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A New Objective Method for Comfort Assessment of Sportswear Knitted Fabrics

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ABSTRACT

The aim of this study is to develop a new approach for objective comfort assessment of knitted fabrics used in sportswear industry. The method is based on measurement of various mechanical and heat / mass transfer properties and converting the test results into the axis values to draw multi-axial graphics. The graphic area is used to calculate unitless Total Comfort Value (TCV); the higher the TCV the higher the clothing comfort performance the fabric has.

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KEYWORDS

Knitted fabric, clothing comfort, multi-axial graphic

1. INTRODUCTION

Clothing comfort which influences buyers' choices is complex effect of mechanical and heat/moisture transfer properties of fabrics and garments. As described before, heat/moisture transfer properties of fabrics could be primarily listed as air permeability, water vapor permeability, moisture management and thermal conductivity [1-3] and they are used to assess the thermal comfort; whereas mechanical properties could be described variously as tactile, low-stress, appearance, and durability consisting abrasion resistance, pilling tendency, and wrinkle recovery; used to assess the mechanical comfort [4-8]. There have been various attempts to obtain "comfort indexes" by the objective measurements of those properties since textile industry lacks objective approaches for determining level of comfort and objective measurements of fabric properties allow close prediction of observed comfort [8,9].

This paper introduces a new method using multi-axial graphics to assess the comfort properties of knitted fabrics used in sportswear clothing. The method used the test results of various mechanical and heat /moisture transfer properties. The results were converted to multi-axial graphics for mechanical and heat/moisture transfer properties separately, and the calculated graphic areas (unitless numerical values) were used in comfort index calculation which is named as *Total Comfort Value* (TCV). The higher the TCV, the higher clothing comfort performance the fabric has. The study led to compare clothing comfort of different types of fabrics and the reliability has been confirmed by subjective wear trials.

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2. MATERIAL AND METHOD

2.1 Material

Knitted fabrics were prepared using ring spun cotton (Ne 20/1, Ne 30/1, Ne 40/1), staple polyester (Ne 20/1, Ne 30/1, Ne 40/1) and polypropylene filament (140/72 Denier, 180/72 Denier, 280/72 Denier) yarns. The constructional parameters including yarn arrangements and stitch diagrams are given in Table 1 and 2. All samples were produced on separate circular knitting machines with 22 gauge and 32 ″ diameter for single jersey, 22 gauge and 34 ″ diameter for cross miss, 18 gauge and 34 ″ diameter for double-face and 16 gauge and 34 ″ diameter for stitch transferred knits. The samples were subjected to pretreatment including scouring and rinsing in an uncontrolled industry environment.

2.2 Method

Since many studies related mechanical comfort to different fabric properties which influence formability of fabric, aesthetic appeal, flexibility, wearer's dynamic movements, well-being using the product, visual and tactile quality we used the following properties to assess the mechanical comfort which are also in accordance with earlier studies [4,6,9-11]: the fabric weight and thickness, the wrinkle recovery, the spirality, the bursting behavior, the pilling tendency and the fabric extension under stress (fabric growth). Considering heat / moisture transfer performance we used the followings: capability of the fabric to manage the transport of liquid moisture, water vapor permeability, air permeability, thermal conductivity and thermal absorbtivity; all of were described in details elsewhere [12-15]. Table 3 shows the mechanical and heat / mass transfer properties measurements taken from the samples with the relevant standards at a glance. All the measurements were completed in the standard laboratory climatic conditions and run for five times.

2.2.1. Multi-axial graphics

The tests were used as the axis and before converting the test results to graphics, we have made following assumptions:

1. For mechanical comfort: The lower fabric density (the combination of lower fabric weight and higher thickness) would led to better comfort. The higher wrinkle recovery and fabric growth was related to flexibility; thus related to better comfort. The higher bursting strength and distension, the lower pilling tendency, spirality and dimensional change after laundry were as matter of appearance and quality, thus they were related to better mechanical comfort.

2. For thermal comfort: The higher air permeability, the better transport of liquid moisture, the higher water vapor permeability, the higher thermal conductivity and thermal absorbtivity would give better thermal comfort.

3. All parameters had same contribution on comfort, so any weighting factor is not used

The test results were at different scales so some of them were converted to the same scale (between *0.1 – 10*) by using different coefficients prior using as axis value to make them have similar contributions on graph areas: Bursting strength results were divided by 100, bursting distension by 10, air permeability by 200, relative water vapor permeability by 10, thermal conductivity by 10, thermal absorbtivity by 20 and overall moisture management capability values were multiplied by 10.

The pilling and wrinkle recovery rating scores were used as axis value; if the score was an intermediate value like 2-3, it was used as number with a half, like 2,5.

