Effect of carbonisation treatments on the low stress mechanical properties of polyester cotton fabrics

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Abstract— **The effect of carbonisation of polyester cotton blended fabric following treatment with sulphuric acid on its low stress mechanical properties is reported. Kawabata evaluation system was used for testing the untreated and treated samples. It has been found that bending, shear, friction properties have increased in carbonised sample. The geometrical properties, namely, areal density and thickness show an increase in comparison with untreated samples. Specific handle force and air permeability show a decrease.**

INTRODUCTION

In the carbonisation process the cellulosic component of the polyester cellulosic blend is dissolved by treating the fabric with 70% sulphuric acid with the result that one gets, 100% polyester fabric. Carbonisation is also carried out for wool in order to remove vegetable matter from it.

Carbonisation of wastes containing polyester and cotton has been reported to get carbon for burning purposes.

Recently, carbonisation of polyester/cotton blend fabrics using dilute Phosphoric acid to prepare polyester/Carbon (PET/CAR) blend fabrics is reported by Shengnan Li etal.(2019). The authors have characterised the treated samples by FTIR, XRD, SEM and thermo gravimetric analysis

FTIR – Fourier Transform Infra red spectroscopy

XRD – X – ray diffraction

SEM – Scanning electron microscopy

Besides these, the untreated and treated samples were studied for UPF (Ultra violet protection factor. Inductive Static voltage crease recovery angle, light passing through the polyester cotton and polyester carbon fabrics and tensile strength. PET/ carbon blend fabrics exhibited superior antistatic properties, good UV and crease recovery and reasonable tensile strength.

Deo and Roshan Paul (2000) have reported on the enzymatic treatment as an alternative to carbonisation of disperse/reactive dyed polyester-cotton blends. A series of polyester cotton blend differing in blend composition was produced and dyed with disperse reactive combination of dyes and then treated with cellulose enzyme as an alternative to carbonisation. This led to the removal of reactive dyed portion of the blends, thereby altering the Lambda max (ƛmax) towards disperse dye. This trend was found to be similar for all the blends and was found to be independent of cotton. In the case of cotton rich blends, the traces of cotton were found after the normal enzyme treatment. This was revealed on comparing the results with those of carbonised samples. . The fabrics were therefore given more severe treatment with the enzymes to remove the traces of cellulose. In view of this, it has been found that severe enzymatic treatment can provide an alternative to carbonisation.

Carbonisation of polyester/Cotton blend was done to produce gas with hydrogen content. Dudnyk etal. (2013) have reported on production of coal with calorific value of 30.2 MJ/nm³and gas with heating value of more than 7 MJ/nm³ suitable for further conversion to a liquid fuel.

From the literature review, it is evident that only few workers have dealt with the carbonisation of polyester cotton blended fabrics. Characterisation of carbonised polyester fabric has been done but the mechanical and handle properties have not been reported.

This present report is concerned with the carbonisation of polyester/cotton blended fabrics. Fabrics properties have been measured using Kawabata Evaluation system and the results are reported. Air permeability, handle force and drape also were determined.

EXPERIMENTAL

Details of polyester cotton blended fabric are given in Table 1 .Properties of carbonised samples are also given.

Table -1 Geometrical properties of fabrics.

Weave	Fabric	Ends/cm	Picks/cm	GSM	Thickness(mm)	Warp count (Tex)	Weft count (Tex)
Plain	Uncarbonised	36	31	40	0.27	9.5	5.5
Plain	Carbonised	36	31	44	0.3	9.5	5.5

Preparation of polyester/cotton fabric for carbonisation

Polyester cotton fabrics were immersed in 70% sulphuric acid. They were then washed thoroughly.

Testing

Both uncarbonised and carbonised fabrics were tested for mechanical properties using Kawabata Evaluation system to know the changes that have occurred in them. Specific handle force was determined by a special device. Besides this, air permeability and drape were measured in accordance with the relevant standards.

Table 2 Data on low stress mechanical properties of fabrics made from polyester regular and polyester carbonised yarns by KES-F

KES-F Data	Regular	Carbonised
Tensile		
LT-1	1.00	0.78
LT-2	0.90	0.77
LT	0.95	0.78
WT-1(J/m²)	0.064	0.059
WT-2(J/m²)	0.225	0.235
WT (J/m²)	0.145	0.147
RT-1 (%)	84.52	83.33
RT-2 (%)	60.80	59.29
RT (%)	72.66	71.31
EMT-1 (%)	0.26	0.31
EMT-2 (%)	1.00	1.23
EMT (%)	0.63	0.77
Bending		
B-1 (μN.m)	1.83	2.74
B-2 (μN.m)	1.03	1.73
B (μN.m)	1.43	2.24
2HB-1	0.427	0.604
2HB-2	0.063	0.211
2HB (mN)	0.244	0.408
Shear		
G-1 (N/m)	0.3295	0.5108
G-2 (N/m)	0.4263	0.3785
G (N/m)	0.3779	0.4446
2HG-1 (N/m)	0.2107	0.2450
2HG-2 (N/m)	0.8281	0.6958
2HG (N/m)	0.5194	0.4704
2HG5-1 (N/m)	0.8526	1.9625
2HG5-2 (N/m)	1.3695	1.3891
2HG5 (N/m)	1.111	1.6758
Surface		
MIU-1	0.1644	0.1804
MIU-2	0.1527	0.1727
MIU	0.1585	0.1765
MMD-1	0.0092	0.0092
MMD-2	0.0186	0.0181
MMD	0.0139	0.0136
SMD-1 (μm)	2.75	2.02
SMD-2 (μm)	8.19	6.63
SMD (μm)	5.47	4.32
Compression		
LC	0.52	0.57
WC (J/m²)	0.025	0.031
RC (%)	79.46	72.96
Thickness (To mm)	0.27	0.30
Thickness(Tm mm)	0.164	0.188
Weight (mg/cm²)	3.95	4.45
Primary hand value		
KOSHI	2.0	2.90
NUMERI	2.90	2.50
FUKURAMI	6.98	6.79
HARI	0.97	2.20
THV (W)	2.63	2.89
THV (S)	2.90	2.71
TAV	29.78	14.77
Specific handle force	296	269
Air permeability	132	106
Drape%	27	31

RESULTS AND DISCUSSION

Table 1 shows the geometrical properties of fabrics from which it is clear that areal density and thickness have increased. This may be due to consolidation due to protecting.

Table 2 shows the tensile bending, shear friction, compression primary handle, handle properties of both the fabrics. It will be seen that tensile properties are unaffected while bending and shear properties show an increase. Whilst friction shows an increase for carbonised fabric which is 100% polyester fabric surface roughness shows a decrease. WC compressional energy shows an increase for carbonised sample. Total handle value shows an increase in carbonised sample in comparison with un carbonised sample. Specific handle force is less indicating that the handle has improved following carbonisation. Drape is poor for carbonised sample in relation to uncarbonised sample. Air permeability is less for carbonised sample.

In some cases, quite unexpected results have been obtained as for example be in bending shearing and drape. It must be remembered that following carbonisation, 100% polyester fabric has been produced which will have the properties of polyester fabric.

The drop in specific handle force shows that the handle has improved. Bending properties determined by Kawabata bending tester and cantilever bending tester are found to be highest for treated sample.

CONCLUSION

It has been demonstrated that carbonisation treatment has led to an increase in bending, shearing, friction and an improvement in handle. Areal density and thickness of fabric following carbonisation are found to be high for carbonised sample. This may be due to consolidation of fabrics. Some other properties such as thermal resistance and UPF can be determined as future work.

REFERENCES

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