Study the Affect Range of Thermo Physiological Comfort Property For Produced fabrics As a Result of Hollow Fibers' ratio variation

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Abstract: During the latest times, there has been a development to the Textile Fibers to a great extent, and this report, aims, basically, at the production of new fabrics which shall be interacted with the body changes in the different atmospheric conditions circumstances. The development is also fast in the production of new textile fibers. The methods and the technologies of their production according to the modern chemical theories which have depended upon more than one kind of technology for gaining of new characteristics to the fibers. That is in addition the production for smart fibers that have a vital role in many of the uses, therefore these fibers are distinguished quickly according to the reaction, and also they are reacting with the nature of the use. In addition, they can change their form and nature according to the various changes, such as the change in the temperature or the secretion of the sweating or the physiological changes to the human body that accompany the different kinds of the overstrain. That is because there are some textile materials possess the ability to form a layer from the warm air inside them, this layer reacts negatively for the diminishing of the thermal transportation, thus, the different atmospheric conditions can be overcome, the matter which makes the human being feels comfortable. The feeling of comfort will never be realized except by the guaranteeing of the realization of the thermal balancing to the body between the interior generated thermal on one side, and between the thermal losing on the other side. Therefore, the research has given concern to the study of The effect of Hollow Fibers ratio variation on fabrics, thermal insulation, that is by the production of 60 samples that have been woven by the use of two materials which are Polyester hollow fibers and cotton, and the blend between them both according to different ratios, Those samples were of four different weaving structures which are: plain 1/1, twill 2/1, twill 2/2, and twill 3/1. Each of the four structures used was produced with four different numbers of picks per cm which are (16, 18, 20 and 22) picks/cm, then a test has been applied for the thermal insulation upon all produced fabrics, and the scheduling of the tests results, then making a statistic analysis for them, and the drawing of the illustrative relations concerning them.

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Key word: Warp (end): Vertical yarns; **Weft (Pick)**: Horizontal yarns; **yarn Count**: thickness of Yarn; **Picking device**: The Method Which Used To Pass Wefts; **Picks per Cm**: Number of weft yarns per Cm

1. Introduction

The physiological thermal comfort depends upon what is called the Micro Climate which is to be established between the human skin and the interior layer of the cloth [1] . The circle of the natural activity for the human being is composed of the work and comfort or rest, and the total of the active processes which safe the required power for the vital activity – it produces the thermal, but if the produced thermal increased, the body starts to get rid of it, and that is by means of the secretion of each of the sweat and damp or moisture from the body's surface, thus the comfort starts to become less and the thermal separations starts to diminish also, that is because the sweat and the moisture become adapted into the fabric bores [2,3] .

The temperature of the air that is surrounding the human body is the clear affecting factor in defining the degree of the body's temperature, and that in the low temperature, the clothes become supported with a very high importance in keeping the temperature of the human skin, and that is because the body doesn't possess the capacity to compensate what might be lost of the temperature, whether that is by means of the transporting or by rays, and in order to diminish this temperature, the clothes that must be used are those which shall not permit the leaking of the moisture or the temperature from the human body[4] .

The extent of the effect of the clothes upon the keeping or maintaining of the temperature of the body upon many factors, among them the factors of the temperature connection, and the kind of the textile material, and the physical properties to the clothes, and also the suitable measure and the clothes' color [4].

The air is to be considered as bad connective to the temperature, therefore, it is considered the best natural separator to the thermal, if the air was found into the product, it means that it protects the attiring person against the cold, on the other hand, it keeps the body thermal or temperature [5].

It has been found that the fitness, or the suitable measurement is one of the most important factors which affect the thermal insulation of the clothes, and the resistance of the vapor of the moister, because the thermal insulation increases and the resistance of the vapor of the clothes to the moister whenever the size of the air pockets between the clothes and the body was small [6].

Resistance becomes less of the temperature to the clothes when they become wet, and when the human being secrete the sweat, the water shall occupy the place of the air pockets [7]. There are many of the textile materials which are used in the field of the thermal insulation such as the glassy fibers which are distinguished according to the decrease of the factor of the thermal connection to them, and also the Nomex Fibers and the Carbon fibers [8].

