ASSESSMENT OF THE ELECTROSTATIC PROPENSITY OF PES / METALLIC WOVEN FABRICS

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ABSTRACT

Although the field of electrostatics has been known for years, many of the phenomena associated with it are still not understood. This has led many authors to state that electrostatics is both a science and an art. Static charge has been a major source of problem in textile industry as well as consumers. Static problems in textile industry have become more serious as synthetic fibers and higher processing speeds are met. This research was undertaken to gain better understanding of electrostatic propensity of polyester / metallic woven fabrics . A total of twenty seven woven fabrics were produced in three different weave types (sateen 8 , 4/4 hopsack and Kautshok) from (100% polyester , 100% metallic and (50% polyester , 50% metallic) (1 pick : 1 pick)) weft blend , 100% polyester warp , of three different weft set (22 picks/cm , 28 picks/cm , 34 picks/cm). The test results obtained showed that the amount of generated static charges showed great variance according to: the type of material (The maximum static charges were at 100% polyester) , type of weaving in 100% PES weft in the woven fabrics (The maximum static charges was for 4/4 hopsack) .

***Keywords:* Electrostatic Propensity , Metallic yarns , Woven Fabrics.**

I. INTRODUCTION

Nowadays, interest in protection against electrostatic discharge (ESD), regarded as an important issue, is still growing. ESD may lead to serious economic losses and can also be hazardous to humans. In zones where substances with low values of ignition energy occur, ESD may involve a high risk of fire or explosion [1]. In the age of 'the electronic civilization', ESD has become a problem not only for the electronics industry. High-tech electronic systems accompany us nearly everywhere, at work, in private places, modern cars, planes, ambulances with resuscitation equipment, etc. Occurrences of low level ESD from people have been reported to cause device failures and yield losses [2]. It was found that 60 – 90% of defective devices were damaged by ESD [3].

In the textile industry, static electricity may cause many problems if it is not under control. These problems may be:

• Electronic equipment can be overloaded and break down.

• Static discharge in an operating room may lead to an explosion.

• Risk of shock.

• Increased production time: In some areas very long textile materials are produced. Because of the static charge on it, roll should be used for some time to allow static charge dissipation.

• Fiber breakage and decreased fabric strength: Spun bond machine during production, before transferring the web to calender bonding, the fabric sticks to the belt. This may cause fabric breaks during production and higher process time [4 - 6].

The world textile market is dominated by three classes of melt extruded synthetic fibers, namely polyester, polypropylene, nylon, all of which are based on low energy polymers. These three classes of materials are effective insulators, having inherent resistance values of > 10^{14} ohm-cm. When insulating polymeric materials are contacted or rubbed with any other material (conductor or insulator), a static electric charge is generated on the polymer surface. Because of the insulating properties of these polymers, the charge that is generated is fairly stable and only slowly dissipates [7]

Static electricity arises when surfaces that were in contact are separated [8 - 10]. Indeed, the rubbing of two insulating materials against each other can give rise to a static buildup of up to several thousand volts. The build-up charge is then suddenly released, either by a spark or a surge, when a certain voltage is reached; the latter is influenced by several factors like the conductivity of the charged body, the humidity of the environment, etc. [7, 8].

Some materials such as glass, hair, and Nylon tend to give up electrons and become positively charged. Other materials such as Polypropylene, Vinyl (PVC), Silicon, Teflon, and Silicone tend to collect electrons and become negatively charged . The ability of material to surrender its electrons or absorb excess electrons is purely a function of the conductivity of the material with which you are working. [11]

All synthetic fibres are treated with a finish very shortly after their exit from the spinnerets. This ‘spin finish’ contains lubricating oils and other components, including antistatic agents. The high speeds of modern fibre processing would not be possible without these finishes. Chemical processing aids in yarn making, knitting, weaving and nonwoven manufacture also contain antistatic agents. Having accomplished their purpose, these processing aids are usually removed during fabric preparation. Non-durable antistats are also applied to technical textiles that are neither washed nor shampooed, for example textile filters, conveyer belts, transport bands and driving cords.

