

DEVELOPMENT OF WATER AND STAIN-REPELLENT FINISHED HANDLOOM SAREES USING ON-LOOM INTEGRATED FINISHING DEVICE

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Abstract: Generally, powerloom fabrics are imparted with special finishes such as Water and Stain Repellency, Flame Retardancy and UV Protection Finish. At present special finishes are not imparted to the handloom sarees. An attempt has been made to impart Water and Stain repellent finish to the handloom sarees using 'On-loom integrated finishing device'.

'On-loom integrated finishing device' is a novel technique to impart the required finishes to the handloom fabric during weaving itself i. e., the finish process is integrated with the weaving process. 'Water-and-Stain-repellent finish' is essential not only to develop new products in handloom sarees but also to have value added products.

Through this work three different types of fabrics, namely 100% silk, silk-cotton and 100% cotton have been considered. The process parameter variables are three different concentrations of finish liquor such as 40 g/l, 50 g/l and 60 g/l and three different curing temperatures of 140°C, 150°C and 160°C. In total, among 27 samples three best samples of Water-repellent-finished handloom sarees have been selected and compared with Powerloom fabrics of similar finish and construction.

Keywords: Powerlooms, handloom, special finishes, value addition, On-loom integrated finishing device, novel technique, integrated with weaving process

1. Introduction

Generally special finishes such as 'Water-and-Stain-repellent Finish', 'Flame-retardant Finish', 'UV Protection Finish' etc. are imparted only to the powerloom fabrics in a processing unit. In the present system, the processing unit requires a minimum length 500 meters of the fabric to impart such finishes. But, handloom saree fabrics are made only to a maximum length of 80 meters. So, temporary stitching of handloom fabrics to the required length and making the stitch withstand the stretch imparted during the process are practical difficulties that must be tackled, while processing the handloom sarees in Processing Mills.

An attempt has been made to attach a device in the existing handloom through which finish can be imparted to the fabric during the weaving process itself. Three different fabric samples such as 100% Silk, 50:50 Silk-Cotton and 100% Cotton handloom sarees have been considered to impart 'Water and Stain repellent' finish by varying finish parameters of concentration of finish liquor and curing temperature to find out the optimum condition to give best finish efficiency. The best samples from each fabric have been selected. The developed handloom-finished fabric is compared with powerloom-finished fabric of similar specifications commercially available.

2. Materials and Methods

i) On-loom integrated Finishing Device

A novel device has been designed and fabricated and named as 'On-loom integrated finishing device', which consists of a Finish Applicator and Curing Chamber. The finish applicator applies the water-and-stain-repellent finish liquor to the woven fabric while it passes through the specially designed flat surfaced Front Rest. The wet pickup can be adjusted through the number of strokes of applicator. The number of strokes determines the wet pick-up percentage. Through trial and error method, the 70% wet pick up of 'water-and-stain-repellent' finish is obtained with just two strokes.

The curing chamber, which is between applicator and the cloth roll, cures the finish-liquor-applied fabric. The curing chamber is attached with digital controller which is used to control the temperature of the curing chamber ranging from 100°C to 250°C and the curing time can also be controlled from 1 to 10 minutes.

For this study the time duration of 2 minutes has been considered as standard by synchronising the time taken for weaving, finishing and drying, before the fabric goes for curing. Based on the literature review in this work three different concentrations of finishing liquor such as 40 g/l, 50 g/l and 60 g/l have been taken, and three different curing temperatures such as 140°C, 150°C and 160°C have been considered, to impart 'Water-and-Stain-repellent Finish'.

ii) Preparation of Water-and-Stain-repellent Liquor

Water and Stain Repellent Liquor consists of fluorocarbon chemical to impart finish and acetic acid to adjust to the pH value of 5. For example, to prepare 40 g/l concentrated 'Water-and-Stain-repellent' Liquor, 40 grams of fluorocarbon chemical is dissolved in water to make it into solution of 1 litre. The acetic acid has been added to adjust the pH of the liquor to the value of 5.

iii) Selection of Fabric Samples

Three different sets of handloom saree fabrics have been considered to impart 'Water-and-Stain-repellent' Finish. The selection of these handloom sarees is done based upon a survey, assessing a high consumption of sarees in the market. The specifications of the selected handloom samples have been tabulated in the Table 1.

