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ELECTROSTATIC CHARGE GENERATED FROM THE CONTACT-SEPARATION AND SLIDING OF RAYON/POLYESTER TEXTILES ON WOOL

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ABSTRACT
The quality and comfort of textiles depends on the intensity of electrostatic charge (ESC) generated due to their contact and friction with other textiles. The present work investigates the ESC generated from the contact-separation and sliding of the composites of rayon and polyester (PET) strings blended by carbon fibers (CF) on wool fibers. The present experimental work showed that the values of ESC generated at 100 % rayon were relatively low. Sliding of rayon/PET on wool recorded higher ESC values than that observed for contact-separation. When rayon/PET was blended by CF, drastic drop in ESC was observed from the contact-separation and sliding of strings on wool. It seems that the the presence of CF conducts the charge from one surface to the other causing significan drop in the resultant ESC generated on the two surfaces. It can be concluded that blending rayon/PET by CF drastically reduced ESC so that the proposed textile became environmentally safe, where the effect of CF was significant.

KEYWORDS
Rayon, polyester, strings, electrostatic charge, carbon fibers.

INTRODUCTION
Triboelectrification of the textiles controls their comfort and quality. Recently, several researches were carried out to investigate ESC generated from the contact of polymeric textiles on cotton and wool, [1 - 4], either by blending polymeric strings of different electrostatic properties or by CF. Test specimens containing PET, polyamide (PA), rayon strings were tested by sliding against cotton and wool fibers, where ESC of the tested materials was measured. It was found that ESC generated on the tested blend decreased with increasing PA content. The zero values of ESC at sliding were observed at 93 % PA. Blending wool and cotton fibers with polymeric ones drastically decreased ESC generated from their contact with each other, [5 - 7]. Therefore, the proposed blends can be environmentally safe.

Besides, it could be concluded that addition of carbon fibers (CF) drastically decreased ESC compared to that observed in strings free of CF due to the easy charge transfer provided by the CF.

In sport, the ability of textiles to cause friction-induced injuries to skin such as blistering was inspected, [8 – 10]. The mechanical contacts and friction between foot, sock and shoe during walking and running should be studies. One of the solutions to reduce ESC is to use textiles with conductive threads that are properly earthed.

The contact of the car seat covers against the clothes generated ESC of values that depended on the electrostatic properties of the contact materials, [11 - 13].

The contact of hair and head scarf of different textiles materials were tested, [14 - 19]. The commonly used textile fibers such as cotton, nylon and polyester were tested against African and Asian hair. It was found that sliding displayed higher ESC than contact and separation. Nylon showed the lowest friction. Because human hair is considered good insulator with high electrical resistance, it generates ESC when rubbed human skin, polymers and textiles, [20 - 22].

The aim of the present work is to measure ESC generated from the contact-separation and sliding of both rayon/PET strings blended by carbon fibers on wool.

EXPERIMENTAL

ESC generated from the contact-separation and sliding of rayon/PET strings, Fig. 1, on wool was measured by the electrostatic fields (voltage) measuring device, Fig. 2. The test specimens were adhered into the surface of a wooden block of 50 × 50 × 50 mm, Fig. 3. The test specimens were of rayon and PET of 1.0 mm diameter while the wool fibers were of 0.1 mm diameter. They were shaped in forms of plain weaves textiles and blended by 2.0 wt. % CF content. It is known that rayon is made from natural cellulose, such as wood. It has the texture of natural fibers such as silk, wool and cotton. Experiments were carried under normal loads of 2, 4, 6, 8 and 10 N and 20 mm/sec velocity for 200 mm sliding distance.

	
100 wt. % PET.	**100 wt. % Rayon.**

Fig. 1 PET and rayon test specimens.

Fig. 2 Electrostatic measuring device.

