Comparative Study of Air Permeability of Polyester/ Metallic Blended Woven Fabrics

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Abstract: The air permeability of a fabric is a measure of how well it allows the passage of air through it. The ease or otherwise of passage of air is of importance for a number of fabric end uses such as industrial filters, tents, sailcloth's, parachutes, raincoat materials, shirting's, down proof fabrics and airbags. A total of twenty seven woven fabrics were produced in three different weave patterns (sateen8, 4/4 hopsack and Kautshok) from (100% polyester, 100% metallic and 50% polyester, 50% metallic (1 pick: 1 pick) weft blend, of three different weft set (22 picks/cm, 28 picks/cm, 34 picks/cm). The fabrics of satin 8 obtained the highest rates of air permeability at 22 picks/cm for 100% metallic weft. The fabrics produced from kautshok obtained the lowest rates of air permeability at 34 picks/cm for 100% polyester weft.

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Key words: air permeability, polyester, metallic, woven fabrics.

1. Introduction

Air permeability is an important property of the fabric. It has a decisive influence on utilization of fabric for some technical applications (filters, parachutes, and sails) and clothing application as well.

Air permeability is a measured by the ease with which the air passes through the material. ASTM D737-99 defines air permeability as "the rate of air flow through a material under a differential pressure between the two fabric surfaces" expressed in cubic feet per square foot per second. Air permeability of a fabric depends on parameters like the fabric cover and fabric porosity. Total cover of a fabric may be defined as the ratio of area covered by the warp and the filling yarns to the area covered by the fabric. Porosity of a fabric may be defined as the "ratio of the projected geometrical area of the opening across the material to the total area of the material" or the "ratio of air space to the total volume of the fabric expressed as percentage".

Other fabric parameters that influence the air permeability of a fabric are type of weave, type of yarn (spun or filament), yarn size (linear density), twist factor in the yarn, thread density (ends and picks), and crimp%. Type of weave determines the manner in which the yarns are interlaced in fabric. By changing the order of interlacements the air permeability of the fabrics can be varied [1]. When the size of the yarn changes the area occupied by the yarn in the fabric and therefore the porosity of the fabric also changes. The twist factor in the yarn has a significant influence on the air permeability of the fabric since twist affects yarn size. The air permeability of the fabric increases with twist factor. The thread density has a negative relationship with the air permeability of the fabric, the air permeability decreases with increasing thread density.[2]

The geometrical characteristics of textile fabrics are very important for evaluating and simulating a lot of fabric properties, one of which is air permeability. The permeability of fabric is closely linked to its structure. A number of authors, e.g.[3 – 7] have dealt with the possibility to predict the value of the permeability of fabrics based on their structural parameters. In some applications woven fabrics are used as filters or protective barriers whose function is to prevent the penetration into the human body of various micro particles or microorganisms. The elements of the structure which decide whether a woven fabric is capable of performing such a function are the inter-yarn pores, which are dependent on the weave and structural parameters of the fabric. These factors need to be pre-determined in the designing phase and realized in the weaving process [5, 6, 8].

A structure of textile materials is very complicated and very varied, while the structure is determinative for an air permeability of textile materials. A size of the pores in textile, a shape of the pores, their arrangement and frequency are decisive characteristics of a fabric with point of view air permeability [9].

The total porosity of woven fabric usually comprises two types of porosity: the micro porosity (or intra-yarn porosity) is caused by the void spaces between fibers in yarns, the macro porosity (or inter-yarn porosity) is caused by the void spaces between yarns. Even very small change in the structure of the fabric causes a change in the permeability at the given location of the fabric. Therefore, it is necessary to keep a high degree of uniformity of the fabric structure to ensure stable values of the permeability throughout the entire fabric area[10].

The geometry of fabric changes when strain is applied to the fabric. The change in the geometry of the fabric is due to various mechanisms of fabric deformation under the influence of uniaxial and biaxial stress. The mechanism includes yarn consolidation (diameter decrease), yarn flattening, yarn bending, fiber rotation, fiber extension and fabric shearing [11, 12].

Metallic yarn is a synthetic yarn that has a metallic appearance. It contains certain metal elements, which provide it with gloss and at the same time stability and tension [13].

Types of metallic yarn:

- Un supported metallic yarn
- Supported metallic yarn
- Metallic round yarn
- Special types

The metallic yarn is used mainly in the textile industry.the metallic yarns are woven, braided, and knit into many fashionable fabrics and trims. For additional variety, metallic are twisted with other fibers such as wool, nylon, cotton and synthetic blends to produce yarns which add novelty effects to the end cloth or trim. They make all textiles more attractive by adding sparkle.