The hollow fibers are distinguished also that they supply the human being with the warmth and comfort without the extra weighing, and that is if it was damp – they are the fabrics which are lighter in their weighing, and they lead an important role because they are made of the fibers that contain a core space by which a stagnant air with great ability to the thermal insulation. Also the one who attires such clothes, he shall be 20 % lighter and faster from the other insulating other fabrics, 50% faster from the cotton material. Where the area of the bigger surface which allows the quick evaporation and the removal of the damp and the faster one fro the skin to surface of the fabric which shall be able to evaporate according to an immediate speed [9].

Also, the hollow fibers are those which are composed of a mixture of the good appearance and the practice, thus you can imagine that there is a weave structure and it is a reactive one with the force of the body and it increases the activity of the blood circle and it grants a power and increases the muscles' force. There is no doubt that this is incredible and it gives a force from within the hollow fibers and that is by the production of the dresses or garments which do not appear as being beautiful from the side of the appearance only, but they are distinguished by the characteristics of the excellent practicing [10].

The hollow fibers also are distinguished by the lower density and the area of the vacuum which can be benefited from by putting a material in them. A production has been produced for some of the smart textiles which store the temperature, and that is by the besieging of the Carbid of the Zerkeniom inside the hollow core space of the fibers. This material is called Solar – Alpha, and it has the characteristics of the absorbing the solar rays and turning it into temperature that is shall be released into fabrics [11].

A summery for the public or general requirements to the fabrics that are insulating to the temperature in the following [12]:

1. The comfort.
2. Ergonomically Design.
3. Light of weight.
4. Durability of life.
5. Flame resistance
6. Easy care towards the product:
7. The dimensional stability, color fastness, retaining appearance.

2. The Experimental Work:

Two kinds of textile materials were used in this research: polyester hollow fibers and cotton and difference in blending ratio between them.

Table (1):The specifications of machine used for produced all samples

No.	Property	Specification
1	Kind of loom	Dobby
2	Number of loom healds	16 healds
3	Speed of machine	280 picks per minute
4	Picking device	Rigid Rapier
5	Kind of shading	Open shade
6	Width of loom	200 cm
7	Take up motion	Positive
8	Lett off motion	Positive

Table (2):The specifications of warps used for produced all samples

Warp specifications / Kind of material	The first warp		The second warp				The third warp				The fourth warp			
	100% polyester hollow fibers		67% polyester hollow fibers, 33% cotton				50% polyester hollow fibers, 50% cotton				33% polyester hollow fibers, 67% cotton			
	Arrangement of ends	Arrangement of wefts	Arrangement of ends		Arrangement of wefts		Arrangement of ends		Arrangement of wefts		Arrangement of ends		Arrangement of wefts	
Polyester hollow fibers	100%	100%	2		2		1		1		1		1	
Cotton	-	-		1		1		1		1		2		2

Table (3):The specifications of produced samples

No.	Property	Specification
1	Kind and count of ends	Polyester hollow fibers 162 × 2 denier, cotton $32/2^{(S)}$.
2	Kind and count of wefts	Polyester hollow fibers 162 × 2 denier, cotton $32/2^{(S)}$.
3	Reed used (dents per cm)	8 dents per cm
4	Reeding (sleying)	4 ends/dent
5	Number of ends/cm (warp set)	32 yarns per cm
6	Number of wefts/cm (weft set)	16, 18, 20 and 22 picks/cm
7	Number of healds used	12 healds + 2 for selvges
8	Drafting system	Directly (on line)
9	Width of reed	150 cm
10	Weave structures	Plain (1/1), twill (2/1), twill (2/2) and twill (3/1)

Tests and analysis:

In this part test was carried out in order to evaluate the produced fabrics, this test was: the thermal insulation of fabrics were determined according to A. S. T. M. designation: D1518-85 (Re approval, 1998)[13].

3- Results and Discussion:

Results of experimental test carried out in the following table (4) and graphs and were statically analyzed for statistically.