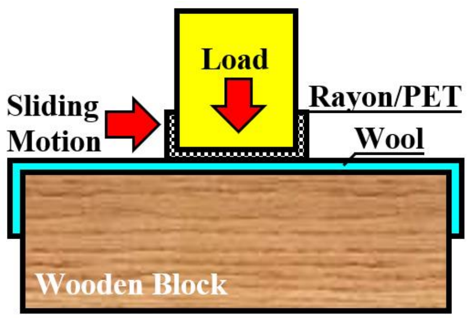

Fig. 3 Arrangement of the teste test procedure.

RESULTS AND DISCUSSION

Contact-separation of rayon/PET with wool generated ESC of values shown in Fig. 4. The negative ESC generated on the surface of rayon/PET increased with increasing PET content. Those values were -175, -360, -460, -560 and -650 at 2, 4, 6, 8 and 10 N respectively at 100 % PET. The values of ESC generated at 100 % rayon were relatively low due to the short gap between rayon and wool in the triboelectric series, Table 1. The triboelectric series are used to determine the charge polarity of the materials, where the position of the materials in the triboelectric series controls the intensity of ESC. The different materials when contact or rub each other, they may get charged. It is known as triboelectrification process, [23]. The charge can transfer in form of electron transfer, ion transfer and material transfer, [24, 25].

It seems that the effect of addition of viscose into PET did not reduce the negative ESC due to the aggressive action of wool. On the counterface, ESC generated on the surface of wool with rayon/PET is illustrated in Fig. 5. The positive ESC generated on the wool surface significantly increased with increasing PET content representing relatively higher values up to 482, 612, 1440, 1540 and 1823 volts at 2, 4, 6, 8 and 10 N load respectively.

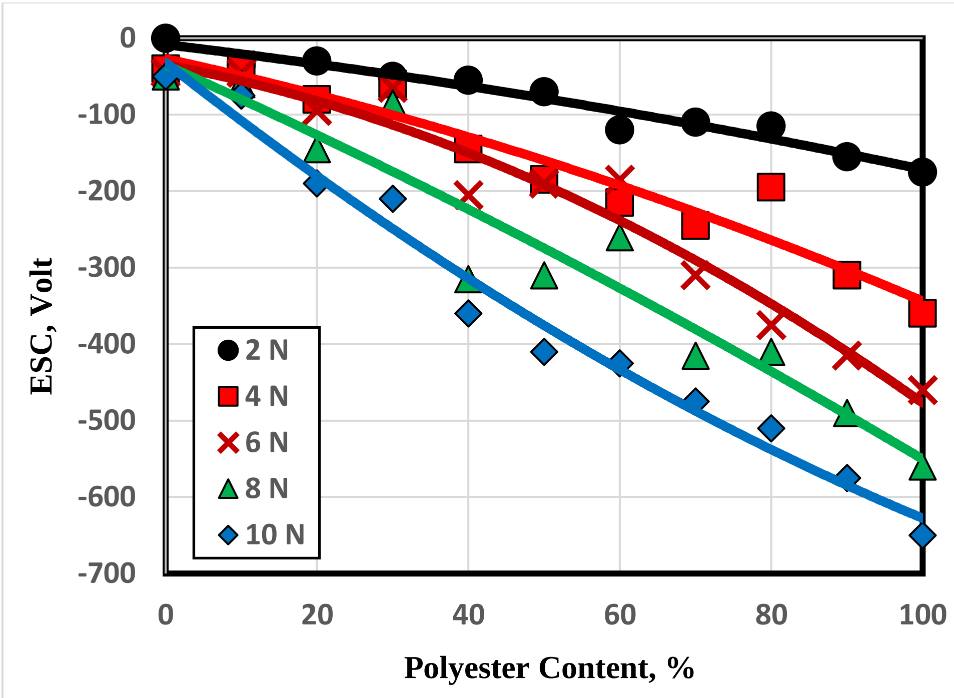

Fig. 4 ESC generated on the surface of rayon/PET from the contact-separation with wool.