Metallic yarns have been used in just about every form of textiles. Some end uses have been in automotive fabrics, television front fabrics, bath towels and face cloths, clerical vestments, bathing suits, hosiery, upholstery, hat bands, etc. Also in theatrical clothing, theater backdrops, doll clothing, banners and uniforms.[14]

The main purpose of the present study is to investigate the effect of some fabric construction factors on polyester / metallic woven weft blended fabrics air permeability.

2. Experimental Work

2.1 Materials

The warp yarn used in this experiment is 150/1 Denier 100 % polyester yarn. The warp density is 72 yarn /cm. The filling yarn used in this experiment is: 150/1 Denier 100 % polyester yarn,150/1 Denier MX-Type Metallic Yarn from BLUE SKY TEX.

2.2 Experimental Variables

The following four variables were used for the experimental design.

1) Type of weave
3) Weft blend
4) Weft set

- Type of weave:

Three different types of weaves were used in this experimental design – Hopsack 4/4, Sateen 8 and Kautshok as shown in Figure (1).

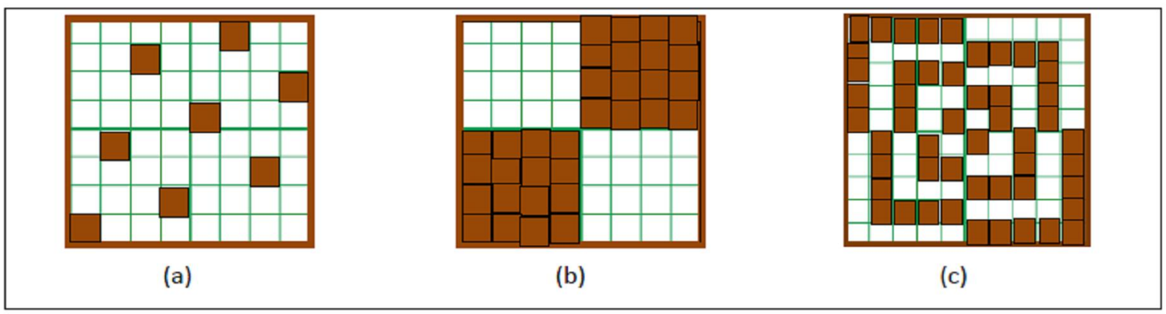


Figure (1): Weave design of: (a) sateen 8, (b)Hopsack 4/4, (c)Kautshok

Weft blend:

Three different weft blend ratios were used in this experimental design:

- 100% polyester
- 100% metallic
- 50% polyester, 50% metallic (1 pick: 1 pick)

Weft set:

Three different weft sets were used – 22 picks/cm, 28 picks/cm, 34 picks/cm.

2.3 Laboratory test

2.3.1 Scanning electron microscopy and EDX

SEM-EDX of metallic yarns was studied using a scanning electron probe microanalyzer (JXA-840A) Japan. The specimens in the form of fabrics were mounted on the specimen stabs and coated with thin film of gold by the sputtering method. The micrographs were taken at magnification of 2000× using (KV) accelerating voltage.

2.3.2 Measurement of Air permeability

Air permeability test on the produced samples was carried out at the standard conditions for textiles with an air temperature (20±2℃) and relative humidity of air (65±5%) according to ASTM D737-99 test procedure.

3. Results and Discussions:

Results of experimental tests carried out on the produced samples were presented in the following tables and figures.

3.1 Electron microscopy and EDX

The result of Scanning electron microscopy and EDX is shown in figures (2,3).

3.2 Air permeability:

Results of air permeability test carried out on the produced samples were presented in table (1).

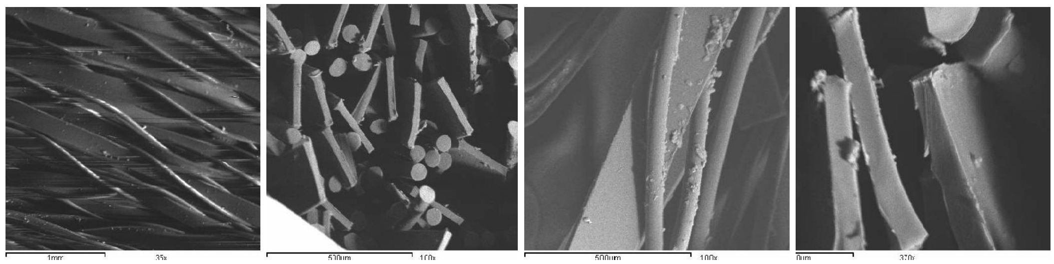
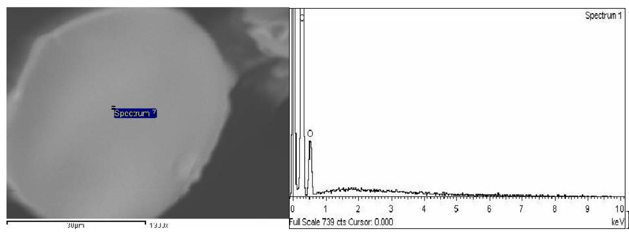
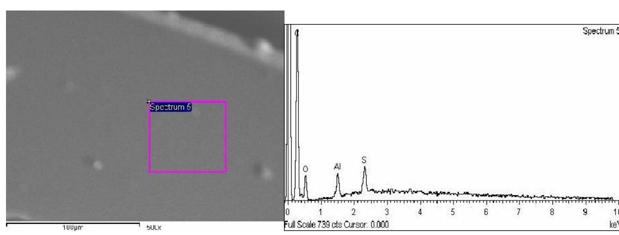


