Effect of Spandex Ratio on the Properties of Woven Fabrics Made of Cotton / Spandex Spun Yarns

Mofeda Abdul Rahman AL-ansary

Fashion Design Department, Design and Art College, King Abdul Aziz University, Jeddah, kingdom of Saudi Arabia. **m_ansary2011@yahoo.com**

Abstract: Woven fabrics made of core- spun yarns containing spandex gained great attention in the last decade due to its extensibility and comfort properties. The key factor in producing such fabrics is the spandex ratio. The present study focuses on the effect of spandex ratio on different fabric physical and mechanical properties such as: breaking strength, breaking extension, shrinkage %, fabric growth and air-permeability. The findings of this study revealed that the ratio of spandex had a significant influence on the physical properties of woven fabrics. The statistical analysis detected a very good correlation between spandex amount ratio and physical properties of fabrics woven from cotton/ spandex core- spun yarns.

[Mofeda Abdul Rahman AL-ansary. **Effect of Spandex Ratio on the Properties of Woven Fabrics Made of Cotton / Spandex Spun Yarns.** Journal of American Science 2011; 7(12):63-67]. (ISSN: 1545-1003). http://www.americanscience.org. 8

Keywords: Spandex, Spandex ratio, Core-spun yarn, Woven fabrics, Drawing ratio, Physical properties.

1. Introduction

Spandex (also known as elastane) is a manufactured fiber in which the fiber-forming substance is a long chain synthetic elastomer consisting of at least 85% by weight of segmented polyurethane. While many different soft-segmented chemistries for spandex have been evaluated over the years, only polyether and polyester chemistries remain in use today. Also for major commercial spinning processes (solution dry spinning, solution wet spinning, reaction spinning, and melt spinning) for spandex have been practiced over the last 30 years. The various processes yield fibers with distinctively different attributes including cross-sectional geometry and stress-strain properties [1-3]. Today there are many spandex producers all over the world and several brands, types and costs of spandex in the market [4-6]. The main types of spandex yarns that are used in weaving and knitting machines together with other yarns are bare, single-covered, double-covered, core-spun, and core plies yarns. Each form of spandex properly used, provides for a high elasticity in fabric [7].

Various previous studied have reported the physical and chemical properties of spandex fibers. An elastic fiber has been characterized by high breaking elongation (exceeding 100% and generally 50 to 800%), a low modulus of elasticity (approximately 1/1000 that of a conventional "hard" fiber, such as nylon, cotton, and so on) and both a high degree and a high rate of recovery from 100% stretching (about 95%) [8,9]. Spandex fibers are resistant to hydrolysis (Lycra had power retention of 100% after boiling for 1 hour in water at pH 3 to 11). In addition the spandex fibers have good resistance to ultraviolet radiation, oxygen, heat, and oil [10].

Fabrics containing spandex yarn have a wide application value, especially because of their increased extensibility, elasticity, high degree of recovery, good dimensional stability, and simple care [11- 13]. In apparel industry, these kinds of fabrics are used for sport wear, and leisure cloths, hosiery, underwear and swimwear, so therefore for body-confirming garments which ensure stable shape under loading during wearing [9].

2. Materials and Methods

Experimental

Throughout this study, five fabric samples were woven using Sulzer weaving machine with following specifications:

Weave structure: 1/1 plain.
Warp yarn density: 62 ends / inch.
Weft yarn density: 56 picks / inch
Warp yarn count : 30 Ne (100% cotton)
Weft yarn count : 30 Ne (100% cotton- spandex core spun yarn)
Spandex linear density: 78 dtex

All fabric samples differ in the amount ratio of spandex in the cotton – spandex core spun yarns, i.e. 4%, 5%, 7%, 9%, and 11%.

Laboratory tests were carried out in weft direction under standard conditions of 20 ± 2 °C air temperature, 65% ± 2% relative humidity. The breaking strength and elongation of the fabrics were measured according to ASTM D1682. Air permeability of the woven fabric samples was measured according to ASTM D737. Washing shrinkage of woven fabrics was measured according to AATCC test method 135-2010 (ISO 359).

Fabric growth “the difference between the original length of a specimen and its length after the application of a specified tension for a prescribed time and the subsequent removal of the tension" can be calculated as follows:

% Fabric growth = (B - A) / A * 100

Where,

B= distance between bench marks, mm, measured after release of the tension force following 1 hour recovery.

A= original distance between bench marks prior to tension force.

Statistical analysis:

Test results in this study were assessed statistically using Analysis of variance (ANOVA) at significance level $0.05 \leq \alpha \leq 0.01$. To predict the properties of woven fabrics at the different levels of spandex ratio, the regression analysis was conducted. To detect the strength of the relationship between independent and dependent variables, the coefficient of correlation was evaluated. These regression lines can be used to predict the woven fabric properties at different levels of spandex ratios.

