A NEW APPROACH FOR ASSESSMENT OF POLYPROPYLENE FIBER USAGE IN SPORTSWEAR

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ABSTRACT

In this study, %100 polypropylene, polyester and cotton knitted fabric samples with various knit types were produced and a large group of heat and mass transfer properties of the samples were instrumentally measured with relevant standards. The results were used to assess the suitability of polypropylene fiber usage in sportswear with comparing to polyester and cotton; for this purpose a totally new approach based on multi-axial graph has been applied. This method provided an easy way of thermal comfort assessment of fabrics considering the contribution of all measured parameters and giving mathematical statements of thermal comfort.

Key Words: Polypropylene**,** polyester, cotton, thermal comfort

1. INTRODUCTION

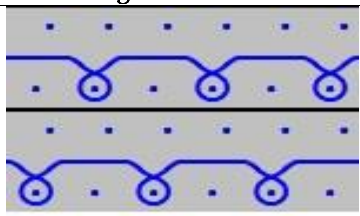
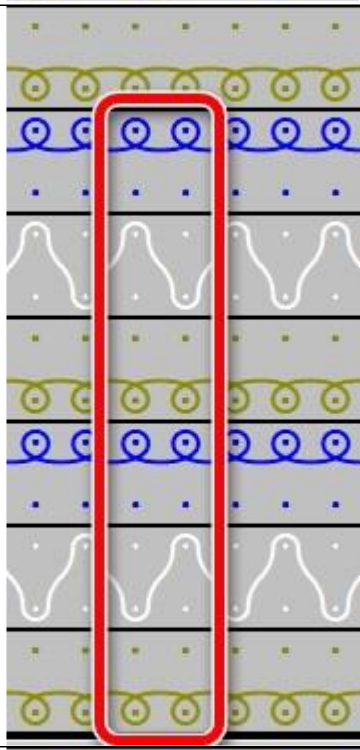
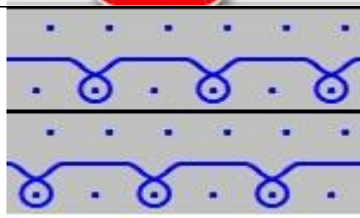
Sportswear should provide sufficient heat, air and moisture transfer; be lightweight and not restrict movement to help wearer to be active and comfortable [1]. Polypropylene, an olefin fiber, is claimed to be suitable for use in sportswear due to its ability to wick moisture away from the body [2, 3], low moisture absorbency, good moisture management, high thermal resistance in wet state, good oleophilic property [4] and high thermal absorptivity [5]. Therefore, polypropylene fiber usage in sportswear is increasing in the last decade but its market share is still low. There is need for detailed assessment of thermal comfort sensation of polypropylene fabrics considering heat and mass transfer properties and comparing them with that of polyester and cotton fabrics which are widely used fiber types in sportswear. This study is an attempt to make the mentioned comparison by using a new approach based on multi-axial graph. For this purpose, polypropylene, polyester and cotton yarns with similar fineness have been employed to produce knitted fabrics, suitable for sportswear, and various heat and mass properties of the fabrics were measured. The measurement results were graphed into multi-axial type, graph areas were calculated and used as objective assessment of thermal comfort.

2. MATERIAL AND METHOD

%100 cotton (Ne 30/1), %100 polyester (PES) staple (Ne 30/1) ring spun and %100 polypropylene (PP) CF yarns (180 / 72 Denier) were employed to produce plain knit (single jersey), 2-yarns fleece (single jersey) and double sided (double jersey) fabrics. The stitch diagrams of the fabrics and structure details are given in Table 1.

All the samples were subjected to mild scouring in industry environment. Since heat and mass transfer properties of fabrics are accepted as thermal comfort components; air permeability (in accordance with ASTM D 737), wicking (in accordance with AATCC 195), water vapour permeability (in accordance with the Permetest instrument standard derived from ISO 11092), thermal conductivity and thermal absorptivity (in accordance with the Alambeta instrument standard) measurements were completed in controlled laboratory environment of about 20°C and 65% R.H. controlled laboratory environment. The water vapour permeability of the samples were characterized with relative water vapour permeability value of the Permetest and wicking with overall moisture management capacity (OMMC) value of the MMT Moisture Management Tester. The measurements were repeated four times and CV% values were lower than 10% in all cases.

Table 1. Details of fabrics

Sample no	**Course x wales**	**Weight (g/m^2)**	**Stitch diagram**
RLCO	10 x 15	141,00	
RLPE		146,80	
RLPP		191,00	
RRCO	11x15	280,80	
RRPE		279,60	
RRPP		395,60	
2-CO	11 x 13	173,80	
2-PE		183,80	
2-PP		242,20	

3. RESULTS AND DISCUSSION

The results of the measurements are given in Table 2. Later, the results were used to draw multi-axial graphs; but since the values were on different scales, normalization was applied to convert them into the same scale: air permeability results were divided by 200, OMMC results were multiplied by 10, relative water permeability and thermal conductivity results were divided by 10 and thermal absorptivity values were divided by 20. The multi-axial graphs are given in Figure 1.

