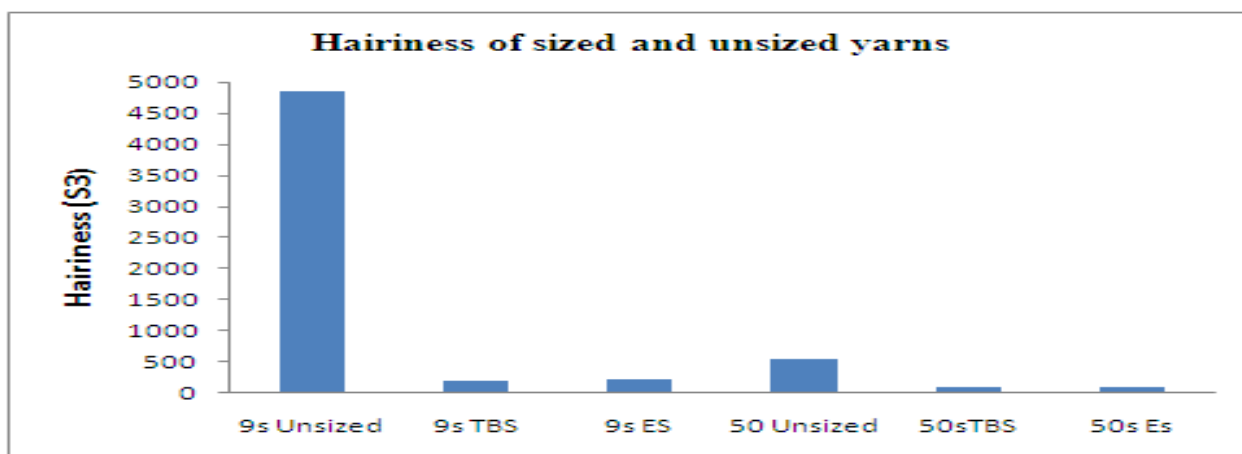


Fig 3: Hairiness of sized and Unsized yarn

The hairiness of yarn reduces by sizing because the projecting fibers are laid down on the surface of yarn and bound to the yarn body and covered with a thin size film.

C Results of Size Add-on (%) for sized yarn

The size add-on test results of both the cotton counts sized with TBS and ES are shown in table 3 as under.

Table 3 : Size Add-on (%) for sized yarn

Yarn Detail	Sized sample weight in (g)	Desized sample weight in (g)	Size Add-on (%)
9 ^s sized TBS	0.828	0.749	9.54
50 ^s sized TBS	0.154	0.140	9.09
9 ^s sized ES	0.690	0.640	7.25
50 ^s sized ES	0.174	0.162	6.91

The size add-on was found around 22% lower in the yarns sized with Esterified starch as compared to Thin-boiling starch. The add-on is at squeeze pressure of 1kg./cm² for 9s and 800g. for 50s cotton counts.

D Results of Yarn Abrasion Resistance Test on MAG-SITRA Abra Tester by RRI Value:

Table 4: Yarn Abrasion Resistance Test Results

Yarn Detail	Abrasion Resistance Value			SD	CV %	*RRI
	Min .	Max .	Mean Avg.			
9 ^s Unsize d	192	331	239.45	37.25	15.56	1596
9 ^s sized TBS	226	431	328.45	50.46	15.36	2190
9 ^s sized ES	230	456	356.40	69.02	19.37	2376
50 ^s Unsize d	35	62	47.85	6.86	14.34	135
50 ^s sized TBS	54	74	61.75	4.77	7.72	175
50 ^s sized ES	58	73	67.4	4.71	6.99	191

*RRI – Relative Resistance Index

The yarn abrasion Relative Resistance Value (RRI) is shown in the above table 4 and the graph prepared for the same is shown in fig.4 as under.