3. Results and Discussion

Breaking strength

Figure 1 illustrates the effect of amount spandex ratio on the breaking strength of woven fabrics; it is shown that this ratio has a significant impact on fabric breaking strength at 0.01 significance difference. A decreasing trend is detected proving that as the amount ratio of spandex increases the fabric tensile strength decreases. Increasing the amount ratio of spandex from 4 to 11% leads to a reduction of the breaking strength of the woven fabrics by 38%; this is because the lower tenacity of spandex fibers compared with cotton fibers.

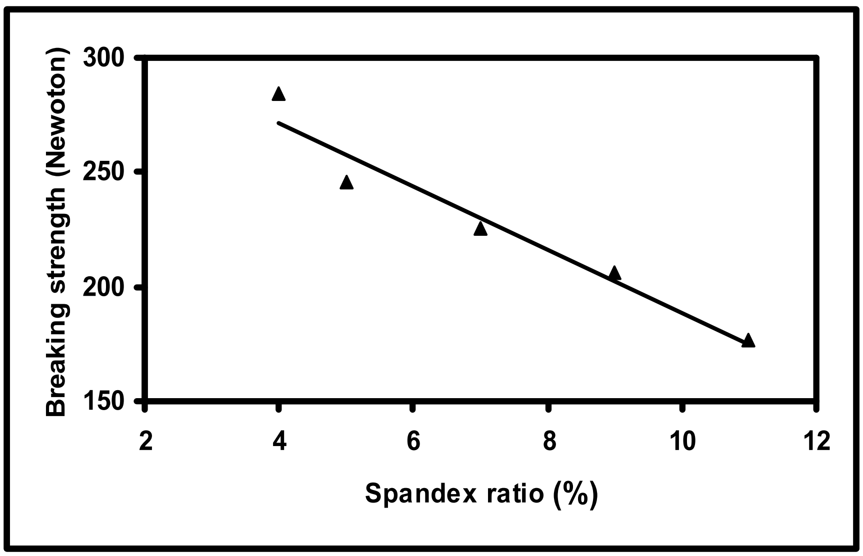

Figure1: effect of spandex ratio on fabric breaking strength

The regression relationship between amount ratio of spandex and woven fabric breaking strength has the following form:

Breaking strength (Newton) = -13.8* spandex ratio +327

The statistical analysis proved that the correlation coefficient between breaking strength and amount spandex ratio is - 0.96 which means a significant inverse relationship between the two variables.

Breaking extension

Fabric breaking extension values were plotted at different levels of spandex ratios in figure 2. The statistical analysis proved that amount ratio of spandex in the weft core – spun yarn has a remarkable effect on fabric breaking extension at 0.01 significance level. A positive correlation between spandex ratio and woven fabric breaking extension is noticeable. Increasing the amount ratio of spandex leads to an increase of the fabric breaking extension from 38% to 75%. The positive influence of spandex ratio on fabric breaking extension may be related to the higher elongation of spandex fibers (500%) compared with cotton fibers (7%).

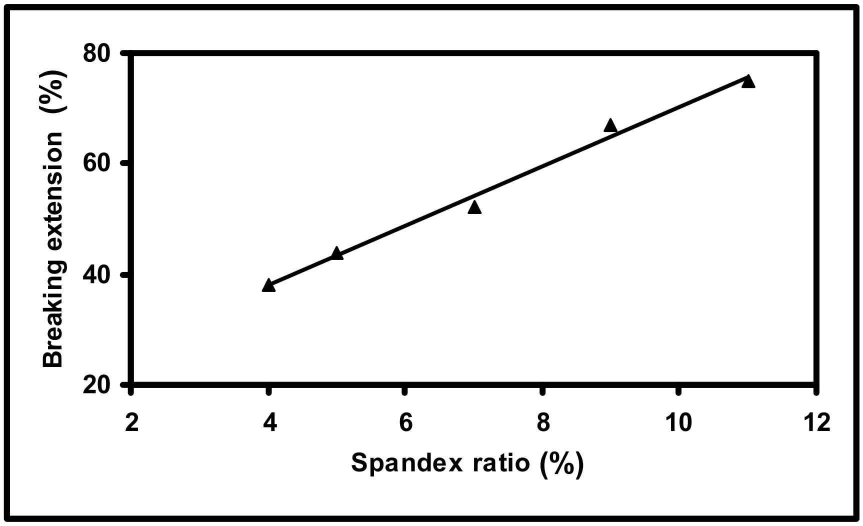

Figure 2: Effect of spandex ratio on fabric breaking extension

The regression relationship correlating the two variables is a straight line with the following form:

Breaking extension (%) = 5.4* spandex ratio +16.4

The correlation coefficient between amount ratio of spandex and fabric breaking extension has the value of 0.99, signifying a positive and strong relationship.