Table1 Specifications of the samples chosen for the study

S.No	Fabric Details	Specifications			
		Warp Count	Weft Count	EPI	PPI
1.	100% Silk	20/22D (3ply) Silk	20/22D (3ply) Silk	100	80
2	50-50 Silk-Cotton	20/22D (2ply) Kora Silk	2/100 ^s CGM Cotton	96	64
3	100% Cotton	2/100 ^s CGM Cotton	2/100 ^s CGM Cotton	80	72

The above specified handloom sarees were woven using the handloom attached with 'On-loom integrated finishing device'. The fabric was treated with 'Water-and-Stain-repellent finish' of three different concentrations and cured at three different temperatures. The efficiency of the finish has been studied through Water-repellent Test (Spray Test AATCC – 22). The optimum condition to achieve maximum efficiency has been studied for all the three fabrics.

3. Results and Discussions

Three different sets of process parameters have been considered as shown in Table 2. In total 27 samples using 3 different fabrics having 9 different finished samples have been developed. The finished samples have been evaluated for Water Repellent efficiency.

Table 2. Water Repellent Efficiency- Spray Test Results for 9 different sets of process parameters

S.No	Fabric Details	WR Efficiency 40g/l and 2 min			WR Efficiency 50g/l and 2min			WR Efficiency 60 g/l and 2 min		
		140° C	150° C	160° C	140° C	150° C	160° C	140° C	150° C	160° C
1	100% Silk	80	85	90	85	90	95	100	100	100
2	Silk : Cotton	85	90	90	90	95	95	95	100	100
3	100% Cotton	85	90	90	90	95	95	95	95	100

Among three different concentrations, 60 g/l shows higher efficiency percentage (upto 100%) when compared to other two concentrations of 40 g/l and 50 g/l.

The 100% silk gives 100% Water Repellent Efficiency at 140°C itself, whereas silk-cotton gives at 150°C and 100% cotton gives at 160°C. Based on the above test results the optimum process parameters to achieve 100% Water Repellent Efficiency for 3 different materials are tabulated in Table 3.

Table 3 Optimum Process Parameters to achieve 100% Water Repellent Efficiency

S.No	Fabric Details	Process Parameters		
		Concentration	Temperature	Time
1.	100% Silk	60 g/l	140°C	2 Minutes
2	50-50 Silk-Cotton	60 g/l	150°C	2 Minutes
3	100% Cotton	60 g/l	160°C	2 Minutes

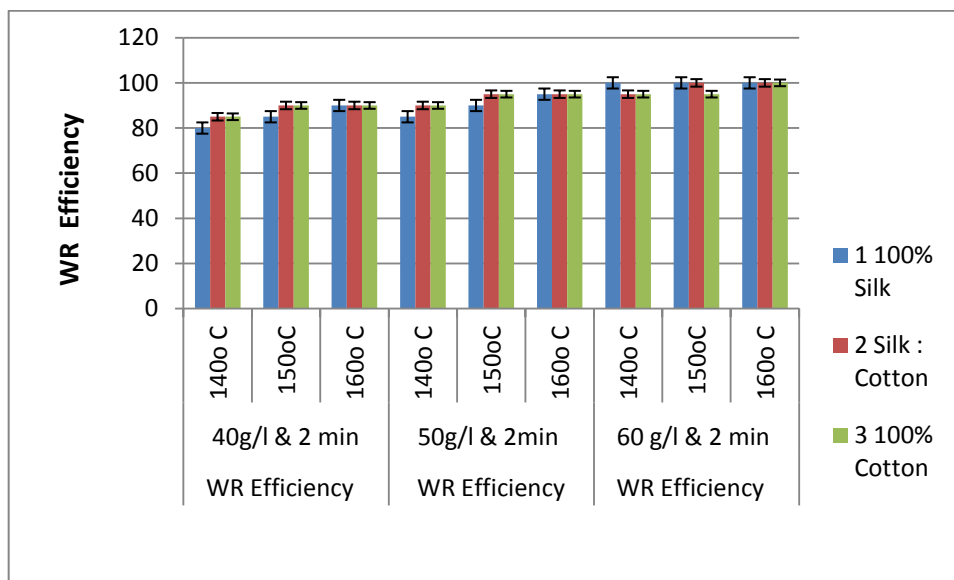


Fig 1 Water Repellent Efficiency- Spray Test Results (AATCC – 22)

