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# Investigation of the effect of different structural parameters of cotton woven fabrics on their air permeability

**E Tastan<sup>1</sup>, M Akgun<sup>1</sup>, A Gurarda<sup>1</sup> and S Omeroglu<sup>1</sup>**

<sup>1</sup>Uludag University, Faculty of Engineering, Textile Engineering Department, Görükle Campus, 16059, Nilüfer, Bursa, Turkey

E-mail: esratastan@uludag.edu.tr

**Abstract.** This study presents an investigation of the effect of different structural parameters of cotton woven fabrics on their air permeability. For this purpose, 24 fabric samples having different structural properties were obtained by using three different weave types (plain, 1/3 twill and 1/7 sateen), two different weft yarn counts (Ne 20/2 and Ne 70/2) and four different yarn twist levels (120, 360, 600, and 840 turns/m). Cotton Ne 50/1; 150 turns/m warp yarns and 40 threads/cm warp density were used in all fabric samples. The relationship between the fabrics structural parameters like weft yarn count, weave type, yarn twist number and air permeability behavior are investigated.

It has been shown that the increase of yarn counts and yarn twist led to an increase in air permeability values of cotton woven fabrics. Also, cotton woven fabrics with 1/7 sateen weave have the maximum air permeability value; these fabrics are followed by the fabrics having weave types of plain and 1/3 twill in spite of high weft density.

## 1.Introduction

In recent years, a cotton fabric often finds its application in producing work wear with high hygienic requirements and for protection against low temperatures. Also cotton fabric has very good breathable characteristics. It has low thermal conductivity, therefore it is an ideal material for both summer and winter clothes, in summer it prevents skin from heat and in winter it preserves warmth of body [1].

The most important parameters effecting thermophysiological comfort of cloths are thermal resistance, water vapour permeability and air permeability.

The resistance of a fabric to air permeability will depend upon the fabric construction, especially density, thickness and the yarn properties [2]. The differences in structural parameters of fabrics cause different permeability behaviors at the same environmental conditions [3,4]. For woven fabric, yarn twist also important. As twist increases, the circularity and density of the yarn increase, thus reducing the yarn diameter and the cover factor and increasing air permeability. Increasing yarn twist also may allow the more circular, high-density yarns to be packed closely together in a tightly woven structure with reduced air permeability [5].

Yarn twist factor has remarkable influence on air permeability of fabrics. Most of the fabrics showed increased air permeability as the yarn twist factor increased. Twist is the measure of the spiral turns given to a yarn in order to hold the constituent fibers or threads together. It is necessary to give a yarn coherence and strength. When a large twist is given to a yarn, it becomes compact and spaces in it are increased making the fabric more air permeable [6].

The resistance of a traditional textile fabric and garment to air permeability will largely depend upon the fabric construction, notably density, porosity and thickness, and to a lesser extent on the fibre properties [7,8]. The woven fabrics have a porous structure. The porosity is defined by the ratio of free space to fiber in a given volume of fabric. The air passes through the pores from the surface of the fabric [9].

The purpose of this study to investigate the relationship between the fabrics structural parameters like weft yarn count, weave type and yarn twist number and air permeability behavior.



## 2. Material and Methods

### 2.1. Material

24 types of different woven fabrics in plain, 1/3 twill and 1/7 sateen weave designs were measured. The structural properties of fabrics used can be seen in **Table 1**.

**Table 1.** Structural properties of fabric samples

Fabric Code	Weave Pattern	Weft Density [threads/cm]	Weft Yarn Count [Ne]	Weft Yarn Twist [turns/m]	Fabric Unit Weight [g/m <sup>2</sup> ]
F1	Plain	18	20/2	120	189,14
				360	189,02
				600	189,02
				840	189,47
F2	Plain	24	70/2	120	189,04
				360	188,92
				600	189,08
				840	188,69
F3	1/3 Twill	22	20/2	120	189,58
				360	188,35
				600	189,50
				840	189,61
F4	1/3 Twill	32	70/2	120	188,90
				360	189,23
				600	189,28
				840	189,21
F5	1/7 Sateen	26	20/2	120	189,63
				360	188,73
				600	188,76
				840	189,67
F6	1/7 Sateen	38	70/2	120	189,24
				360	188,94
				600	189,06
				840	188,96