Table 1. Triboelectric series of the tested textiles.

POSITIVE CHARGE	
	WOOL
	RAYON
	COTTON
	POLYESTER
NEGATIVE CHARGE	

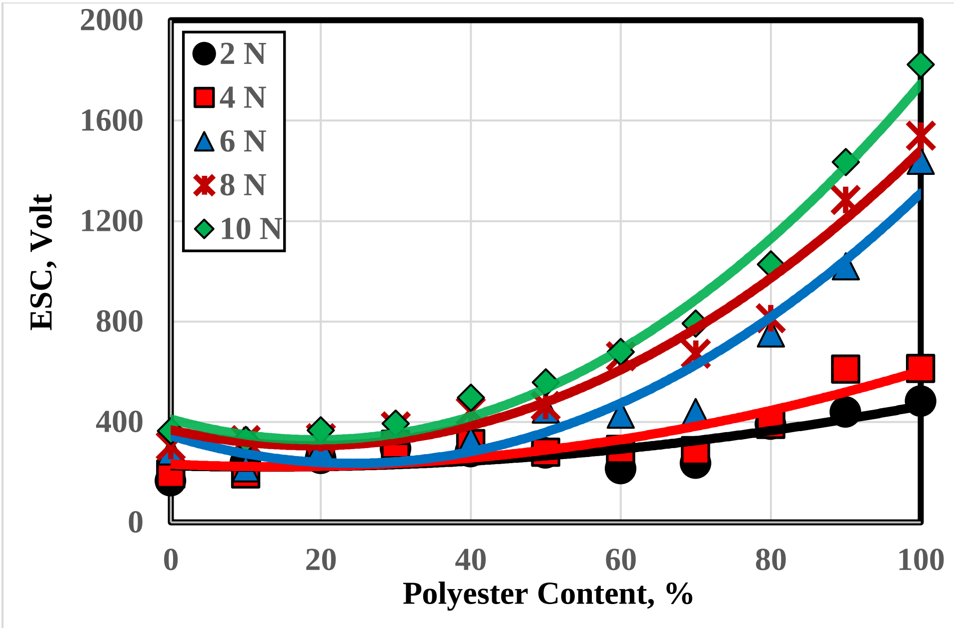

Fig. 5 ESC generated on the surface of wool from the contact-separation with rayon/PET.

Sliding of rayon/PET on wool recorded higher ESC values than that observed for contact-separation, Fig. 6. The highest negative values displayed by 100 wt. % PET were -402, -1158, -1500, -1578 and -1872 volts at 2, 4, 6, 8 and 10 N load respectively. ESC generated on the surface of wool, Fig. 7, displayed positive values of 2511, 3490, 5890, 6153 and 7691 volts at 2, 4, 6, 8 and 10 N load respectively. The significant increase in the values of ESC may be caused by the ranking of the viscose, PET and wool in the triboelectric series, Table 1.