Although antistatic finishes applied after dyeing or printing are more common with hydrophobic fibres, fabrics made from cotton, rayon and wool may also be antistatic treated depending on the intended use. Examples of textiles that are treated with antistatic finishes include carpets for computer rooms, upholstery fabrics and airbags for automobiles, conveyor belts, filtration fabrics, airmail bags, parachutes, fabrics for hospital operating rooms, and protective clothing for work with flammable gases, liquids and powdered solids.[12]

Compared to the increasing interest of scholars in researching the static charge generation/dissipation of materials, there are few standard methods addressing the measurement of such parameters. There are four major organizations publishing electrostatic standards; American Society of Testing and Materials (ASTM) (D4238-90 : Standard Test Method for Electrostatic Propensity of Textiles Electrostatic Discharge)[13] , (ESD) Association (Electrostatic Discharge Association)[14] , American Association of Textile Chemists and Colorists (AATCC) (Test Method 134-2011 : Electrostatic Propensity of Carpets)[15] , and International Standard Organization (ISO) (ISO/DIS 18080 **:**Test methods for evaluating the electrostatic propensity of fabrics)[16] . These organizations developed test methods to assess resistivity, and static charge generation and accumulation. In addition to the four organizations mentioned above, the Federal Test Method (FTM) developed a standard test concerning charge dissipation. Devices to charge and procedure to generate static charge using such devices are provided as standard to increase measurement accuracy and reproducibility[17].

The aim of this research is to reveal features of the electrostatic propensity of different woven fabrics containing metallic and polyester yarns .

II. MATERIALS AND EXPERIMENTAL METHODS

Twenty Seven woven fabrics were manufactured at department of spinning , weaving and knitting for this study. All the fabrics were manufactured using 72 yarn /cm , 150/1 Denier 100 % PES yarn as warp. for weft two types of yarns were used : 150/1 Denier 100 % PES yarn , 150/1 Denier MX-Type Metallic Yarn from BLUE SKY TEX ,Three different weft sets were used : 22 picks/cm , 28 picks/cm , 34 picks/cm using three different weft blend ratios: 100% polyester -100% metallic – (50% polyester , 50% metallic) (1 pick : 1 pick).Three different types of weaves were used in this experimental design : Hopsack 4/4 , Sateen 8 and 10 x10 Kautshok . EDX , SEM of metallic yarns at different magnification power are presented in Fig (1-2).

After weaving, the samples were subjected to washing in automatic washing machine using the following recipes: Liquor ratio (LR) =1: 20 , Detergent = 5g/l , Temp = 40°C , Time = 30 min.The samples were washed several times with cold water then centrifuged to remove the excess water. Finally, the samples were dried at ambient conditions.

Electrostatic propensity test on the produced samples was carried out at the standard conditions for textiles with an air temperature (20±2°C) and relative humidity of air (65±5%) according to ASTM D 4238 test procedure . The values were determined with a FMX-003TM Electrostatic Field meter.

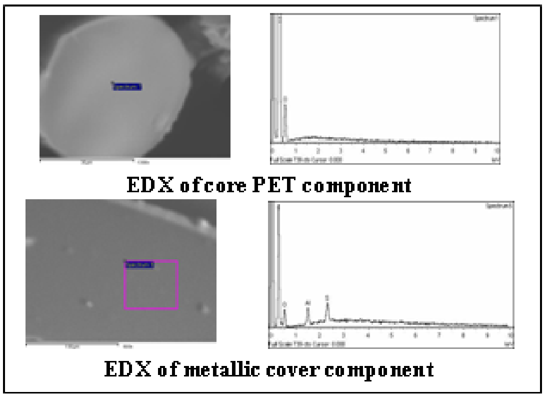

Figure (1) : EDX of Metallic Yarns

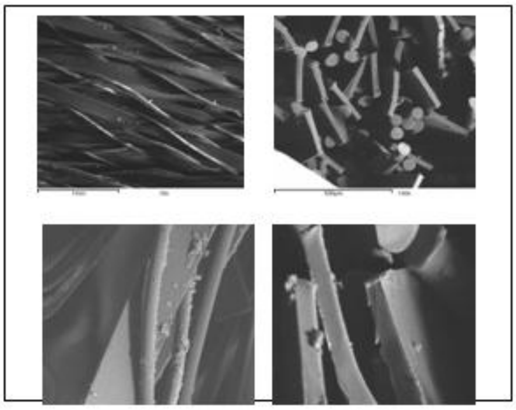

Figure (2) : SEM of Metallic Yarns at Different Magnification Power

III. RESULTS AND DISCUSSION

The results of the experiments carried out to measure the electrostatic propensity of the tested samples are shown in Figs. (3 – 7).