From Figure 1 it is observed that at all the three curing temperatures with 40 g/l all the 3 fabric samples show Water Repellent Efficiency between 80 to 90%. This is due to insufficient polymerisation which causes lower WR Efficiency. The same trend is observed in 50 g/l concentration with a slight improvement of WR Efficiency in the range of 85 to 95%, whereas at 60 g/l it gives 100% WR Efficiency for all the three materials.

As far as 100% silk is concerned a complete polymerisation of finish occurs at 140°C itself. As far as silk- cotton is concerned full polymerisation occurs at 150°C and for 100% Cotton it occurs at 160°C.

The study is made to find out the effectiveness of the finish in the On-loom integrated finishing device under different parameters, to find the optimum process parameters for better efficiency.

3.1 SEM & FTIR Analysis for 100% Cotton WR finished samples

SEM Analysis helps to confirm the presence of WR finish on the samples. WR finish has been imparted to all the 27 samples with 3 different processing temperature and 3 different concentration. The optimised process parameters for 3 different varieties of samples has been finalised. Among 3 different materials samples such as 100% Silk, 50-50 Silk-Cotton, 100% Cotton WR finished samples, 100% cotton sample has been analysed for the SEM & FTIR. Similar trend has been observed for the remaining 2 samples such as 100% silk and 50- 50 silk-Cotton.

3.1.1 SEM Analysis

SEM images for 100% cotton, samples of unfinished fabrics and WR finished samples are shown in figures 2 (a) & 2 (b) and 3 (a) & 3 (b), with 1000 X & 2000 X magnification respectively.

Figure 2 - SEM images of unfinished sample

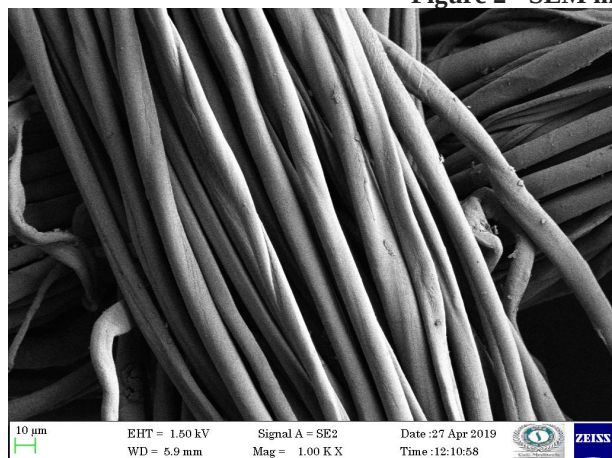


Fig. 2(a)

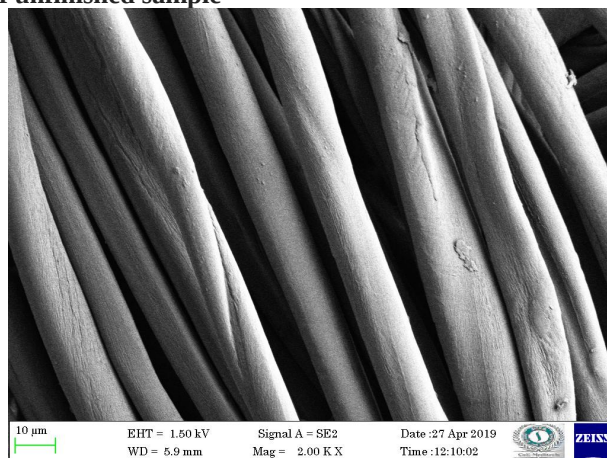


Fig. 2(b)

Figure 2 (a,b) shows untreated cotton samples in which it clearly shows a smooth round shaped mercerised cotton fibre only and it confirms there were no polymer aggregates or any other agglomerations over the surface of the cotton fibre.