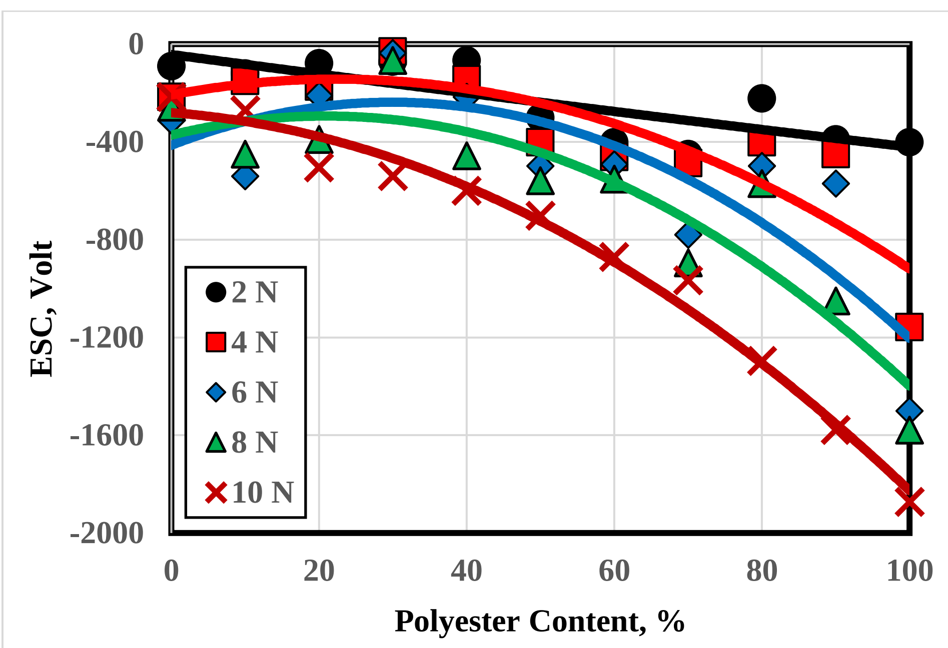

Fig. 6 ESC generated on the surface of rayon/PET from the sliding on wool.

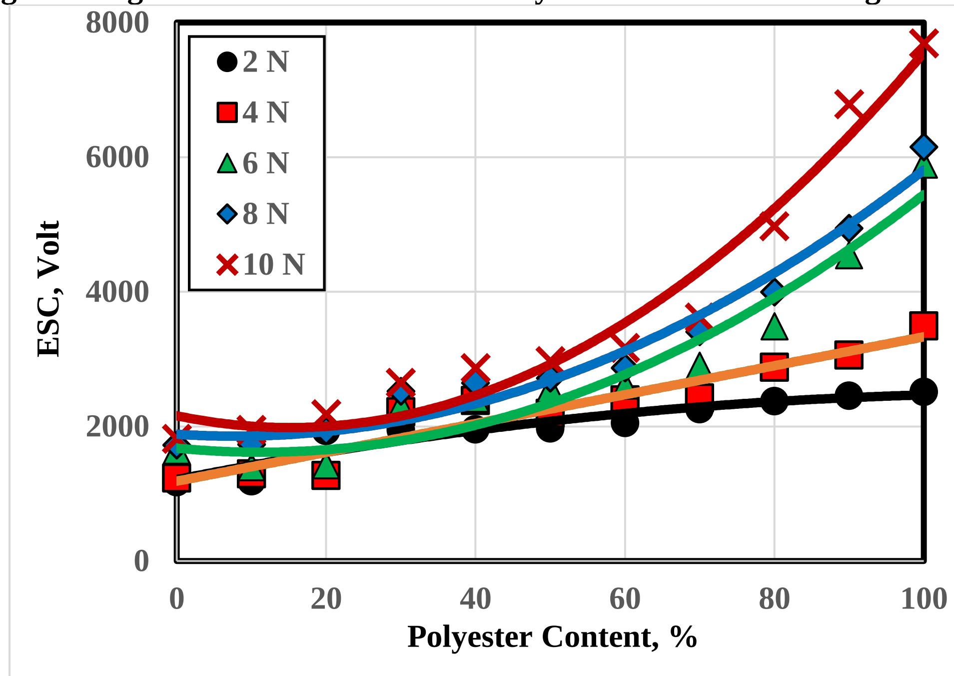

Fig. 7 ESC generated on the surface of wool from the sliding on rayon/PET.

After contact-separation and sliding, the distribution of ESC on the contact surface is illustrated in Fig. 8. rayon/PET gaines negative charge after rubbing wool, while wool gains positive ESC. The presence of CF conducts the charge from one surface to the other, where the resultant ESC generated on the two surfaces depends on the content of CF. It is known that the ESC intensity depends on the rank of the contact materials in the triboelectric series. Therefore, the contact between rayon/PET and wool causes wool to be positively charged and rayon/PET to be negatively charged.