Fabric shrinkage

Effect of spandex ratio on fabric shrinkage in weft direction is shown in figure 3. It is noticed that spandex amount ratio has a significant influence on fabric shrinkage in weft direction at 0.01 significance level. A decreasing trend is detected conforming that as the spandex ratio in cotton – spandex core yarn increased, fabric shrinkage in weft direction is decreased. This might be due to the lower of the quantity of cotton fibers with the increased spandex ratio, which in turn lowers fabric shrinkage.

Statistical analysis proved that increasing spandex ratio from 4% to 11% leads to decreasing of fabric shrinkage in weft direction by 40.6%. This may be related to increasing the retraction force in weft direction due to increase in spandex ratio.

The regression relationship between spandex ratio and woven fabric shrinkage in weft direction is a straight line of the following form:

Fabric shrinkage (%) = - 1.9* spandex ratio + 38.1

The correlation coefficient between spandex ratio and fabric shrinkage in weft direction is negative and strong by a value of -0.94.

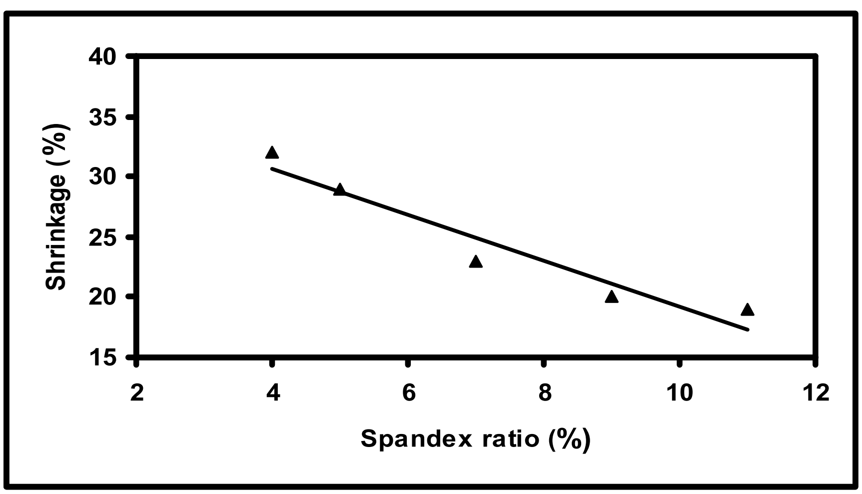

Figure 3: effect of spandex ratio on fabric shrinkage

Fabric growth

The plot of fabric growth versus spandex ratio contained in the weft core spun yarn is presented in figure 4. The statistical analysis showed a significant impact of amount ratio of spandex on the growth of woven fabric at 0.01 significant level.

A negative correlation between spandex ratio and fabric growth was noticed. As the amount ratio of spandex increases the fabric growth decreases. The statistical analysis proved that increasing the spandex ratio from 4% to 11% leads to a reduction in fabric growth from 4% to 2%. This is due to increasing the retraction force in the weft direction of the woven fabrics by the increase in spandex ratio.

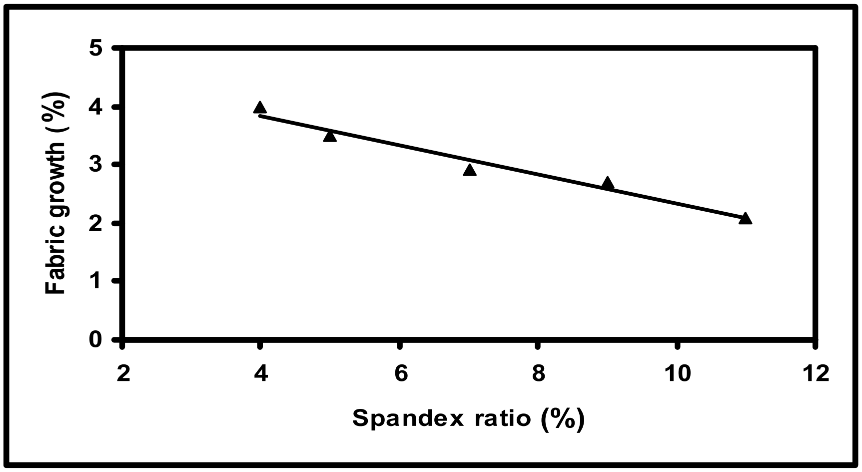

Figure 4: Effect of spandex ratio on fabric growth

The regression line which correlates spandex ratio to fabric growth is a straight line of the following form:

Fabric growth (%) = - 0.25* spandex ratio +4.85

The correlation coefficient between the two variables equals -0.99.