Fig. 3(a)

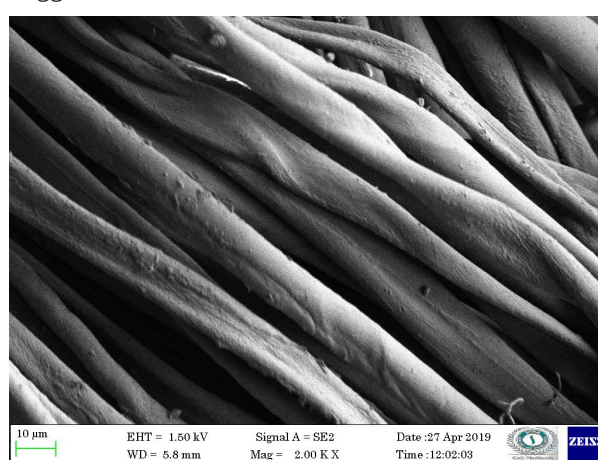


Fig. 3(b)

Figure 3 - SEM images of Water Repellant finished sample

Figure 3 (a) & (b) shows SEM images of WR finished 100% cotton sample in which 'WR finish coating' can be seen on the surface of the fibres. It is also observed that 'WR finish coating' appears evenly spread on the fibre surface as a thin layer. Similar trend has been observed for the remaining two samples of 100% silk and 50-50 Silk- Cotton.

3.1.2 FTIR Analysis

FT-IR(Fourier transform - infrared) spectroscopy is useful to identify different functional groups in the IR spectrum. IR spectroscopy gives the functional groups involved in the fabric samples and also shows the interaction with the fibre molecule in the form of intensity such as Weak, Medium and Strong etc. To generate the IR spectrum, different frequencies of infrared light are passed through a sample, and the transmittance of light at each frequency is measured. The transmittance (%) is then plotted versus the frequency of the light (Wavenumbers in the units of cm^{-1}).

Different intensities and functional groups produce band absorptions at different locations of the sample which shows in the IR spectrum. Recognizing where the absorptions generated by the common functional groups occur will help to interpret IR spectra. FTIR Analysis for 100% cotton has been shown in this paper in which Fig 4 (a) shows spectrum of untreated sample, Fig 4(b) shows spectrum of WR finished sample and Fig 4 (c) shows spectrum of superimposing of both samples.

The cotton fabric samples developed were given water repellent finishes and evaluated for its absorption in the FT-IR instrument. The graphical test report of the untreated and water repellent treated fabric samples superimposed one over the other is shown in Figure 4 (a,b,c).

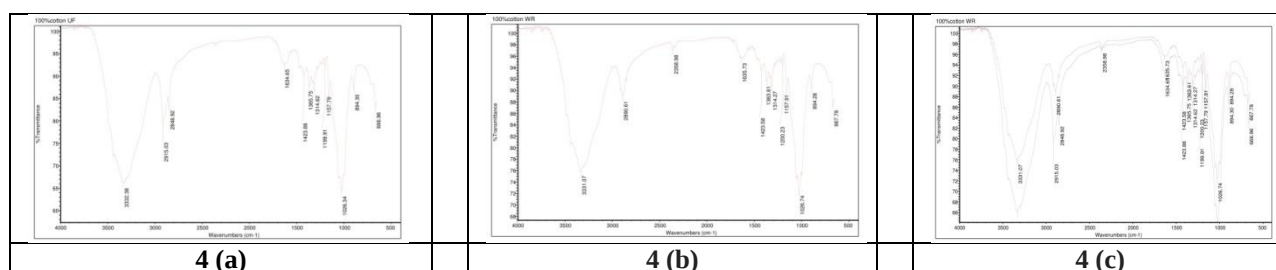


Figure 4(a,b&c) FTIR Spectrum of Untreated, WR Finished samples and Super imposing of both samples

It is observed from the Figure 4 (a, b & c) that the absorption band spectra (3200cm^{-1} to 3600cm^{-1}) of water repellent finish treated fabric sample has the maximum depth of % transmission of 76 % as compared to the untreated sample of 66%. This can also be observed in the band spectra of 2915cm^{-1} where the transmission % intensity is 88% as against 79% in untreated sample. In both the fabric samples, the bands at 800cm^{-1} , 1200cm^{-1} , 950cm^{-1} , 980cm^{-1} and 1100cm^{-1} may be assigned to the vibration of Si_6O_{18} , Si_2O_6 and SiO_2 bands for both the fabric samples. From the report, it is evident that there is effective penetration of water repellent finish applied on the fabrics.