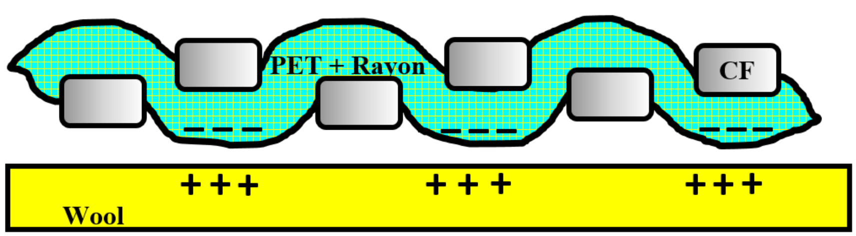

Fig. 8 Representation of ESC generated on the contact surfaces; after contact-separation and sliding.

The effect of blending rayon/PET by CF on ESC generated from the contact-separation of strings with wool is illustrated in Fig. 9, where the negative values of ESC recorded -35, -72, -92, -112 and -130 volts at 2, 4, 6, 8 and 10 N load for 100 wt. % PET. The drop of ESC is attributed to the easy charge transfer offered by the CF. ESC generated on the surface of wool fibers, Fig. 10, recorded relatively lower values,

where the highest value (365 volts) was represented by sliding of 100 wt. % PET on wool. Based on that results it is seen that the effect of CF was significant.

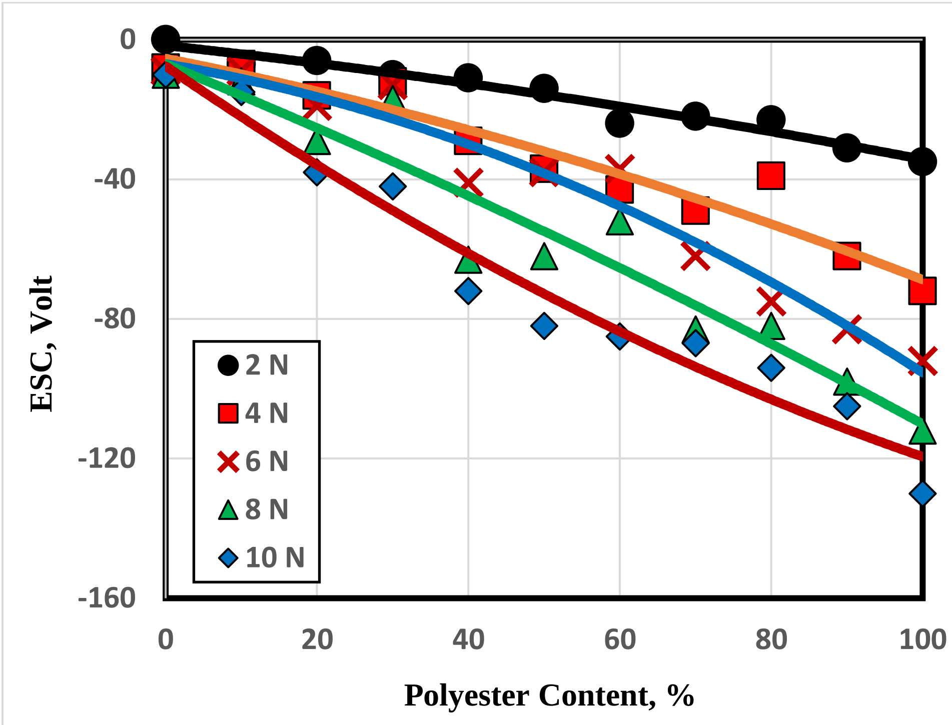

Fig. 9 ESC generated on the surface of rayon/PET blended by carbon fibers from the contact-separation with wool.