Table (4):The results of thermal insulation test applied to produced samples

Fabrics' blend ratio / Picks per cm	Weave structure	16	18	20	22
100% polyester hollow fibers	Plain (1/1)	1.65	1.70	1.72	-
	Twill (2/1)	1.66	1.75	1.80	1.85
	Twill (2/2)	1.72	1.72	1.75	1.85
	Twill (3/1)	1.83	1.85	1.90	1.98
67% polyester hollow fibers, 33% cotton	Plain (1/1)	1.54	1.60	1.65	-
	Twill (2/1)	1.57	1.62	1.67	1.70
	Twill (2/2)	1.60	1.62	1.66	1.66
	Twill (3/1)	1.62	1.65	1.70	1.72
50% polyester hollow fibers, 50% cotton	Plain (1/1)	1.50	1.50	1.52	-
	Twill (2/1)	1.54	1.55	1.57	1.60
	Twill (2/2)	1.52	1.57	1.62	1.62
	Twill (3/1)	1.60	1.60	1.62	1.65
33% polyester hollow fibers, 67% cotton	Plain (1/1)	1.19	1.25	1.30	-
	Twill (2/1)	1.42	1.45	1.50	1.54
	Twill (2/2)	1.42	1.42	1.50	1.55
	Twill (3/1)	1.50	1.54	1.55	1.57

Weave structures:

Table (4) which containing the results of tests show that, fabrics produced from twill weave structure (3/1) has verified highest readings for thermal insulation property, followed by fabrics produced from twill weave structure (2/2), after that fabrics produced from weave structure (2/1) and lastly fabrics produced from plain weave structure (1/1) which recorded the least readings. As this connected to the length of the float which the weave structure is composed and which includes warm and imprisoned air in between them, thus the increase in the length of the float increases the thermal isolation to the produced fabrics (all other executional specifications are constant).

Number of picks per cm (weft set)

Figures (1- 4) show that there is an increasing relation between number of wefts per cm and the thermal insulation that due to the increase of quantity of air existing between wefts, as a result of increasing number of picks per cm. That leads to decrease the quantity of lost heat, therefore the thermal insulation values are increase (all other executional specifications are constant).

Table (5): Regression equation and correlation coefficient for the effect of wefts number per cm (X) and the ability of produced fabrics to insulate heat (Y), using plain weave structure (1/1).

Fabrics' Blend ratio	Regression equation	Correlation coefficient
100% polyester hollow fibers.	Y = 0.0175 X + 1.375	0.970725
67% polyester hollow fibers, 33% cotton	Y = 0.0275 X + 1.10167	0.998625
50% polyester hollow fibers, 50% cotton	Y = 0.0050 X + 1.41667	0.866025
33% polyester hollow fibers, 67% cotton	Y = 0.0275 X + 0.751667	0.998625

Table (6): Regression equation and correlation coefficient for the effect of wefts number per cm (X) and the ability of produced fabrics to insulate heat (Y), using twill weave structure (2/1).

Fabrics' Blend ratio	Regression equation	Correlation coefficient
100% polyester hollow fibers.	Y = 0.0310 X + 1.176	0.987742
67% polyester hollow fibers, 33% cotton	Y = 0.0220 X + 1.222	0.993859
50% polyester hollow fibers, 50% cotton	Y = 0.0100 X + 1.375	0.9759
33% polyester hollow fibers, 67% cotton	Y = 0.0205 X + 1.088	0.995862

Table (7): Regression equation and correlation coefficient for the effect of wefts number per cm (X) and the ability of produced fabrics to insulate heat (Y), using twill weave structure (2/2).

Fabrics' Blend ratio	Regression equation	Correlation coefficient
100% polyester hollow fibers .	Y = 0.0210 X + 1.361	0.879593
67% polyester hollow fibers, 33% cotton	Y = 0.0110 X + 1.426	0.946729
50% polyester hollow fibers, 50% cotton	Y = 0.0175 X + 1.25	0.94388
33% polyester hollow fibers, 67% cotton	Y = 0.0235 X + 1.026	0.948576

Table (8): Regression equation and correlation coefficient for the effect of wefts number per cm (X) and the ability of produced fabrics to insulate heat (Y), using twill weave structure (3/1).

Fabrics' Blend ratio	Regression equation	Correlation coefficient
100% polyester hollow fibers .	Y = 0.0250 X + 1.415	0.965834
67% polyester hollow fibers, 33% cotton	Y = 0.0175 X + 1.34	0.987976
50% polyester hollow fibers, 50% cotton	Y = 0.0085 X + 1.456	0.928809
33% polyester hollow fibers, 67% cotton	Y = 0.0110 X + 1.331	0.964764