Air Permeability

Figure 5 illustrates air permeability of fabrics woven at different levels of spandex ratios. The statistical analysis showed that spandex amount ratio has a profound effect on fabric air permeability. As the spandex ratio increases, the rate of air permeability of woven fabrics increases. The statistical analysis showed that increasing the amount ratio of spandex from 4% to 11% leads to an increase of fabric air permeability by 63%.

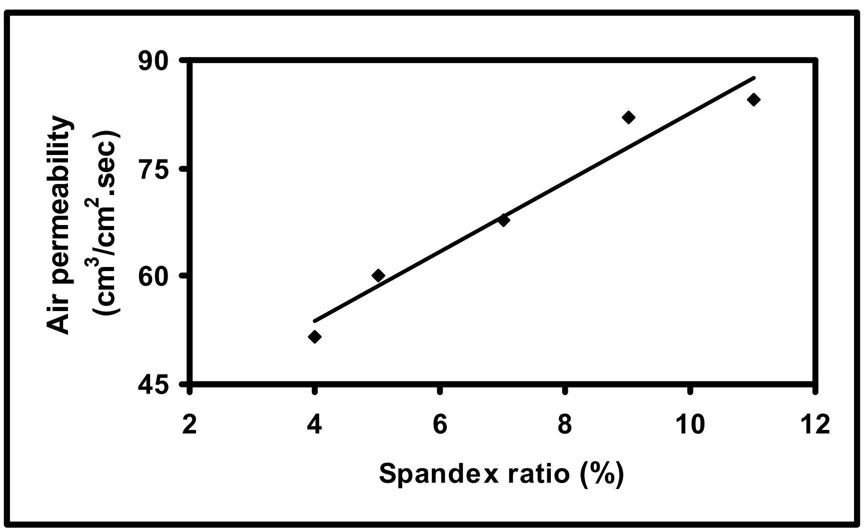

Figure 5: Effect of spandex ratio on fabric air permeability

The regression relationship between fabric air permeability and spandex ratio has the following straight line:

Fabric growth (%) = - 0.25* spandex ratio +4.85

The correlation coefficient between the two variables equals 0.97.

4. Conclusions

The results obtained in this study revealed that the spandex ratio in cotton-core spun yarns has a remarkable effect on physical and mechanical properties of woven fabrics. The statistical analysis showed that increasing the spandex ratio enhanced the fabric extensibility, and rate of air permeability. On the other hand, increasing spandex ratio reduces fabric tensile strength, shrinkage and growth of woven fabrics.

References

1- Boliek, J. E. (2000). "Elastane Yarns 1950-200" Chemical Fibers International, pp. 154-156.
2- Sekan, T., and Yasemin, K. (2008). Experimental Investigation of Effects of Spandex Brand and Tightness Factor on Dimensional and physical Properties of Cotton/Spandex Single jersey Fabrics. Textile, Res. J., 78(11):966-976.
3- Bhat,G., Chand, S., and Yakopson, S. (2001). Thermal Properties of Elastic Fibers. Thermochimica Acta, Vol.61,367-368,161-164,.
4- WWW.asahi-kasei.co.jp/fibers/en/rocia/index.html.
5- www.lycra.com.
6- www.radicispandex.com.
7- Bayazit, M. A.(2003). Dimensional and and physical properties of Cotton/Spandex Single Jersey Fabrics. Textile Res. J., 73(1): 11-14.
8- Lou. C.W. and Chang. C. W. (2005). Production of Polyester Core-Spun Yarn with Spandex Using Multi-Section Drawing Frame and a Ring Spinning Frame. Textile Research Journal, 75(5):395-401.
9- Šajn, D., Geršak, J., and Bukošek, V.(2004). A Study of The Relaxation Phenomena of Fabrics Containing Elastane Yarns, in “Proceedings of the 2nd International Textile, Clothing and Design Conference – Magic World Of Textiles, Dubrovnik, Croatia, 3–6 October 2004” 605–610.
10- Hicks, E. M., Ultee, A. J., and Drougas, J. (1965). Spandex Elastic Fibers. Science, New series, 147:373-379.
11- Çeken, F. (1996). “Some Investigations of the Dimensional Properties of Knitted Fabrics Containing Different Materials”, Doctoral Thesis, Ege University, I·zmir, 1995.
12- Tasmac, M. (2000). Effects of Spandex Yarn on Single Jersey Fabrics. Tekstil Konfeksiyon., 6: 422–426.
13- Mukhopadhyay, A., Sharma, I C., and Mohanty, A. (2003). Impact of Lycra Filament on Extension and Recovery Characteristics of Cotton Knitted Fabric. Indian J. Fibre Textile Res., 28:423–430.

11/11/2011