Figure (3) shows the relationship between picks number and weaving type of 100 % PES and static charges. It is clearly shown that the amount of generated static charges showed great variance according to the type of weaving. The maximum static charges was (6.1 kv) at 22 picks/cm for 4/4 hopsack , while the minimum was (2.2 kv)at 22 picks/cm for kautshock. The weaving construction tested showed different trend with picks number , 4/4 hopsack and satin 8 showed decreasing trend with increasing of picks number , while kautshok showed increasing trend with increasing of picks number.

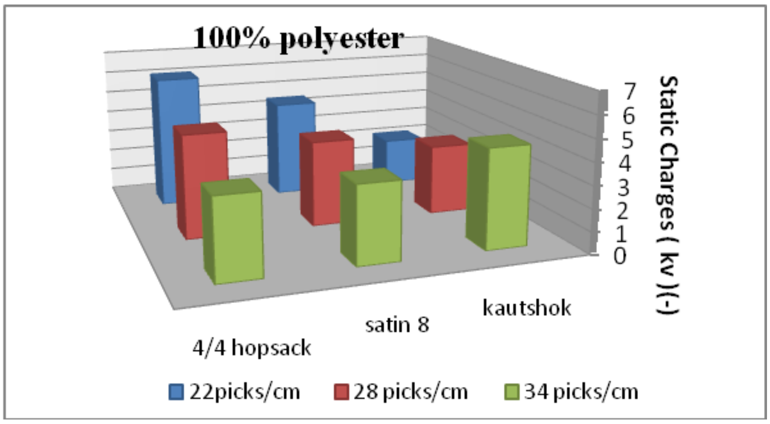

Figure 3 . Relationship Between Picks Number and Weaving Type of 100 % PES and Static Charges

Figure (4) shows the relationship between picks number and weaving type of (50 % PES , 50% metallic) and static charges. It is shown that the amount of generated static charges showed great variance according to the number of picks. The maximum static charges were at 28 picks/cm for the three weaving types , (4/4 hopsack (2.5 kv) – kautshock (1.1 kv) , satin 8 (0.8 kv) , while the minimum were at 22 picks/cm for 4/4 hopsack (0.6 kv) – satin 8 (0.05) kv.

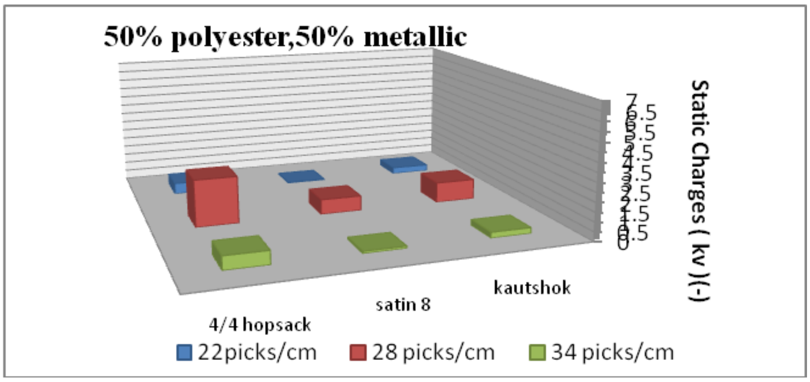

Figure 4 . Relationship Between Picks Number and Weaving Type of (50 % PES , 50% Metallic) and Static Charges

Figure (5) shows the relationship between picks number and weaving type of 100% metallic and static charges. The maximum static charges was (1.1 kv) at 22 picks/cm for satin 8 and that might be attributed to the long floats of satin weave, while the minimum was (0.06 Kv) at 22 picks/cm for kautshock .

