

## Typical Clothing Ensemble for the Textile Worker

Yang Ruiliang

School of Mechanical Engineering  
Tianjin Polytechnic University  
Tianjin, China  
E-mail: yangruiliang2001@sina.com

Sun Wen

School of Mechanical Engineering  
Tianjin Polytechnic University  
Tianjin, China  
E-mail: 99936313@qq.com

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**Abstract.** Objective: Typical clothing ensemble for the textile worker in the cotton textile workshop was investigated, which can be used to assess the real thermal condition in the cotton textile workshop. Methods: A yearlong survey of typical fabrics and clothing ensembles in four different cotton textile workshops was carried out in 2013. Four seasons were taken into account for this survey and participants included 572 female workers and 288 male workers. Results: Various clothing ensembles for textile workers were listed. The typical material of clothing ensembles and the most typical clothing ensembles for textile workers were investigated and summarized in this paper. Conclusion: The most common material worn by the textile workers was cotton fabrics with high water absorption properties and an increased level of comfort. The most typical clothing ensemble for female worker, with the static value of basic insulation 0.48clo, included short-sleeve shirt, shorts, sandals, bra and panties, half-slip and cap. While the most typical clothing ensemble for the male worker, with static value of the basic insulation 0.39clo, included short-sleeve shirt, shorts, briefs, and sandals.

### Introduction

The type of clothing materials has an influence on the thermal insulation, which is one of the most important parameters in the thermal models adopted by the ASHRAE 55 [1], ISO 7730 [2], and ISO 7933 [3]. However, material type and clothing are rarely investigated during the actual textile workshop [4].

The textile industry is one of the most important industries in China for its huge amount of workers and its substantial output [5]. But the low wages [6] and poor workshop environments [7] led to labor shortages in recent years in China, so it is necessary to research the thermal environment of the Chinese textile workshops, which was investigated by the authors in 2014 [8-9]. But the former research of the authors didn't discuss the type of material and clothing, which is one of the most important parameters in the thermal models [10].

The main objective of this work is to investigate typical types of clothing materials and assess the thermal insulation of those clothing ensembles in the cotton textile workshop.

### Typical Clothing Ensemble for Textile Worker

A yearlong survey of typical fabrics and clothing ensembles in four different cotton textile workshops located in Zhengzhou City (one of China's key textile cities) was carried out in 2013. Four seasons were taken into account for this survey and participants included 572 female workers and 288 male workers, as shown in TABLE I.

Table 1 Personal information of the participants

		Male worker	Female worker	Total
<b>Sample size</b>		288	572	860
Age (years)	Avg.	45.7	42.8	43.8
	Min.	24	24	22
	Max.	55	51	55
Height (cm)	Avg.	169.2	159.8	162.9
	Min.	162	150	150
	Max.	178	165	185
Weight (kg)	Avg.	70.3	58.1	62.2
	Min.	60	48	43
	Max.	82	74	90
Seniority (years)	Avg.	23	18	20
	Min.	2	2	2
	Max.	35	31	33

Because the temperature in the cotton textile workshops is often measured above 300 K throughout the year, the cotton textile workers wear clothing ensembles with minimal thermal insulations. The typical clothing materials worn by textile workers are shown in TABLE II. It can be seen in TABLE II that the most typical material is cotton fabric with high water absorption properties and increased comfort.

Various typical clothing ensembles for textile workers in this survey are shown in Fig. 1. Basic insulation is defined as thermal insulation from the skin's surface to the outer clothing surface in a static condition and is adopted in the thermal models by the ASHRAE 55 [1], ISO 7730 [2], and ISO 7933 [3]. Basic insulation depends on the type of material, the thickness and the body surface area covered. For convenience, the most typical material, average thickness, and common clothing area were the factors that were chosen. The detailed basic insulation of an individual garment is stated in ISO 9920 [11]. Basic insulation for an ensemble ( $I_{cl}$ ) can be estimated based on a summation of the insulation of individual garments using the following empirical equation [11]:

$$I_{cl} = 0.161 + 0.835 \sum I_{clu} \quad (1)$$

Table 2 Typical material of clothing ensembles for textile workers

Sex	Clothing ensembles	Fabrics	Number	Percent
Female worker	Underwear	Cotton fabrics	355	62.1
		Mixed fabric of cotton and polyester	63	11.0
		Polyester fabrics	126	22.0
		Other fabrics	28	4.9
	Shirt	Cotton fabrics	259	45.3
		Mixed fabric of cotton and polyester	130	22.7
		Polyester fabrics	110	19.2
		Other fabrics	73	12.8
	Trousers	Cotton fabrics	261	45.6
		Mixed fabric of cotton and polyester	181	31.6
		Polyester fabrics	74	12.9
		Other fabrics	56	9.9
Male worker	Underwear	Cotton fabrics	161	55.9
		Mixed fabric of cotton and polyester	91	31.6
		Polyester fabrics	6	2.1
		Other fabrics	30	10.4
	Shirt	Cotton fabrics	139	48.3
		Mixed fabric of cotton and polyester	70	24.3
		Polyester fabrics	45	15.6
		Other fabrics	34	11.8
	Trousers	Cotton fabrics	138	47.9
		Mixed fabric of cotton and polyester	85	29.5
		Polyester fabrics	39	13.5
		Other fabrics	26	9.0

where  $I_{clu}$  is the basic insulation of the individual garment. The basic insulation values for various typical ensembles were calculated using Eq. (1), shown in Table 3.