The reciprocal of the fabric density values were used as axis value. This not only led to convert the value to the mentioned scale but also to associate the low fabric density with better comfort since the reciprocal of lower fabric density gave higher value and that increased the calculated graph area which was used in comfort value calculation. Similarly, the spirality and the dimensional change testing results were converted to axis value by using following Equation (1):

Axis value for spirality and

$$\text{dimensional change: } \frac{1}{[|\,Test\,result\,| + 0,1]} \qquad (1)$$

so that *0* as test result was converted to *10* which is the maximum in selected scale; and the lower test results were converted to higher axis values. Then, unitless multi-axial graph area was calculated by Equation (2):

$$\text{Graph area} = \frac{1}{2} * \left(\sum_{1}^{n}[Axis\ value\ (n-1) * Axis\ value\ n)\right] * \sin((360/n*\pi)/180) \qquad (2)$$

and Total Comfort Value (TCV) was calculated by Equation (3) as offered before [16]:

$$TCV = {}^{1}/_{3}\, C_{mechanical} + {}^{2}/_{3}\, C_{thermal} \qquad (3)$$

where, $C_{mechanical}$ is the area of multi-axial graphic of mechanical properties (mechanical comfort) and $C_{thermal}$ is the area of multi-axial graphic of heat/mass transfer properties (thermal comfort).

Table 1. Sample plan

Sample Code	Knit type	Face Side		Back side	
		Fiber Combination	Yarn Count	Fiber Combination	Yarn Count
1	Single Jersey	100% PP	140/72 Denier	-	
2		100% PES	Ne 20/1	-	
3		100% CO	Ne 20/1	-	
4		100% PP	180/72 Denier	-	
5		100% PES	Ne 30/1	-	
6		100% CO	Ne 30/1	-	
7		100% PP	280/72 Denier	-	
8		100% PES	Ne 40/1	-	
9		100% CO	Ne 40/1	-	
10		25/75% PP/CO	180/72 Denier / Ne 30/1	-	
11		50/50% PP/CO	180/72 Denier / Ne 30/1	-	
12		75/25% PP/CO	180/72 Denier / Ne 30/1	-	
13		25/75% PES/CO	Ne30/1 Ne 30/1	-	
14		50/50% PES/CO	Ne30/1 Ne 30/1	-	
15		75/25% PES/CO	Ne30/1 Ne 30/1	-	
16	Cross miss	100% PP	180/72 Denier	100% PP	180/72 Denier
17		100% PP	180/72 Denier	100% CO	Ne 30/1
18		100% PP	180/72 Denier	50/50% PP/CO	180/72 Denier / Ne 30/1
19		100% CO	Ne 30/1	100% PP	180/72 Denier
20		100% CO	Ne 30/1	100% CO	Ne 30/1
21		100% CO	Ne 30/1	50/50% PP/CO	180/72 Denier / Ne 30/1
22		50/50% PP/CO	180/72 Denier / Ne 30/1	100% PP	180/72 Denier
23		50/50% PP/CO	180/72 Denier / Ne 30/1	100% CO	Ne 30/1
24		50/50% PP/CO	180/72 Denier / Ne 30/1	50/50% PP/CO	180/72 Denier / Ne 30/1
25		100% PES	Ne 30/1	100% PES	Ne 30/1
26		100% PES	Ne 30/1	100% CO	Ne 30/1
27		100% PES	Ne 30/1	50/50% PES/CO	Ne30/1 / Ne 30/1
28		100% CO	Ne 30/1	100% PES	Ne 30/1
29		100% CO	Ne 30/1	50/50% PES/CO	Ne30/1 / Ne 30/1
30		50/50% PES/CO	Ne30/1 / Ne 30/1	100% PES	Ne 30/1
31		50/50% PES/CO	Ne30/1 / Ne 30/1	100% CO	Ne 30/1
32		50/50% PES/CO	Ne30/1 / Ne 30/1	50/50% PES/CO	Ne30/1 / Ne 30/1
33	Double-Face	100% PP	180/72 Denier	100% PP	180/72 Denier
34		100% PP	180/72 Denier	50/50% PP/CO	180/72 Denier / Ne 30/1
35		100% CO	Ne 30/1	100% PP	180/72 Denier
36		50/50% PP/CO	180/72 Denier / Ne 30/1	100% CO	Ne 30/1
37		50/50% PP/CO	180/72 Denier / Ne 30/1	50/50% PP/CO	180/72 Denier / Ne 30/1
38		100% PES	Ne 30/1	100% PES	Ne 30/1
39		100% PES	Ne 30/1	50/50% PES/CO	180/72 Denier / Ne 30/1
40		100% CO	Ne 30/1	100% PES	Ne 30/1
41		100% CO	Ne 30/1	100% CO	Ne 30/1
42		50/50% PES/CO	Ne30/1 / Ne 30/1	100% CO	Ne 30/1
43		50/50% PES/CO	Ne30/1 / Ne 30/1	50/50% PES/CO	Ne30/1 / Ne 30/1
44	Stitch transferred knit (1st report)	100% PP	180/72 Denier	-	
45		100% PES	Ne 30/1	-	
46		100% CO	Ne 30/1	-	
47	Stitch transferred knit (2nd report)	100% PP	180/72 Denier	-	
48		100% PES	Ne 30/1	-	
49		100% CO	Ne 30/1	-	
50	Stitch transferred knit (3rd report)	100% PP	180/72 Denier	-	
51		100% PES	Ne 30/1	-	
52		100% CO	Ne 30/1	-	