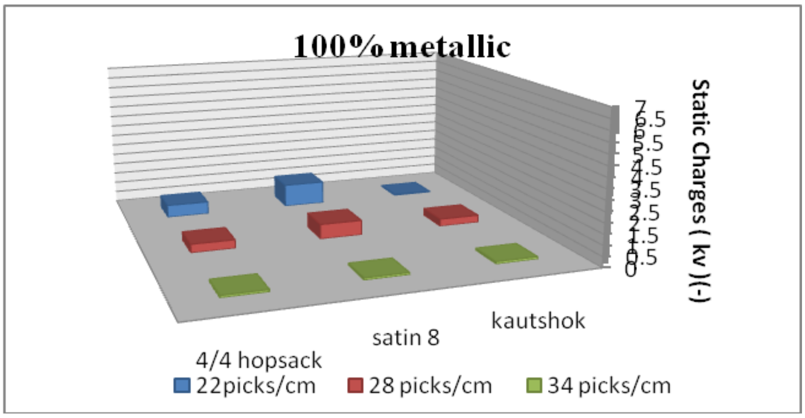

Fig 5 . Relationship Between Picks Number and Weaving Type of 100% Metallic and Static Charges

Figure (6) shows the relationship between the type of material and weaving type for 34 picks/cm and static charges. It is shown that the amount of generated static charges showed great variance according to the type of material . The maximum static charges were at 100% polyester for the three weaving types , kautshock (6.1 kv)-satin 8 (5.6 kv), 4/4 hopsack (4.5 kv)) , while 100% metallic , (50 % PES , 50% metallic) showed different trend, This behaviour can be interpreted on the fact that synthetics such as nylon or polyester are so hydrophobic that they are easy to accumulate electrostatic charges [18].

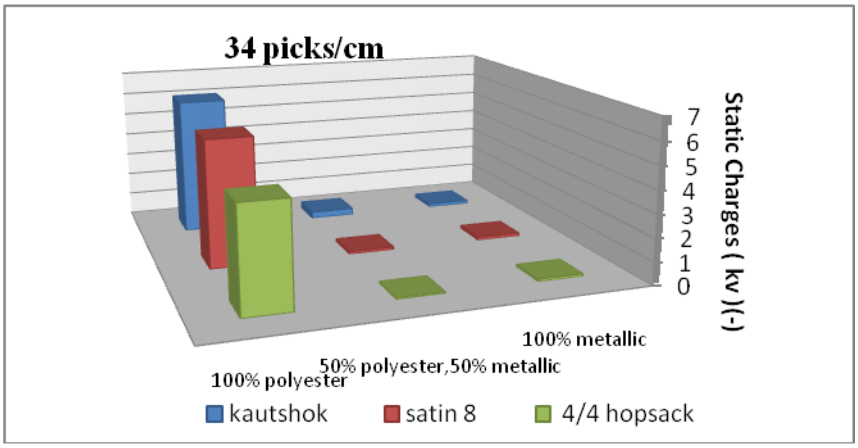

Fig 6 . Relationship Between the Type of Material and Weaving Type for 34 picks/cm and Static Charges

Figure (7) shows the relationship between picks number and the type of material for 4/4 hopsack and static charges. It is shown that the amount of generated static charges showed great variance according to the type of material. The maximum static charges were at 100% polyester for the three picks number, 34yarn/cm (4.5 kv)-28 yarn/cm (3.2 kv), 22yarn/cm (2.2 kv)) , while 100% metallic , (50 % PES , 50% metallic) showed different trends.