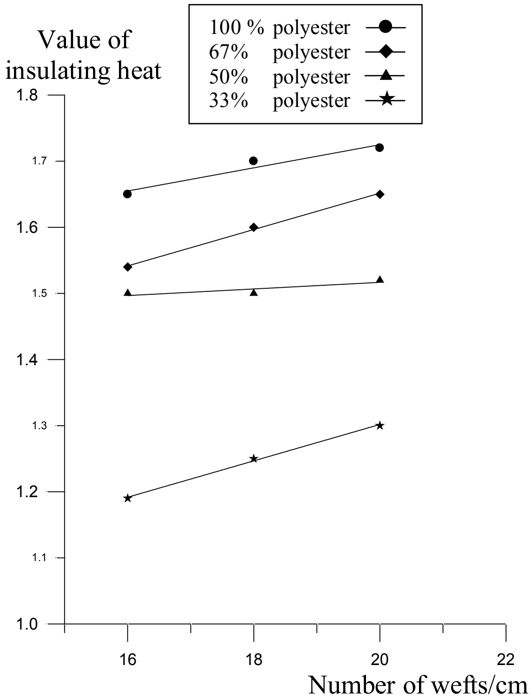

Fig (1):Effect of number picks/cm on thermal insulation for fabrics which produced with plain weave (1/1)

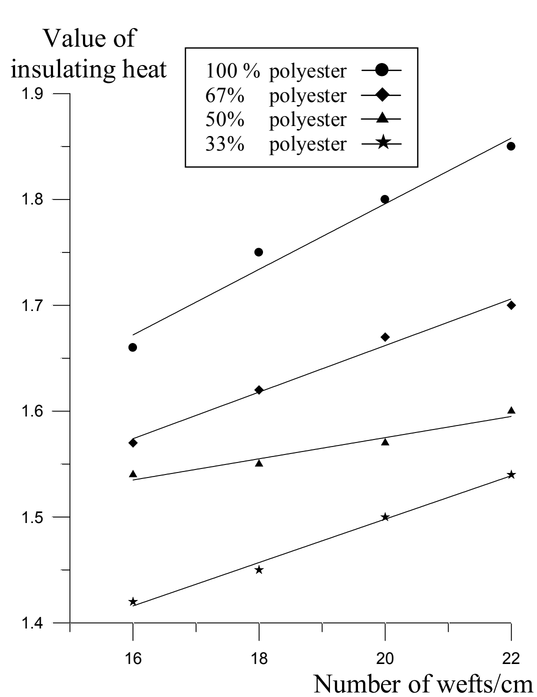

Fig (2):Effect of number picks/cm on thermal insulation for fabrics which produced with twill weave (2/1)

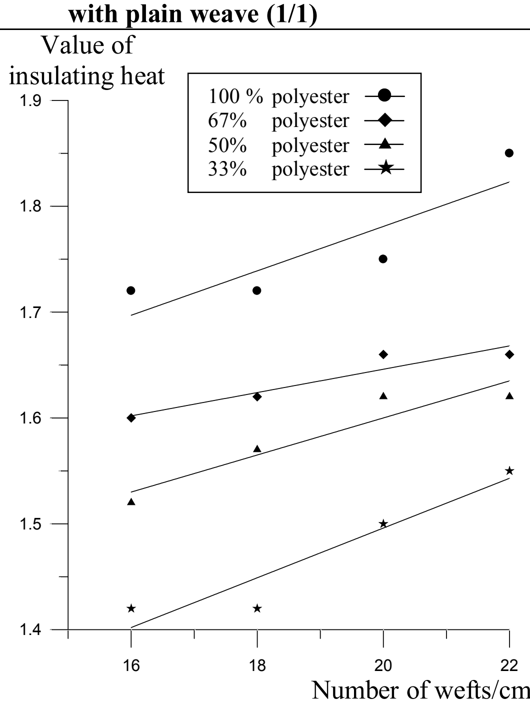

Fig (3):Effect of number picks/cm on thermal insulation for fabrics which produced with twill weave (2/2)