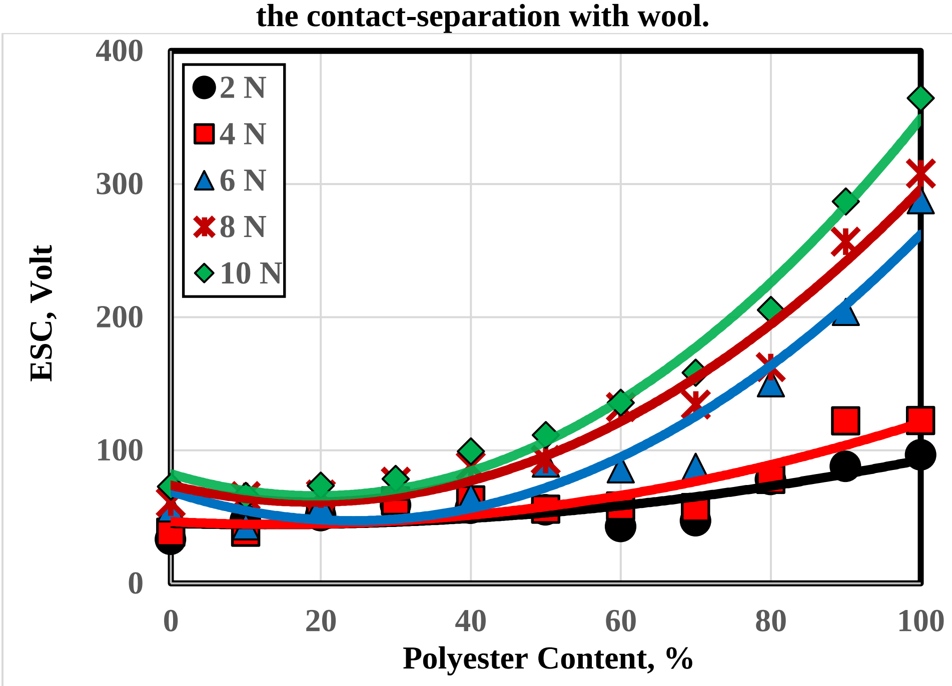

Fig. 10 ESC generated on the surface of wool from the contact-separation with rayon/PET blended by carbon fibers.

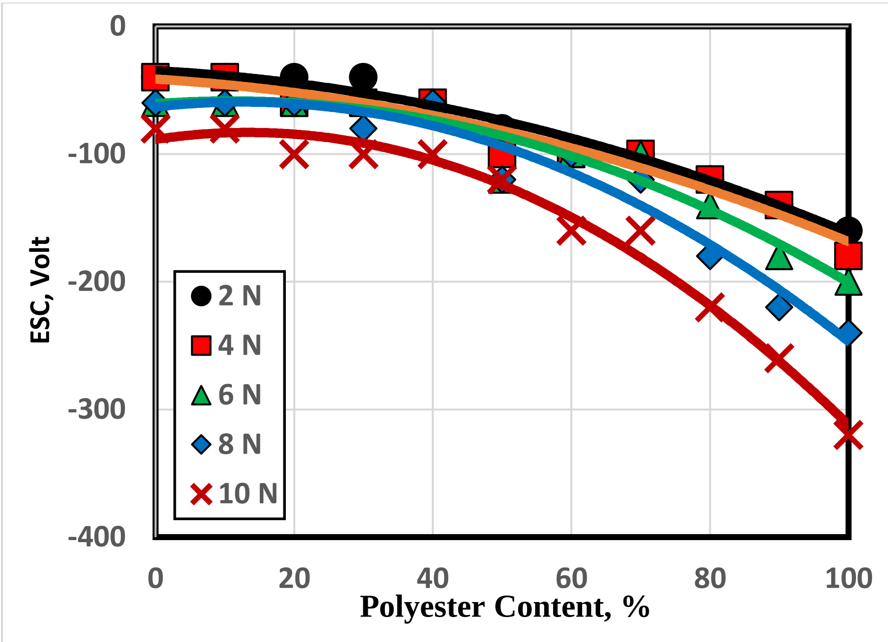

Fig. 11 ESC generated on the surface of rayon/PET blended by carbon fibers from the sliding on wool.