Fig. 1 and TABLE III show the most typical clothing ensemble for female workers, with a basic insulation of 0.48 clo, includes short-sleeve shirt, shorts, sandals, bra and panties, half-slip and cap. Fig. 1 and TABLE III also show the most typical clothing ensemble for male workers, with a basic insulation of 0.39clo, includes short-sleeve shirt, shorts, briefs and sandals. Of the 572 female workers investigated, 52% wore the most typical clothing ensemble (see Fig.2). Of the 288 male workers investigated, 65% wore the most typical clothing ensemble (see Fig.3). The number of workers with the typical clothing ensemble is significantly higher than the number of workers with other types of clothing ensembles, which means it is necessary to research the thermal insulation of the typical clothing ensemble.

Table 3 Various clothing ensembles for textile workers

Ensemble type	No.	Ensemble description	Basic insulation	Number
Typical clothing ensembles for female worker	1	Short-sleeve shirt ( 0.15cloa)	0.48b	298
		Shorts ( 0.06clo)		
		Sandals ( 0.02clo)		
		Bra and panties ( 0.04clo)		
		Half-slip( 0.14clo)		
		Cap( 0.01 clo)		
	2	Short-sleeve shirt ( 0.15clo)	0.39	181
		Shorts ( 0.06clo)		
		Bra and panties( 0.04clo)		
		Sandals ( 0.02clo)		
	3	Short-sleeve shirt (0.15clo)	0.43	43
		Shorts(trousers) (0.06clo)		
		Bra and panties(0.04clo)		
		Socks(0.02clo)		
		Shoes(0.05clo)		
	4	Long-sleeve shirt (0.25clo)	0.65	39
		Fitted trousers (0.22clo)		
		Bra and panties(0.04clo)		
		Socks(0.02clo)		
		Shoes(0.05clo)		
Other ensemble			11	
Total			572	
Typical clothing ensembles for male worker	5	Short-sleeve shirt (0.15clo)	0.39	186
		Shorts (0.06clo)		
		Briefs 0.04clo)		
		Sandals (0.02clo)		
	6	Long-sleeve shirt (0.25clo)	0.65	75
		Fitted trousers (0.22clo)		
		Briefs (0.04clo)		
		Socks(0.02clo)		
		Shoes(0.05clo)		
	Other ensemble			27
Total			288	

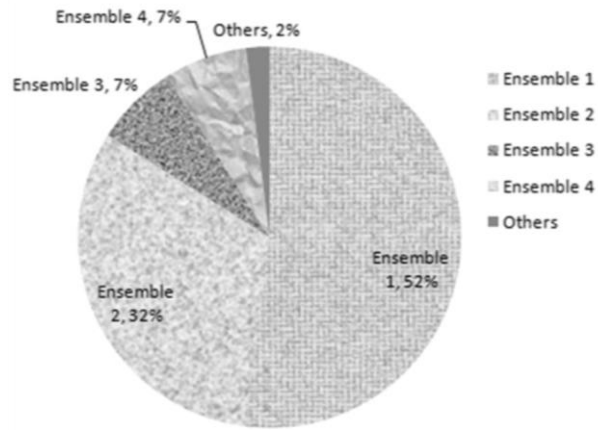
Note: Table notes.

<sup>a</sup> Basic insulation of individual garments was based on the material of cotton fabrics and average thickness.

<sup>b</sup> Basic insulation was estimated based on a summation of the insulation of individual garments using equation (1).

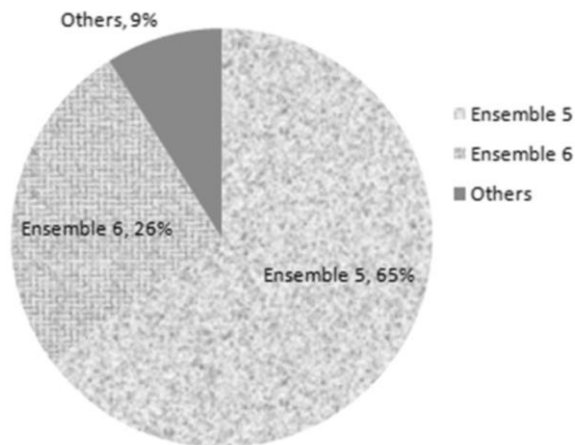


Figure 1. The most typical clothing ensemble for textile workers



Ensemble 1: Short-sleeve shirt, shorts, sandals, bra and panties, half-slip, cap  
 Ensemble 2: Short-sleeve shirt, shorts, bra and panties, sandals  
 Ensemble 3: Short-sleeve shirt, shorts, bra and panties, socks, shoes  
 Ensemble 4: Long-sleeve shirt, fitted trousers, bra and panties, socks, shoes

Figure 2. Various clothing ensembles for female textile workers



Ensemble 5: Short-sleeve shirt, shorts, briefs, sandals  
 Ensemble 6: Long-sleeve shirt, fitted trousers, briefs, socks, shoes

Figure 3. Various clothing ensembles for male textile workers

## Conclusions

The typical types of clothing materials and ensembles of workers in cotton textile workshops were investigated in order to assess their thermal insulation properties. The most common material worn by the textile workers was cotton fabrics with high water absorption properties and an increased level of comfort. The most typical clothing ensemble for female worker, with the static value of basic insulation 0.48clo, included short-sleeve shirt, shorts, sandals, bra and panties, half-slip and cap. While the most typical clothing ensemble for the male worker, with static value of the basic insulation 0.39clo, included short-sleeve shirt, shorts, briefs, and sandals.

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