Table 2. Stitch diagrams of the samples

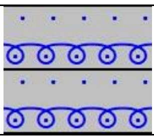
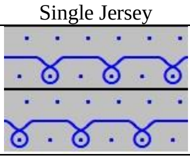
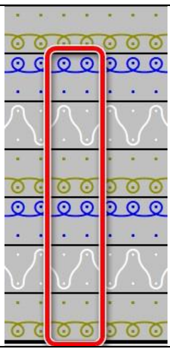
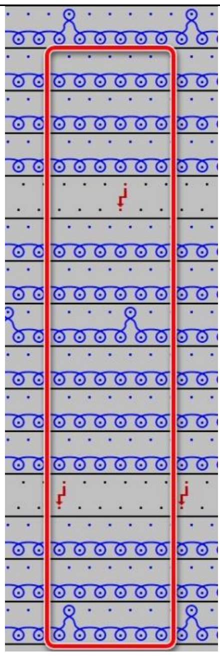
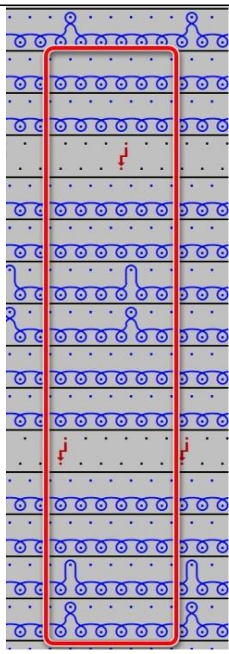
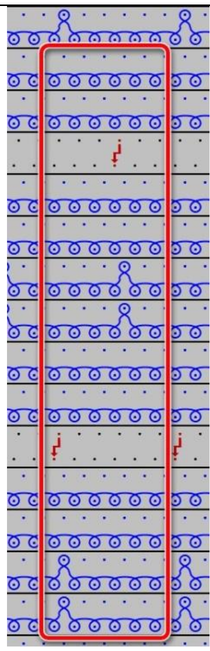
 Single Jersey  Cross miss  Double Face	 Stitch transferred knit (1st report)	 Stitch transferred knit (2nd report)	 Stitch transferred knit (3rd report)

Table 3. The test and measurements

Mechanical properties (Unit)	**Standard / Method**
Fabric weight (g/m^2)	TS EN 12127
Fabric thickness (mm)	ISO EN 5084
Fabric density (g/m^3)	Fabric weight / Fabric thickness
Wrinkle recovery (--)	AATCC 128
Spirality (%)	ISO 16322-2
Bursting strength (kPa) and distention (mm)	ISO 13938-2
Fabric growth in wales and courses (%)	ASTM D 2594
Propensity to pilling (--)	ISO 12945-1
Dimensional changes after laundry in wales and courses (%)	AATCC 135
Heat / mass transfer properties	**Standard / Method**
Air permeability (l/m^2/sec)	ASTM D 737
Overall moisture management capability OMMC (--)	AATCC 195
Thermal conductivity (mW/mK)	The Alambeta instrument standard
Thermal absorbtivity (Ws $^{0.5}$ / m^{-2}K	The Alambeta instrument standard
Relative water vapor permeability (%)	The Permetest instrument standard

3. RESULTS AND DISCUSSION

The average of the test results were used at graphics are given in Table 4a, 4b and 5. All the tests gave CV% values lower than 10%.