Figure (2): SEM of metallic yarns at different magnification power



EDX of core PET component



EDX of metallic cover component

Figure (3): EDX of metallic yarns

Table (1): The results of Air permeability test on the produced samples.

	100% polyester			100% metallic			50% polyester, 50% metallic		
	22 picks/cm	28 picks/cm	34 picks/cm	22 picks/cm	28 picks/cm	34 picks/cm	22 picks/cm	28 picks/cm	34 picks/cm
Hopsack 4/4	21.13	12.6	7.9	29.16	21.6	17.2	24.9	17.4	12.9
satin 8	54.56	33.16	19.7	66.4	42.5	26.3	65.73	42.2	24.5
Kautshok	17.5	10.88	6.94	22.5	16.93	13.13	20.9	13.56	10.93

3.2.1 Effect of number of picks and weave type on Air permeability of the produced fabrics

Table (1) and figures (4) which represent the relationship between number of picks and fabric weave type and Fabric air permeability for 100% polyester -100% metallic -50% polyester, 50% metallic (1 pick: 1 pick) weft ratio, show that satin 8 obtained the highest rates of air permeability at 22 picks/cmfor 100% metallic weft, kautshok obtained the lowest rates of air permeability 34 picks/cm for 100% polyester weft.

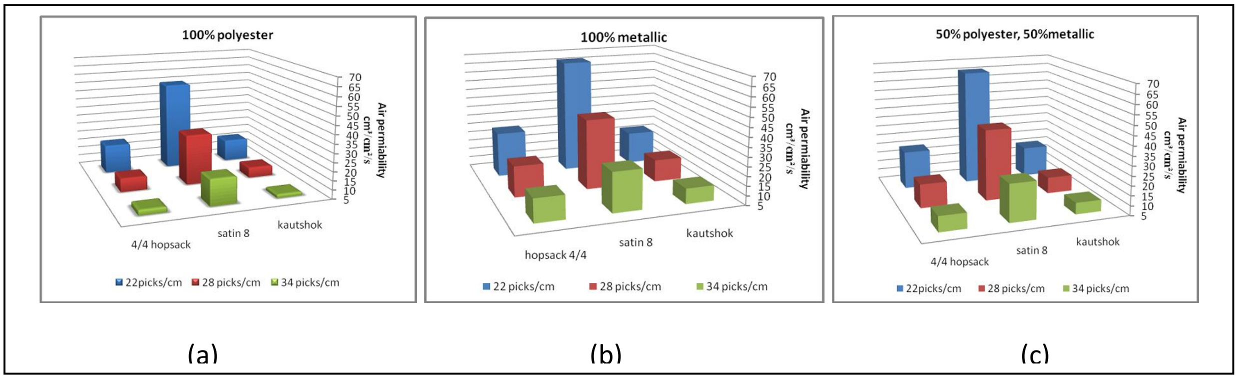


Figure (4): The relationship between weave type and number of picks and air permeability for: (a) 100% polyester – (b) 100% metallic – (c) (50% polyester, 50% metallic) weft ratio

3.2.2 Effect of number of picks and weft blending ratio on Air permeability of the produced fabrics

Table (1) and figure (5) which represent the relationship between number of picks and weft blending ratio and Air permeability for 4/4 Hopsack - Kautshok–Sateen 8, show that sateen 8 obtained the highest rates of air permeability at 22 picks/cm for 100% metallic weft, kautshok obtained the lowest rates of air permeability at 34 picks/cm for 100% polyester weft.

