THE HEAT AND MOISTURE TRANSMISSION PROPERTIES OF KNITTED FABRICS

C.H.Jou, C.H.Lin, T.W.Shyr*, S.S.Soong, I.F.Kao, S.C.Yao
China Textile Institute, Taiwan, R.O.C.
*Department of Textile Engineering, Feng Chia University, Taiwan, R.O.C.

INTRODUCTION

Fibre properties and fabric structures are the key factors governing the heat and moisture transmission property of a fabric. In this work, three fibre types viz.: polyester filament (P), coolmax (Co), and mercerized cotton (Cm), and three knitted fabric types: plain, plating plain, and interlock structures were investigated. KES Thermo Labo II and Thermovision were used to measure the heat and moisture transmission properties.

METHOD OF MEASUREMENTS

• Measurement of fabric surface temperature: (T_{fs})

The fabric surface temperature was measured by thermal dynamic images using the Thermovision 900 series instrument. Fabrics were placed on top of the flask which is stationed in a constant temperature bath. Two sets of temperature (35°C and 40°C) were used in the test. The distance between fabric and water was 7 cm.

• Measurement of warm/cool feeling: (q_{max})

The warmth or coolness of fabric surface was measured by the KES system[1] to obtain:

$$q_{max}=\triangle Tf(\lambda)$$

where $\triangle T$ is the initial temperature difference between the heat source and the material, and

$$\lambda = 4.2\sqrt{\frac{\rho ck}{\alpha o}}$$

ρ : Density (g/cm^3) c: Specific heat (J/g.deg)
k : Thermal conductivity (J/cm.deg.sec)
α_o: Heat source constant

• Measurement of fabric thermal resistance (clo)

The fabric thermal resistance values were obtained on the KES system, the test condition was maintained at room temperature 21°C, and air movement at 0.1 m/s[1].

$$1\ clo=0.155^{\circ}C\ m^2/w$$

• Calculation for fabric permeability index (i_m)

The permeability index is a dimensionless expression relate vapor resistance to thermal resistance. The index were measured by KES system[1].

$$i_m = \frac{\text{resistance of material to passage of heat}}{\text{resistance of material to passage of vapor}} \Big/ \frac{\text{resistance of air to passage of heat}}{\text{resistance of air to passage of vapor}}$$

• Calculation for fabric comfort limit (C_{min} , C_{max})

Comfort limit is the range of body activity levels, within which an individual wearing a clothing system is predicted to be thermophysiologically comfort[2].

$$6.46/clo < M_n < 6.46[(Ts-Ta)+14.025\ i_m\ ]/clo$$

where C_{min}=6.46/clo, C_{max}= 6.46[(Ts-Ta)+14.025 i_m]/clo
Ts : 35°C , Ta : 20°C

RESULTS AND DISCUSSION

The surface temperature of fabric specimen were measured at water temperatures 35 ℃ and 40 ℃ , after 5 minutes the measurements were taken . The results are shown in Table 1, and the q_{max}, clo, i_m, C_{min} and C_{max} values are shown in Table 2.

From Table 1, it was observed that the T_{fs} values at 35℃ were Cm>Co>P. The same relationship holds at 40℃. However, the effect of fabric structure on T_{fs} was not found obvious. From Table 2, it was noted that for the q_{max}, C_{min}, and C_{max} values, Cm>P>Co relation applies; but for the clo values it was Co>P>Cm. The i_m values did not appear to be affected by the yarn or fabric parameters, and the effect of fabric structure in this category was again not obvious.

Table 1 Results of fabric surface temperature (T_{fs}) after 5 minutes exposure

fabric / yarn	35℃			40℃		
	plain	plating	Interlock	plain	plating	Interlock
Cm	27	-	27	28.3	-	27.7
Co	26.3	-	26.2	28	-	27.6
P	25.8	-	26.1	26.8	-	26.7
Cm/Co	-	25.8	26.4	-	28	27.2
Cm/P	-	25.4	26.7	-	26.6	27
Co/P	-	25.3	25.9	-	26.5	27.1

Table 2 Results of heat and moisture properties of fabrics

fabric / yarn	clo			im			qmax			comfort limit		
	plain	plating	Interlock	plain	plating	Interlock	plain	plating	Interlock	plain	plating	Interlock
Cm	0.66	-	0.748	0.36	-	0.395	0.142	-	0.111	142~198	-	125~181
Co	0.877	-	0.867	0.5	-	0.463	0.115	-	0.088	109~162	-	112~161
P	0.725	-	0.783	0.345	-	0.487	0.128	-	0.1	132~175	-	123~180
Cm/Co	-	0.833	0.8	-	0.6	0.497	-	0.095	0.116	-	115~181	115~177
Cm/P	-	0.717	0.725	-	0.433	0.4	-	0.108	0.137	-	132~190	132~182
Co/P	-	0.875	0.9	-	0.49	0.665	-	0.087	0.109	-	111~164	107~174

CONCLUSIONS

1. The fibre type was found affecting the heat and moisture transmission properties of knitted fabrics.
2. The effect of fabric structure was not obvious.
3. The measurement of T_{fs} by thermal dynamic image was found practical.

ACKNOWLEDGMENTS

Our special thanks to the Department of Industrial Technology, Ministry of Economic Affairs, ROC, for the financial support of this work, the assistance of the Fabric Formation Department of China Textile Institute was also acknowledged.

REFERENCES

1.Yoneda. M. and Kawabata. S., 1985, Journal of the Textile Machinery Society of Japan, 31(4), 79.
2. S. S. Woo, 1988, Comfort Properties of Nonwoven Fabrics in Extremely Hot and Cold Environments, North Carolina State University.