Table 4a. Mechanical properties of the samples-part 1

Sample Code	Fabric weight (g/m^2)	Fabric thickness (mm)	Fabric density (g/m^3)	Wrinkle recovery (--)	Spirality (%)	Bursting strength (kPa)
1	241,40	0,65	0,37	3,00	0	604,20
2	186,00	0,54	0,34	3,44	0	478,12
3	181,80	0,65	0,28	2,44	0	241,76
4	191,00	0,52	0,37	2,11	0	475,80
5	146,80	0,47	0,31	3,22	0	275,50
6	141,00	0,51	0,28	2,11	0	191,30
7	153,20	0,52	0,29	3,22	0	377,80
8	102,00	0,39	0,26	3,89	0	249,42
9	113,60	0,49	0,23	2,78	0	171,38
10	149,20	0,53	0,24	2,22	4,8	163,96
11	155,20	0,54	0,28	2,78	5,1	201,66
12	169,60	0,54	0,25	3,22	3,5	178,88
13	144,40	0,51	0,29	2,67	0	207,94
14	148,20	0,47	0,26	3,33	0	185,54
15	148,20	0,48	0,32	3,56	0	241,60
16	242,20	0,79	0,24	2,56	4,8	168,54
17	230,60	0,71	0,28	2,00	0	213,40
18	233,60	0,80	0,25	2,44	0	178,14
19	181,40	0,80	0,32	2,33	0	214,52
20	173,80	0,77	0,26	1,67	0	167,50
21	182,60	0,77	0,31	2,11	0	224,60
22	212,40	0,78	0,31	2,67	0	593,66
23	204,60	0,80	0,32	2,89	0	600,44
24	207,40	0,80	0,29	2,44	0	601,92
25	183,80	0,67	0,23	3,44	3,2	205,58
26	176,80	0,72	0,23	3,44	0	188,66
27	177,80	0,72	0,24	3,78	0	206,46
28	171,00	0,67	0,27	2,89	0	224,08
29	173,60	0,71	0,26	2,89	0	206,40
30	179,60	0,75	0,28	3,56	0	362,86
31	178,20	0,72	0,25	3,22	0	367,08
32	175,60	0,71	0,25	3,67	0	360,40
33	395,60	1,22	0,26	3,22	0	188,68
34	368,80	1,23	0,22	3,67	0	189,62
35	335,40	1,12	0,25	3,44	0	191,08
36	312,00	1,07	0,25	2,89	0	211,94
37	327,60	1,19	0,25	3,22	0	213,10
38	279,60	0,99	0,32	4,11	0	596,48
39	278,80	1,00	0,30	4,11	0	453,94
40	284,00	1,16	0,30	3,11	0	422,66
41	269,40	1,06	0,26	3,89	0	241,54
42	272,20	1,03	0,29	3,89	0	213,20
43	270,40	1,10	0,28	3,44	0	274,28
44	127,40	0,56	0,28	3,56	0	463,84
45	196,60	0,85	0,28	3,78	0	355,74
46	189,60	0,85	0,25	2,89	0	324,78
47	122,60	0,64	0,25	3,00	0	233,42
48	194,60	0,89	0,26	3,44	0	317,24
49	198,40	0,95	0,25	3,78	0	237,88
50	125,00	0,66	0,23	3,00	0	328,88
51	206,00	0,79	0,23	3,22	0	419,00
52	194,60	0,88	0,22	3,67	7,6	206,20

Table 4b. Mechanical properties of the samples-part 2

Sample Code	Bursting distention (mm)	Fabric growth in wales (%)	Fabric growth in courses (%)	Pilling tendency (--)	Dimensional changes in wales (%)	Dimensional changes in courses (%)
1	52,68	4,36	2,05	4-5	-0.2	+0.2
2	37,36	1,79	1,03	1-2	+0.6	-0.8
3	40,28	10,26	4,62	3-4	+4.1	-6.7
4	44,22	2,82	2,05	4-5	+0.6	-0.6
5	32,50	1,28	1,28	1-2	+1.8	+1
6	38,86	8,46	2,82	3	+6.2	-12.2
7	51,88	2,82	1,28	4-5	+1	-0.9
8	41,02	1,03	0,77	2	0	-1.9
9	41,40	4,87	1,54	2	+3	-4
10	39,00	8,21	3,33	4-5	+2.4	-9.6
11	30,38	8,46	3,33	4	+2.3	-7.3
12	33,38	4,10	0,51	4	+2.8	-6.8
13	39,28	7,18	1,54	4	+2.8	-5.7
14	36,92	3,85	1,03	4-5	+0.8	-3.5
15	33,80	3,85	2,05	4	+0.4	-3.1
16	37,30	5,38	2,31	2	+3.6	-11.1
17	31,32	6,92	2,05	2-3	+11.7	-8.5
18	29,66	4,10	0,77	2	+3.5	-4
19	30,50	3,59	1,28	2	+2.1	-6
20	32,24	1,28	0,00	2	+1.8	-5.5
21	37,88	0,77	0,00	2	-0.6	-3
22	48,84	5,13	1,03	4-5	0	-0.2
23	45,02	3,85	1,79	4-5	-0.3	-1.5
24	52,44	4,36	0,77	4-5	+0.6	-0.9
25	38,64	7,95	2,82	4	+1.7	-10.1
26	31,94	10,77	2,56	3	+6.9	-12.7
27	29,72	7,95	3,59	4	+4.8	-10.7
28	37,20	4,36	3,33	4	+2.2	-3.8
29	36,24	7,69	1,79	4-5	+1.4	-5.3
30	39,04	3,08	1,03	2	+0.5	-0.4
31	32,76	4,36	0,26	2	+1.3	-1.3
32	33,30	2,56	0,51	1-2	-0.4	-0.9
33	36,14	6,92	2,82	3-4	+8.8	-10.3
34	35,76	9,23	3,08	4	+6.5	-13.7
35	37,00	7,95	3,85	4	+4.9	-10.2
36	35,50	7,18	1,79	2-3	+2.4	-7.7
37	36,36	3,85	1,03	2-3	+3.6	-5.3
38	49,16	4,10	2,31	4-5	+0.7	-0.9
39	45,98	6,41	2,56	2	+2.1	-2.1
40	37,88	5,64	0,77	2-3	+2	-7.1
41	38,10	7,69	3,33	2-3	+7.8	-15.1
42	29,76	7,44	2,31	2-3	+3.6	-9.8
43	39,18	5,13	2,31	2	+3.2	-5.8
44	39,52	2,31	0,00	4-5	-0.9	-1.3
45	40,12	2,05	0,77	2	+1.5	-1.3
46	33,24	4,87	2,05	4-5	+2.7	-4.8
47	36,56	4,87	3,33	2	+3.6	-11
48	36,50	3,08	2,31	2	+0.7	-6.2
49	33,02	0,77	0,26	2	+1.7	-8.6
50	49,06	5,90	3,08	4-5	+1.9	-2.1
51	43,02	1,54	0,51	2-3	-1.1	-2.6
52	39,46	4,87	2,56	3-4	+7.3	-14.6