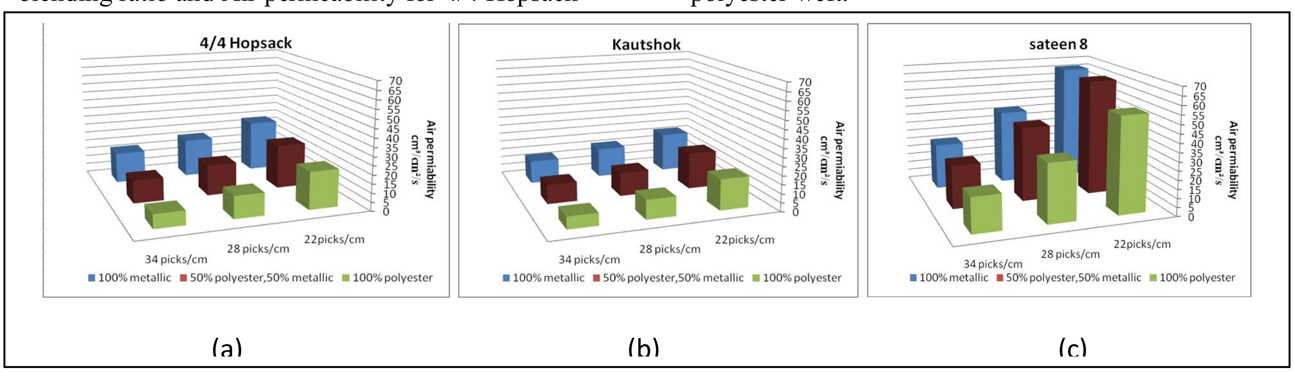


Figure (5): The relationship between number of picks and weft blending ratio on Air permeability of: (a) 4/4 Hopsack – (b) kautshok – (c) Sateen 8

3.2.3 Effect of weave type and weft blending ratio on Air permeability of the produced fabrics. Table (1) and figure (6) which represent the relationship between weave type and weft blending ratio and Air permeability for 22 picks /cm -28 picks /cm -34 picks /cm, show that satin 8 obtained the highest rates of air permeability at 22 picks/cm for 100% metallic weft, kautshok obtained the lowest rates of air permeability at 34 picks/cm for 100% polyester weft.

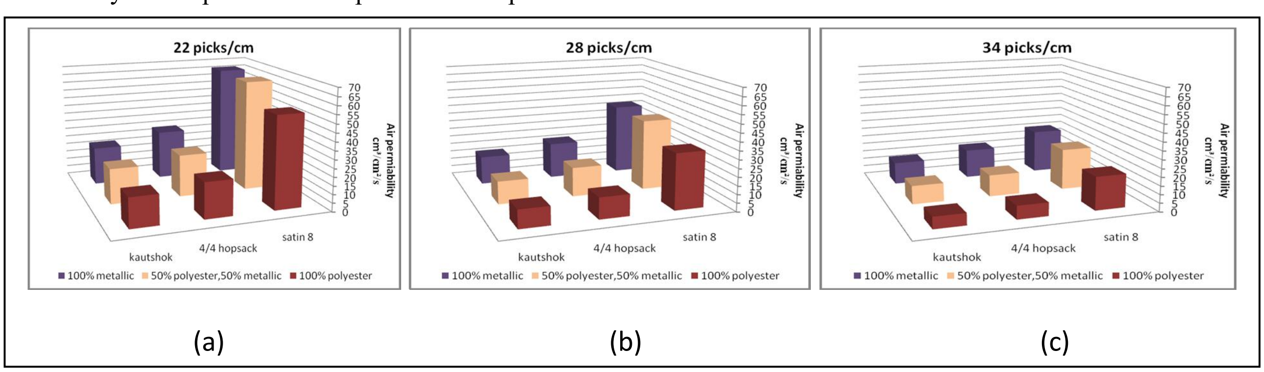


Figure (6): The relationship between weave type and weft blending ratio and Air permeability for: (a) 22 picks /cm – (b) 28 picks /cm –(c) 34 picks /cm

4. Conclusions:

In this study, the air permeability 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:

1. The air permeability increased in the fabrics woven with sateen 8 weave type, the fabrics woven with hopsack weave type was lower and the fabrics woven with kautshok weave type was the lowest. This is maybe due to the effect of fabric weave type on the determination of air permeability. The fabric with a sateen weave has lower cross over points, higher yarn floats and, as a result, lower yarn crimps than the fabric with a hopsack and kautshok when the warp and weft densities are the same.
2. The air permeability increased in the fabrics woven with 22 picks/cm, the fabrics woven with 28 picks/cm was lower and the fabrics woven with 34 picks / cm was the lowest. This is maybe due to the effect of fabric cover factor on the determination of air permeability. The fabric with 34 picks /cm has higher cover factor than the fabric with 28 picks/cm, 22 picks /cm.
3. The air permeability increased in the fabrics woven with 100 % metallic weft yarns, the fabrics woven with 50% polyester, 50% metallic (1 pick: 1 pick) was lower and the fabrics woven with 100% polyester was the lowest. This is maybe due to the effect of fiber cross section on the determination of air permeability. The inter yarn pores were higher in the fabrics produced from metallic yarns than corresponding fabrics produced from round polyester yarns for the same warp and weft densities, as a result of which the air permeability values of these fabrics were higher than corresponding values of the fabrics produced from round cross section fibres.

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