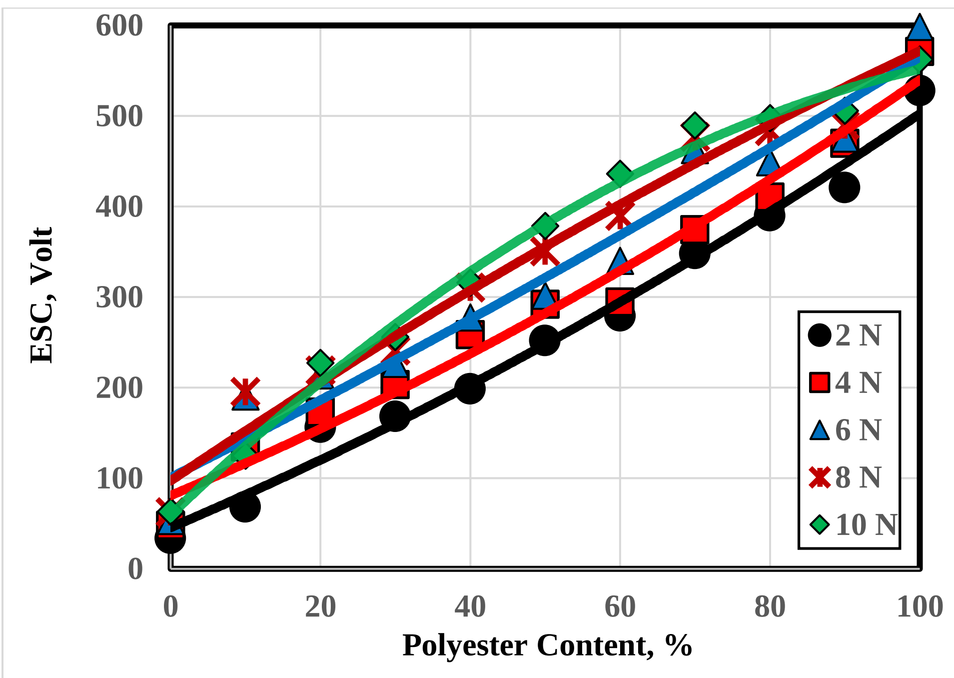

Fig. 12 ESC generated on the surface of wool from the sliding on rayon/PET blended by carbon fibers.

Relatively higher ESC values than that observed in contact and separation were recorded for sliding of the rayon/PET strings blended by CF against wool displayed,

Fig. 11. The maximum values were displayed by 100 % PET (-365 volts) at 10 N load, while ESC gained by the wool surface from sliding on the tested blend recorded 562 volts at 100 % PET and 10 N load, Fig. 12. It can be seen that addition of CF significantly reduced ESC in a manner that the blend became environmentally safe. Based on the results, it is seen that the effect of CF was significant.

CONCLUSIONS

1. The values of ESC generated at 100 % rayon were relatively low due to the short gap between rayon and wool in the triboelectric series. Besides, it seems that the addition of viscose into PET did not reduce the negative ESC due to the aggressive triboelectrification of wool.

2. Sliding of rayon/PET on wool recorded higher ESC values than that observed for contact-separation.

3. Blending rayon/PET by CF caused drastic drop in ESC that generated from the contact-separation of strings with wool. It seems that the drop of ESC is attributed to the easy charge transfer offered by the CF. Besides, ESC generated on the surface of wool fibers recorded relatively lower values.

4. Relatively higher ESC values than that observed in contact and separation were recorded for sliding of the rayon/PET strings blended by CF against wool.

5. It can be concluded that addition of CF significantly reduced ESC in a manner that the blend became environmentally safe. Based on the results, it is seen that the effect of CF was significant.

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