Table 5. Heat / mass transfer properties of the samples

Sample Code	Air permeability (l/m²/sec)	OMMC (--)	Thermal conductivity (mW/mK)	Thermal absorbtivity (Ws $^{0.5}$ / m²K)	Relative water vapor permeability (%)
1	421,80	0,5790	32,36	160,24	54,90
2	1106,00	0,4630	29,12	105,14	57,29
3	383,00	0,2684	32,48	113,48	53,44
4	507,00	0,6344	29,66	141,12	55,07
5	1374,00	0,4725	28,28	97,72	54,45
6	356,20	0,6392	28,16	112,76	65,79
7	961,40	0,2681	29,24	122,20	74,88
8	2042,00	0,4003	24,16	94,70	74,57
9	941,20	0,2949	29,40	93,06	67,10
10	1048,00	0,4202	24,52	131,34	68,45
11	668,40	0,6235	25,10	138,32	66,21
12	1437,50	0,6445	26,12	138,94	67,54
13	611,00	0,4566	23,50	130,96	61,30
14	1096,00	0,6251	22,80	123,28	65,70
15	620,00	0,8692	22,48	124,74	62,11
16	1474,00	0,3101	32,90	132,30	67,64
17	583,00	0,4936	33,14	135,14	65,70
18	1672,00	0,3171	34,48	138,62	67,11
19	821,80	0,4395	30,98	115,02	63,58
20	2294,00	0,8146	31,58	116,08	66,50
21	1136,00	0,2402	31,34	120,08	65,49
22	222,40	0,4514	32,98	138,34	58,78
23	331,80	0,5911	33,42	124,30	58,16
24	267,60	0,4978	36,88	109,22	60,69
25	322,00	0,4716	31,86	110,40	59,86
26	402,40	0,6002	33,40	108,94	62,43
27	369,00	0,7075	28,14	105,50	63,36
28	271,20	0,6057	27,76	119,86	59,02
29	361,40	0,3876	34,92	117,00	58,70
30	1021,20	0,3063	35,36	107,94	62,51
31	864,40	0,7784	30,70	110,56	59,24
32	1016,20	0,2034	35,02	111,62	61,52
33	591,40	0,1517	53,34	156,42	66,14
34	387,40	0,7455	46,82	160,72	68,86
35	456,80	0,7558	48,74	148,86	68,34
36	639,60	0,1891	44,24	152,18	64,02
37	701,80	0,7081	44,94	148,58	67,71
38	339,00	0,7559	38,42	126,38	53,77
39	372,40	0,6742	38,80	117,98	54,03
40	483,60	0,6907	39,38	118,90	54,63
41	619,00	0,6686	39,92	124,38	53,16
42	970,60	0,7732	38,32	115,38	53,75
43	537,40	0,7098	40,70	137,60	53,23
44	1042,40	0,6741	29,50	109,46	56,66
45	968,20	0,7582	34,94	111,18	56,58
46	712,60	0,7500	39,06	125,90	53,65
47	859,40	0,2897	27,80	113,84	57,37
48	1048,00	0,6708	35,20	107,70	54,20
49	927,80	0,6175	27,56	119,60	55,96
50	1972,00	0,0456	29,02	107,58	68,78
51	2167,60	0,7756	34,88	107,60	62,21

The multi-axial graphics are given in Figure 1-4; calculated graphic areas and TCV of the samples are given in Table 6.