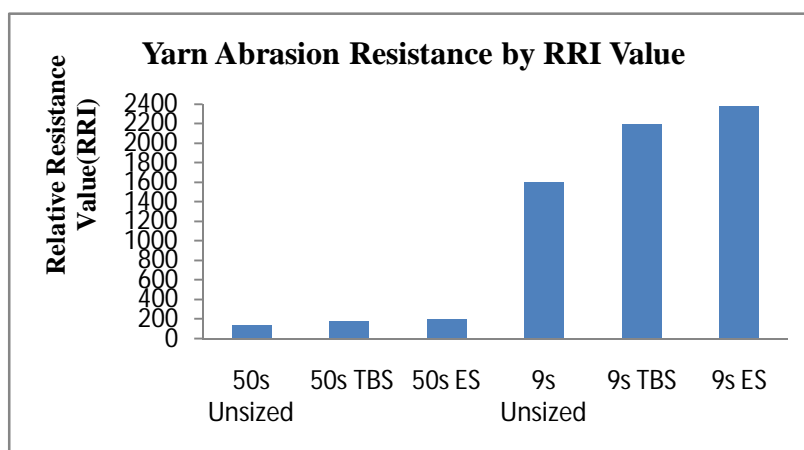


Fig 4: Yarn Abrasion Resistance by RRI value

The RRI value for abrasion resistance of yarn to break is increases after sizing with the application of size material, the sized yarn RRI is seemed higher than unsized yarn for both the counts as per the test results. Abrasion resistance increases after sizing gives better weavability. The abrasion resistance by RRI value found 8% better with the samples sized with Esterified starch than the Thin boiling starch sized samples. The Esterified sized samples gives better weaving potential than thin boiling sized samples even at 22% lower size add-on as discussed in the test 4.2.3 (Size add-on % results). Most of the times yarn breaks after removal of fiber from yarn body due to abrasion. Size coating helps to improve the abrasion resistance of yarn to withstand against the various abrasive stresses, which was better in case of Esterified starch size material than Thin boiling starch size material for both cotton counts 9^s and 50^s.

E Results for Presence of Starch Percentage in Desized Fabric by TEGEWA Scales

After desizing fabric samples one with Esterified and other with Thin boiling starch were compared by Tegewa scale method

Table 5: Results of Desized on Tegewa Scales fabric samples

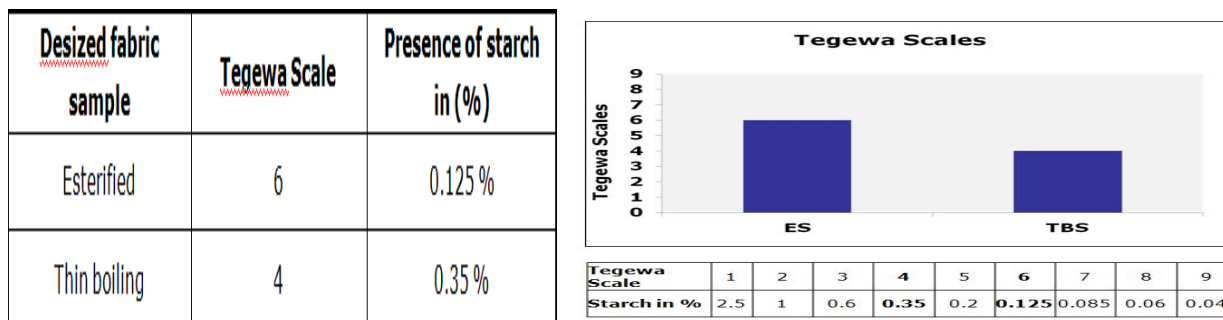


Fig 5. TegewaScaleResults-modified and conventional samples

We assessed that the change of colour of both starch desized samples and matched them on Tegewa scale as shown in the above figure5. The presence of starch in Esterified desized fabric sample was found 0.125% (Tegewa scale -6) while in Thin boiling desized fabric sample , it was 0.35% (Tegewa scale-4)

IV. CONCLUSIONS

In the weaving of coarser and finer count, both starches have shown good tensile strength. Abrasion resistance is reduced because of smoother film and increased flexibility in case of modified starch. Yarn abrasion resistance found 24% better of modified starch supported by RRI values of Abra test and that is with almost 8% less size add-on. This may leads towards cost-effective sizing process, better weaving potential of weave room. Comparative presence of starch percentage after desizing was lower in Esterified starch sample than Thin boiling starch sample on Tegewa scale . Thus it indicates that the amount of effluents coming out from Esterified starch desized fabric is less as compared to Thin boiling starch desized fabric, a more eco-friendly sample . Due to less presence of starch in desized fabric using modified starch, more Dyeing uniformity can be achieved. All this indicators suggest that modified starch (esterified) as a size ingredient may leads effectively to improve weaving potential of a weave room.

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