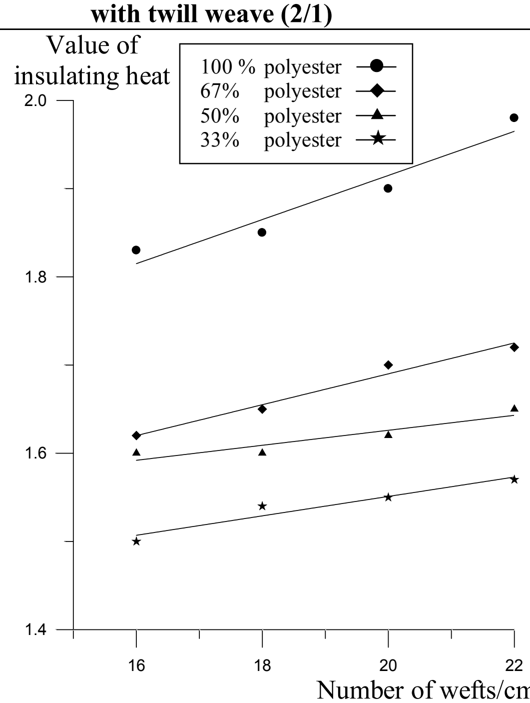

Fig (4):Effect of number picks/cm on thermal insulation for fabrics which produced with twill weave (3/1)

Difference in blending ratio between polyester hollow fibers and cotton fibers:

Table (4) and figures (1-4) showed that: there is an increasing relation between polyester hollow fibers ratio and the thermal insulation, as a result of core space of hollow fibers which contain stagnant air, so it is considered the best natural insulator (all other executional specifications are constant).

Table (9): Multi regression equation for the effect of number of picks per cm (X) and the ratio of polyester hollow fibers (Y) upon the ability of produced fabrics to insulate heat (Z).

Weave structure	Multi regression equation
Plain (1/1)	$Z = -0.0709 + 0.0555\ X + 0.0242\ Y - 0.0009\ X^2 - 0.0001\ Y^2 - 0.00004\ X\ Y$
Twill (2/1)	$Z = 0.9795 + 0.0251\ X + 0.0022\ Y - 0.0005\ X^2 - 0.00002\ Y^2 + 0.0002\ X\ Y$
Twill (2/2)	$Z = 1.3261 - 0.0273\ X + 0.0078\ Y + 0.0013\ X^2 - 0.00002\ Y^2 - 0.00003\ X\ Y$
Twill (3/1)	$Z = 1.8063 - 0.0350\ X - 0.0038\ Y + 0.0009\ X^2 + 0.00003\ Y^2 + 0.0002\ X\ Y$

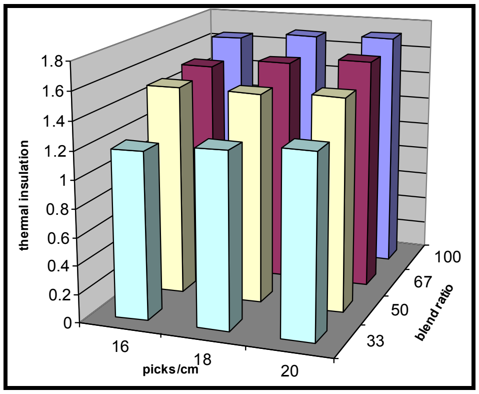

Fig (5): The effect of number of picks per cm and the ratio of polyester hollow fibers upon the ability of produced fabrics to insulate heat for Plain weave 1/1.

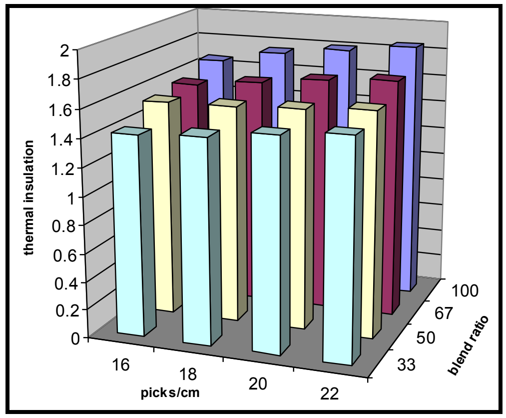

Fig (6): The effect of number of picks per cm and the ratio of polyester hollow fibers upon the ability of produced fabrics to insulate heat for Twill weave 2/1.

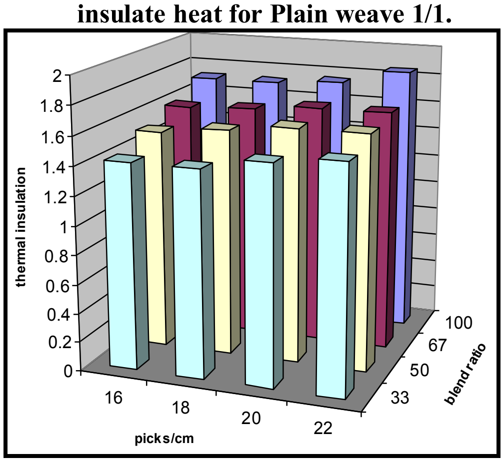

Fig (7): The effect of number of picks per cm and the ratio of polyester hollow fibers upon the ability of produced fabrics to insulate heat for Twill weave 2/2.