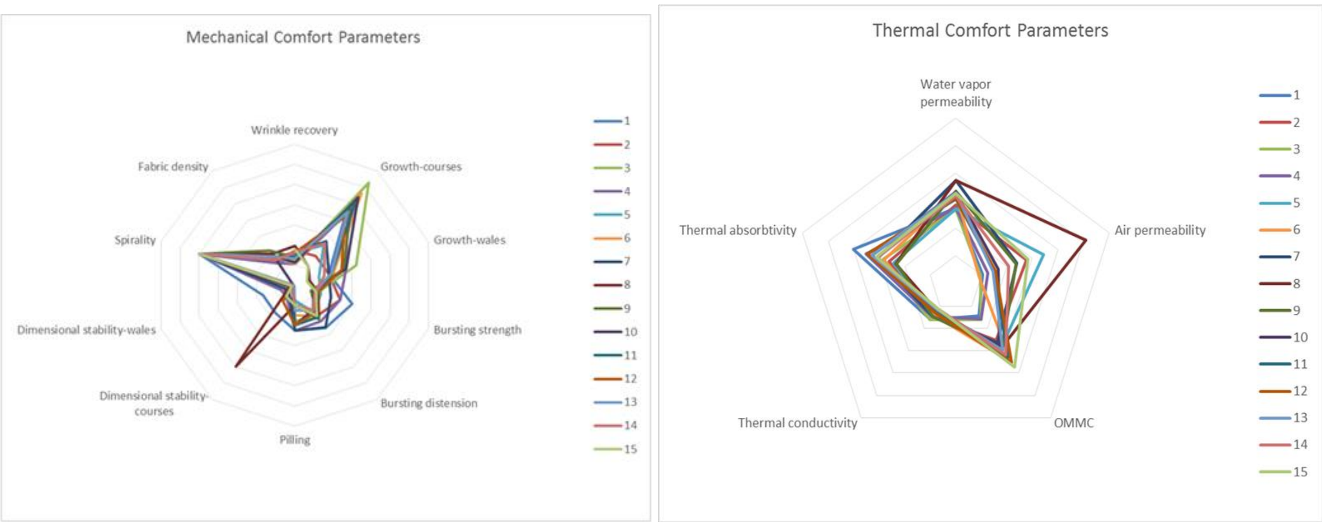


Figure 1. Multi-axial graphics for single jersey samples

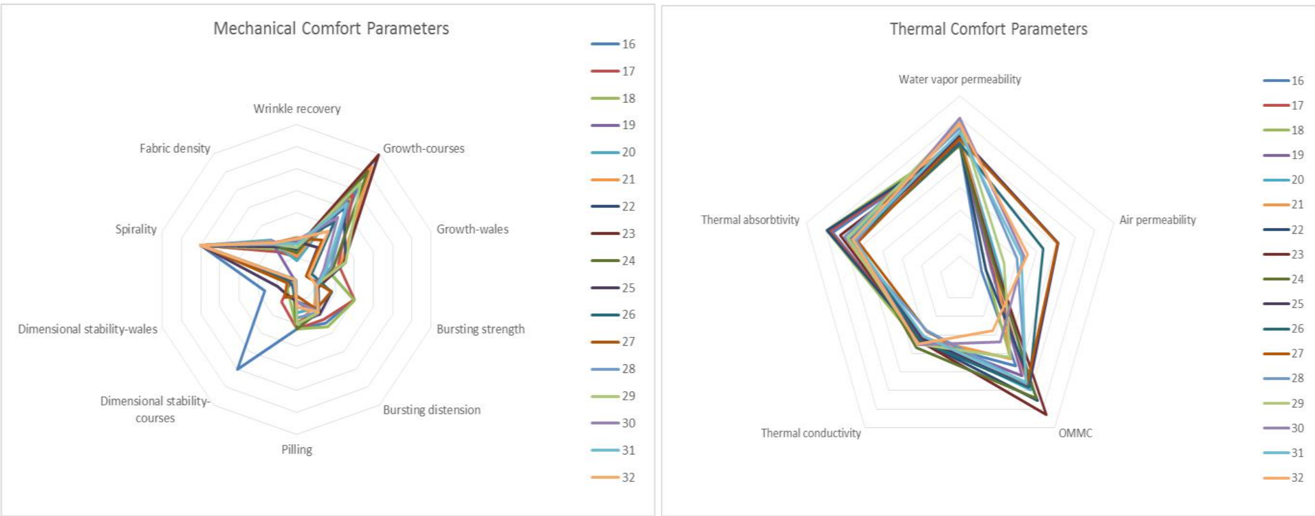


Figure 2. Multi-axial graphics for cross miss samples

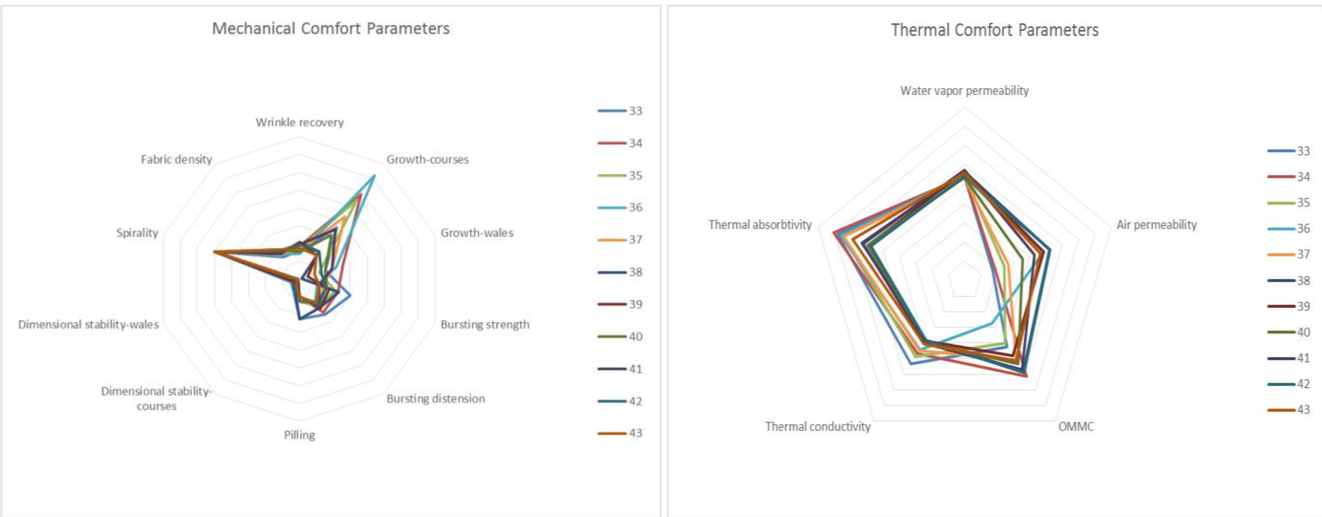


Figure 3. Multi-axial graphics for double-face samples

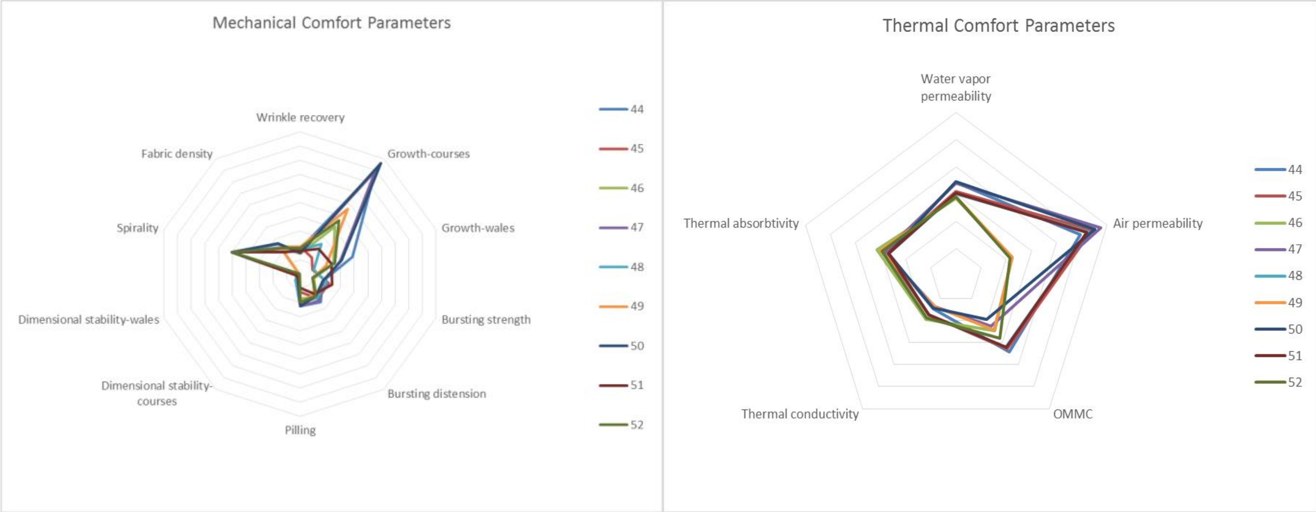


Figure 4. Multi-axial graphics for stitch transferred samples

Table 6. Comfort values of the samples

Knit Type	Sample Code	Graphic Area (Mechanical Properties)	Graphic Area (Thermal Properties)	Total Comfort Value (TCV)
Single Jersey	1	66,84	46,11	53,02
	2	35,28	57,14	49,85
	3	57,98	35,99	43,32
	4	55,67	43,37	47,47
	5	29,96	63,55	52,35
	6	41,78	46,03	44,61
	7	45,09	66,68	59,48
	8	34,57	92,85	73,42
	9	46,14	57,52	53,73
	10	35,68	54,26	48,07
	11	43,28	54,70	50,89
	12	45,69	57,53	53,58
	13	37,41	51,85	47,03
	14	28,41	56,98	47,46
	15	23,63	71,99	55,87
Cross miss	16	82,18	41,75	55,23
	17	55,81	47,50	50,27
	18	53,96	44,81	47,86
	19	28,32	41,07	36,82
	20	49,41	46,55	47,50
	21	48,42	42,75	44,64
	22	43,41	48,49	46,80
	23	56,87	50,82	52,83
	24	47,10	46,63	46,79
	25	34,47	62,88	53,41
	26	35,18	57,35	49,96
	27	32,99	58,56	50,04
	28	39,02	51,35	47,24
	29	50,66	47,72	48,70
	30	36,32	49,17	44,89
	31	38,74	51,13	47,00
	32	30,63	47,74	42,03
Double-Face	33	50,73	58,32	55,79
	34	61,18	62,49	62,05
	35	42,94	56,85	52,21
	36	50,81	59,86	56,85
	37	41,45	58,89	53,07
	38	34,22	67,68	56,53
	39	30,07	59,66	49,80
	40	36,34	54,44	48,40
	41	39,59	63,05	55,23
	42	32,00	64,36	53,57
	43	27,34	65,22	52,59
Stitch transferred	44	97,70	99,72	99,05
	45	34,67	102,77	80,07
	46	32,25	60,63	51,17
	47	86,10	93,70	91,17
	48	41,11	97,16	78,47
	49	39,52	53,34	48,74
	50	88,86	87,51	87,96
	51	40,59	97,49	78,53
	52	51,55	60,37	57,43

From the method used we had the following statements:

1. It is known that synthetic fibers are widely preferred in sportswear market it is contributed to better comfort sensations. The study showed that the TCV value of 100% polyester (PET) and polypropylene (PP) fabrics were higher than that of 100% cotton samples in all knit type in accordance with the sportswear market choice. Within the samples, high TCV values were obtained by PP and PET fabrics with stitch transferred patterns, which also fits well with the latest recent sportswear trends on mesh-structured synthetic fabrics. As observed in single jersey fabrics, TCV

value increased as the synthetic fiber portion in the fabric increases and that is induced greatly by thermal properties. Also as the yarn fineness increased, single jersey fabrics gave better heat/mass transfer (thermal comfort) property but worse mechanical performance (mechanical comfort) which also aggress with the literature [17, 18].

2. For cross miss and double-sided fabrics, the samples with the synthetic face side, which in touch with human skin had higher TCV for cotton face. Also, fabrics with polypropylene face introduced better TCV for polyester face and polypropylene / cotton blends had higher TCV than polyester / cotton blends among double-face knitted samples As the transferred stitch length increases (form 1st report stitches to 3rd report) an important change at TCV was not observed.

3. Among the results, it was also stated that polyester, as a widely used fiber type in sportswear may be replaced with polypropylene fiber with highly acceptable comfort performance.

4. The findings was also revealed with wear trials [19] where 12 male and 12 female volunteers with similar BMI (Body Mass ındex) have worn shirts produced by %100 polypropylene, polyester and cotton single-jersey (Samples 7-9) and stitch transferred fabrics (Sample 44-46). The