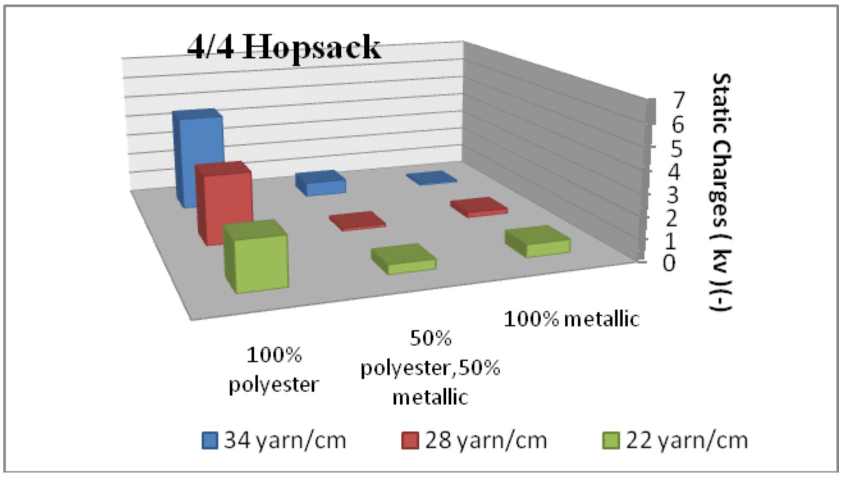

Fig 7 . Relationship Between Picks Number and the Type of Material for 4/4 Hopsack and Static Charges

IV. CONCLUSIONS

In this study, the electrostatic propensity of woven fabrics produced from polyester and metallic yarns with different weave types and different number of weft picks were investigated. From the results, the following conclusions can be made:

- The amount of generated static charges showed great variance according to the type of weaving in 100% PES weft in the woven fabrics .
- The amount of generated static charges showed great variance according to the number of picks in (50% PES , 50% metallic) weft in the woven fabrics .
- The amount of generated static charges showed great variance according to the type of material . The maximum static charges were at 100% polyester .

REFRENCES

[1]. Cieślak M., Wróbel S.; The International Conference: Research and standardization on the field of development and use of personal protective equipment. Kraków, 12–14 September 2005, ISBN 83-7373-037-0, pp. 173–180.

[2]. Holdstock P.; Journal of Electrostatics, 40-41, 1997, pp. 529–534.

[3]. Smallwood J., Paasi J.; Electrostatic 2003 Conference, Edinburgh, 23–27 March 2003.

[4]. Arita, Y., Shiratori, S. S., Ikezaki, K., Methods for the Detection and Visualization of Charge Trapping Sites in Amorphous Parts in Crystalline Polymers, Journal of Electrostatics, 2003; 57, 263-271.

[5]. Harper, W. R., Contact and Frictional Electrification, Oxford University Express, London, 1967.

[6]. Taylor, D. M., and Secker, P. E., Industrial Electrostatics: Fundamentals and Measurements, John Wiley & Sons, New York, 1994.

[7]. Vamsi Krishna Jasti , Electrostatic Charge Generation and Dissipation on Woven Fabrics Treated with Antistatic and Hydrophilic Surface Finishes , doctoral diss ., North Carolina State University , USA , 2011.

[8]. Marchini F.; Advanced Applications of Mettalized Fibres for Electrostatic Discharge and Radiation Shielding, Journal of Industrial Textiles, 1991, Vol. 20, No. 3, pp. 153-166.

[9]. Wilson N.; The Nature and Incendiary Behavior of Spark Discharges from Textile Surfaces, Journal of Electrostatics, 1985, Vol. 16, p. 231 – 245.

[10]. Yoshihiko O., Sugiura N., Nakaoka Y.;Dissipation of Triboelectric Charge into Air from Textile Surface, Textile Research Journal, 1996, Vol. 66, No.5, pp. 337-342.

[11]. R.Perumalraj, P.Jayashree, J.Kanimozhi and R.Ramya , Design and development of electrostatic discharge tester for textile materials , Perumalraj et al./ Elixir Elec. Engg. 40 (2011) 5466-5470

[12]. Qinguo Fan ., Chemical testing of textiles , Woodhead Publishing Ltd , Cambridge , England , 2005 .

[13]. http://www.astm.org/Standards/D4238.htm

[14]. https://www.esda.org/standards/industry-document-list/

[15]. https://www.aatcc.org/Technical/Test_Methods/scopes/tm134.cfm

[16]. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=61385

[17]. Minyoung Suh ., STATIC GENERATION AND DISSIPATION ON TEXTILES , M.S , North Carolina State University , USA , 2008 .

[18]. Shoush K. A., Mohamed M. K., Zaini H. and Ali W. Y., Measurement of Static Electricity Generated from Contact and Separation of Clothes and Car Seat Covers , International Journal of Scientific & Engineering Research, Volume 4, Issue 10, October-2013.