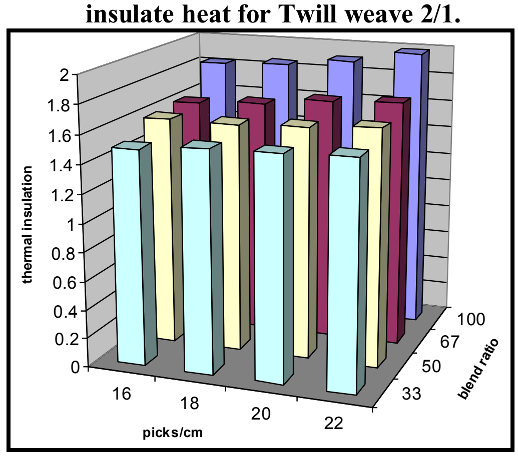

Fig (8): The effect of number of picks per cm and the ratio of polyester hollow fibers upon the ability of produced fabrics to insulate heat for Twill weave 3/1.

Conclusion:

- The study proved that, fabrics produced with twill weave (3/1) verified highest readings where as fabrics produced with plain weave (1/1) recorded the least readings concerning thermal insulation (all other executional specifications are constant).

- There is a great effect from the difference in weft density upon thermal insulation property. The study proved that, the number of picks per cm is directly proportional to the property of thermal insulation (all other executional specifications are constant).
- The study assured that, there is an increasing relation between ration of hollow fibers and the ability of produced fabrics to insulate heat, there for fabrics produced from 100% polyester hollow fibers verified highest readings where as fabrics produced from 33% polyester hollow fibers and 67% cotton fibers recorded the least readings concerning thermal insulation (all other executional specifications are constant).

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References:

1. Mann, S., Barfield, W., (1998) Computational Clothing and Accessories, University of Toron.
2. Shinjung Yoo and Roger L. Barker (2004): Moisture Management Properties of Heat Resistant Workwear Fabrics "Effect of Hydrophilic Finishes and Hygroscopic Fiber Blend", T. R. J., V. 74, N. (11): P. 995.
3. Shinjung Yoo and Roger L. Barker (2005): Comfort Properties of Heat Resistant Protective Workwear in Varying Conditions of Physical Activity and Environment "Thermophysical and Sensorial of Fabrics", T.R.J., V. 75, N. (7): P. 523.
4. طـارق صـالح سـعيد صـالح – بحـث منـشور – مجلـة علـوم وفنون – المجلد السابع عشر – العدد الرابع – جامعة حلوان – اكتوبر 2005.
5. Gore WL. (2003): "Garments & Gloves that protect wearers" The Indian Textile Journal, No. 7, P.136.
6. Chen Y.S., Fan and X. Qlan. (2004): Effect of Garment Fit on Thermal Insulation and Evaporative Resistance, T. R. J., V. 74, N.(8): P. 72.
7. Brownless, Anand, Holmes and Rows (1996): The Dynamics of Moisture Transportation "the effect of wicking on thermal resistance", J. Text. Inst., V.81, No. (1): P.172.
8. Morton W.E. (1975): M.Sc. Tech., F.T.I., Physical Properties of Textile Fibers, University of Manchester, London, Second edition, First published.
9. جيهان ماهر طـه – " استخدام بعض الأليـاف الحديثـة عاليـة الأداء فـي تحـسين الأداء الـوظيفي لبـدل التـدريب العـسكرية الشتوية " - رسالة دكتوراة - كليـة الفنون التطبيقيـة - جامعـة حلوان - 2006م.
10. Wellman, Hollow Fiber, Asmart Blend of Looks & Function, The Indian Textile Journal, July, P. 113, 2002.
11. HVS Murthy, Rahu, Gasai and Prakash (2003): Intelligent Textiles, The Indian Textile Journal, April, P. 29.
12. Manisha A Hira (2003): Fire Resistant Clothing & Its Performance Testing, The Indian Textile Journal, July, P. 39.
13. A.S.T.M. Standard, D 1518 – 98.

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