volunteers were asked to complete a questionnaire for comfort assessment rating the comfort level of 1 – 5 (5 is the most comfortable) after low and high level physical activity. The stitch transferred shirts were rated as “more comfortable” especially after high activity level; and the shirts which were rated more comfortable by the questionnaire after the wear trials have been produced by high TCV fabrics. It was also noted that the differences between TCV values of synthetic and cotton stitch transferred samples was higher than single jersey fabrics which is concluded that the wearer’s subjective perception on separating the comfort level of synthetic and cotton would be easier for stitch transferred fabrics. Wear trials also pointed the same result with higher comfort level rating differences among stitch transferred shirts (lower for cotton).

4. CONCLUSION

This study focused on introducing a new approach on objective comfort assessment of sportswear knitted fabrics. The method compromised various test and analysis of mechanical and thermal (heat / mass transfer) properties of the samples; then the results were converted to axis values to draw multi-axial graphics. The attempt for converting the results was to draw any possible larger area since the area was used to calculate a new value called Total Comfort Value (TCV). It was found that comfort assessment based on TCV agreed with literature findings and latest trend in sportswear industry. The TCV was also verified by wear trials, the study of which is prepared for publication. The future work will be on determining any weighting factors to better understand the effect of fabric parameters on comfort that may be strengthen the method proposed but the current method seems to be satisfying.

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