4. Comparative Study

Water-and-stain-repellent-Finished Fabrics, produced on Powerlooms and acquired from the market, with construction for 100% silk, silk-cotton and 100% cotton, have been considered for the comparative study.

Fig 5 Comparative study of best handloom samples treated with Water-repellent Spray Test with commercially available Powerloom fabrics

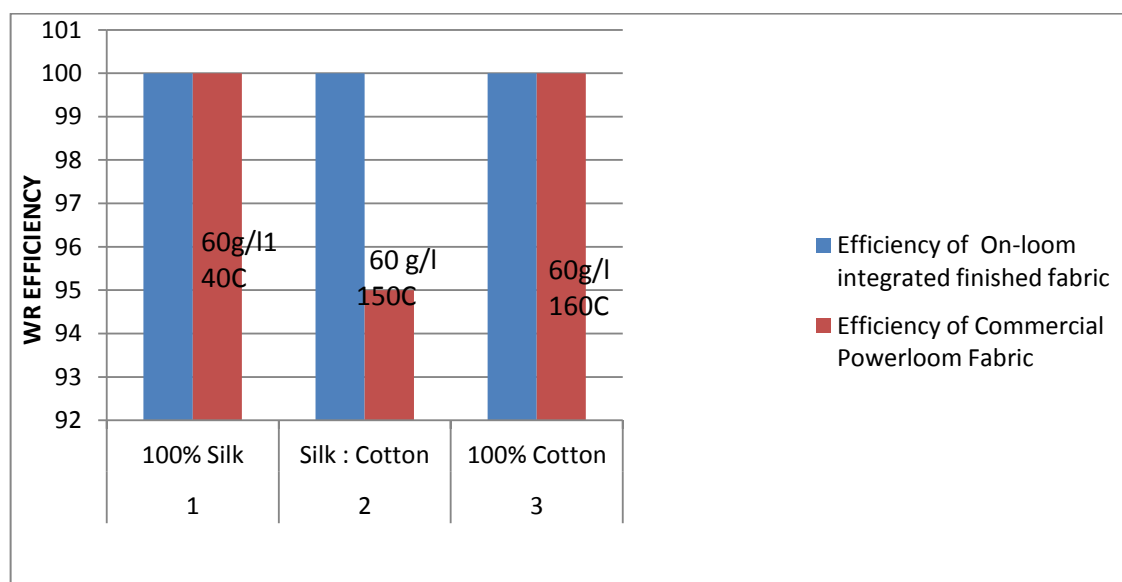


Fig 5 Comparative study of best handloom samples treated with Water-repellent Spray Test with commercially available Powerloom fabrics

Figure 5 shows WR Efficiency of best three selected Water-and-Stain-repellent-finished handloom sarees and Powerloom fabric of similar construction. The results show that the handloom finished fabric using 'On-loom integrated finishing device' gives the same result as Powerloom finished fabric, except silk-cotton of Powerloom finished fabric that shows a slightly lower WR Efficiency of 95%.

5. Conclusion

Design development of 'On-loom integrated finishing device' attached to a handloom is a novel finishing technique. It is used to develop value added handloom products with a special finish.

Optimum Process parameters for three different fabrics of 100% silk, silk-cotton and 100% cotton fabrics are adopted for 'Water/Stain Repellent' finish. Fabric samples produced with Water-repellent Efficiency have been compared with

commercially available Powerloom fabrics of similar construction. It is concluded that the developed handloom 'Water-and-Stain-repellent-finished' fabrics show 100% WR Efficiency as much as commercially available Powerloom finished fabrics do.

6. References

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