Table 2. Heat and mass transfer measurement results of the samples

Sample	Air permeability (l/m^2/sec)	OMMC*	Relative water vapour permeability (%)	Thermal conductivity (W / m.K)	Thermal absorptivity (W.s$^{1/2}$/m^{2}K)
RLCO	356,200	0,698	65,79	28,160	112,760
RLPE	1374,000	0,575	54,45	28,280	97,720
RLPP	507,000	0,317	55,07	29,660	141,120
RRCO	616,000	0,445	53,16	48,500	148,320
RRPE	1042,400	0,582	55,66	38,420	126,380
RRPP	339,000	0,423	53,77	53,340	156,420
2-CO	402,400	0,595	62,43	31,580	116,080
2-PE	1020,20	0,581	62,51	31,860	110,400
2-PP	222,400	0,468	58,78	32,900	132,300

*** Mean of OMMC values of both sides of the sample**

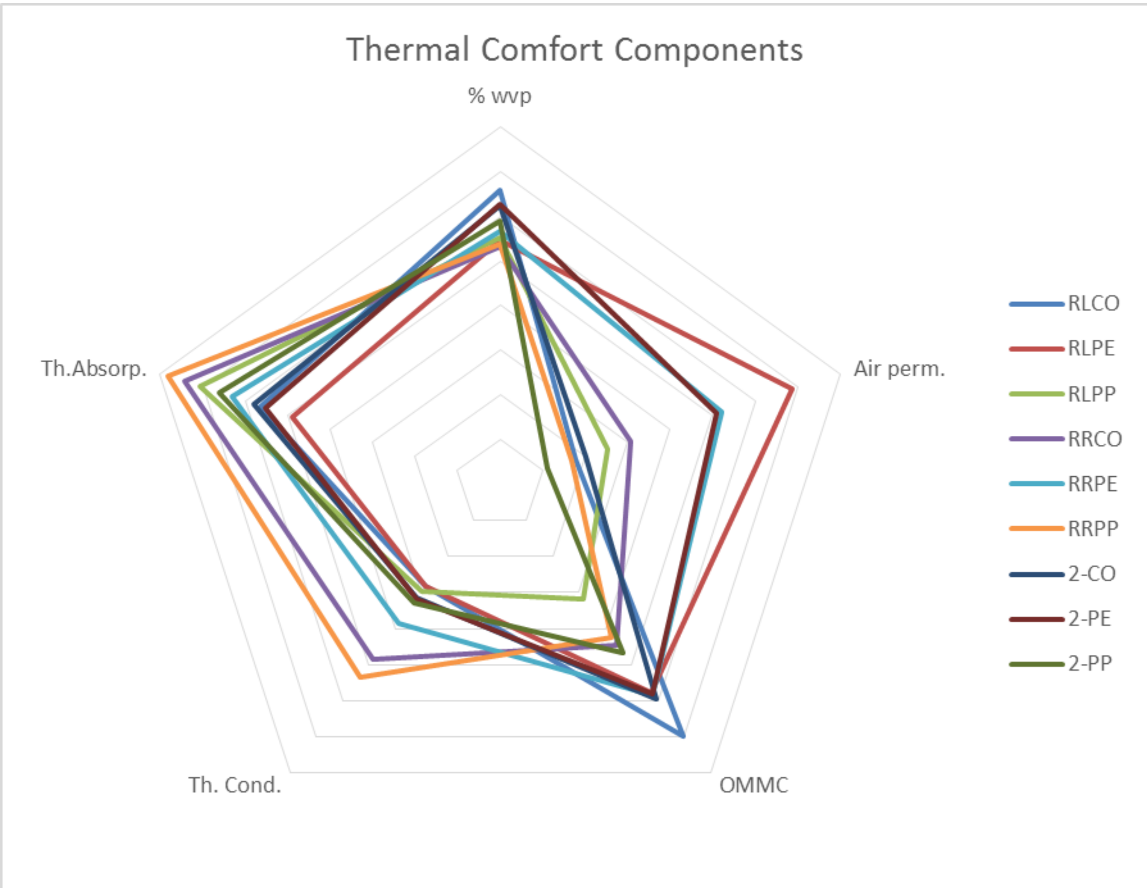


Figure 1. Multi-axial graph of thermal comfort components

The graph area was calculated by simple excel equation and calculations are given in Table 3. The assumption is *the higher the thermal comfort component values, the more the graph area and the more the comfortable the fabric* is. The graph area was taken as objective thermal comfort assessment parameter.

Table 3. The graph area values

Sample	The area (without unit)
RLCO	46,03
RLPE	63,55
RLPP	43,47
RRCO	55,36
RRPE	64,68
RRPP	58,32
2-CO	46,55
2-PE	62,88
2-PP	41,75

Table 3 showed that, among our sample pool, %100 polyester fabrics gave higher thermal comfort performance and it was attributed to mainly high air permeability and good level of moisture management. On the other hand, polypropylene yarns gave satisfying thermal comfort for only double sided structure. Polypropylene samples gave the highest thermal absorptivity but moderate wicking performance.

4. REFERENCES

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