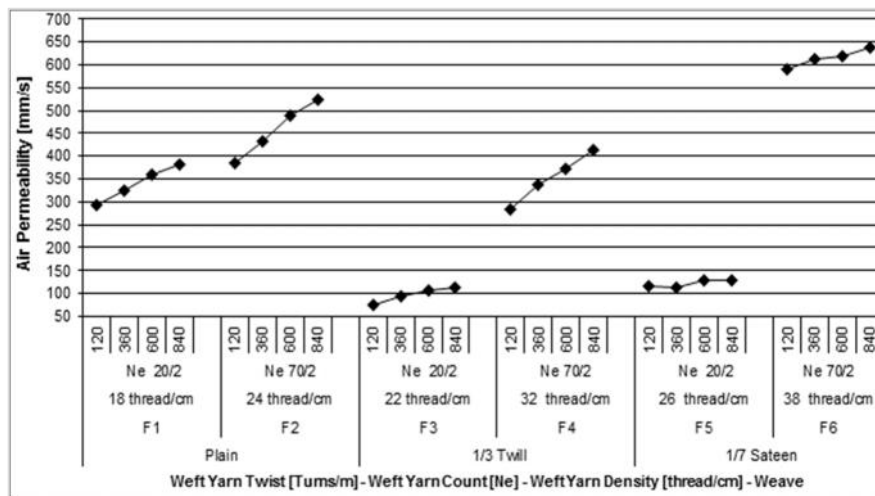
### 2.2. Method

In this study, air permeability test was done to the fabric samples. Air permeability tests were conducted using SDL Atlas M021A model Air Permeability Tester at a test pressure drop of 100 Pa for 20 cm<sup>2</sup> test area. (EN ISO 9237)

## 3. Results and Discussion

The relationship between air permeability and structural parameters of fabric samples was presented in Figure 1. When the effect of the yarn twist level on the air permeability of the fabric samples was examined, it was seen that the air permeability values increased as the yarn twist increased. It has been observed that air permeability is increased in fabric samples using fine yarn, even though the fabric weft density is increasing.

Weave type and yarn density are important factors affecting air permeability as shown in Figure 1, too. The highest air permeability values were obtained in sateen fabrics (F6 samples) with the finest weft yarn (Ne 70/2) and the highest weft yarn density (38 threads/cm). The lowest air permeability values were obtained in twill and sateen fabrics (F3 and F5 samples) with the coarsest weft yarn (Ne 20/2) and the lowest weft yarn density.



**Figure 1.** Air permeability test results of cotton fabric samples

It can be observed in test results that longer the weave float, greater will be the air permeability, because longer weave float means less number of interlacements per unit area and where there are less number of interlacements which allow the air to pass through more freely. It can be concluded that by increasing the weave float like 1/7 sateen fabric samples, air permeability of the fabric was increased. The plain woven fabrics are dense and firm as compared to the 1/3 twill and 1/7 sateen, making air passage more difficult. So 1/3 twill and 1/7 sateen weave design showed more air permeability as compared to the plain weave design. But in this study plain fabric samples showed high air permeability because of low weft density.

Although the F4 (1/3 twill) and F6 (1/7 sateen) fabrics have high weft yarn density values (32 threads/cm and 38 threads/cm, respectively), the use of fine yarns (Ne 70/2) has increased the air permeability of these fabrics.

#### 4. Conclusions

Cotton fabric has low thermal conductivity, therefore it is ideal material for both summer and winter clothes. It prevents skin from heat in summer and preserves warmth of body in winter. Air permeability is very important for thermophysiological comfort of cloths. The resistance of a traditional textile fabric and garment to air permeability will largely depend upon the fabric construction especially density, porosity, thickness and yarn twist factor.

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In this study, it has been shown that the increase of yarn counts and yarn twist led to an increase in air permeability values of cotton woven fabrics. Also, cotton woven fabrics with 1/7 sateen weave have the maximum air permeability value; these fabrics are followed by the fabrics having weave types of plain and 1/3 twill in spite of increase weft density.

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