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RESEARCH AND CHOICE OF THE OPTIMUM STRUCTURE AND HYGIENIC PARAMETERS OF FABRIC OF THE PACK OF SPECIAL CLOTHING FOR WORKERS OF REFRIGERATING SECTIONS

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Abstract: The article deals with the results of research on the choice of a rational pack of fabric for the development of high-quality clothing for workers in refrigerating sections. The optimal composition and thickness of the fabric pack, determined by experimental tests, have been used in the development of special clothing.

Keywords: Refrigerating section, clothing, development, optimal pack of fabrics, optimal composition, hygienic parameters, hygienic properties, package thickness, package composition, top fabric.

INTRODUCTION

The choice of the optimal fabric pack for the development of high-quality special clothing for workers of refrigerating sections is of great importance. The dependence of their hygienic properties on the pack thickness and composition have been studied in order to choose the optimal structure and hygienic parameters of the pack of special clothing materials.

In prepared packs, "Rip-Stop" fabric made of 52% cotton and 48% polyester fibers, developed in Uzbekistan, was selected as a cover fabric, and 3848 article lining fabric made of 100% cotton fiber with linen texture was chosen as lining. Cotton, pressed wadding and padding polyester layers of different thicknesses have been used as the heating layer of the packages. Eight pack variants of the same thickness and different composition were prepared for the experiment, and their thickness limits have been selected based on the research of the fabric pack, accepted in the literature.

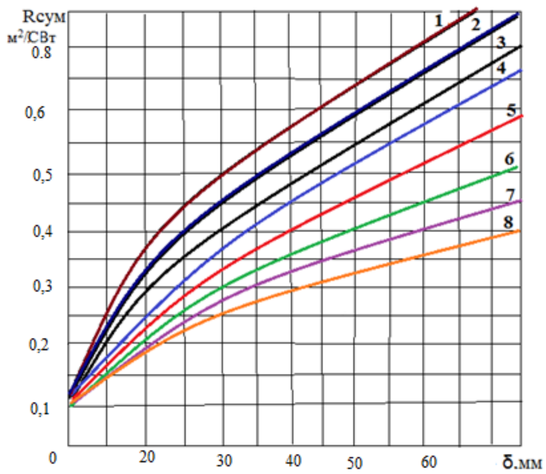
According to the authors [1; 2], the most important parameters in evaluating the hygienic properties of clothing intended for cold climate conditions are total thermal resistance, hygroscopic property, moisture transfer and air permeability. Therefore, the evaluation of the hygienic properties of the samples of the selected pack of fabrics was carried out according to these indicators.

MATERIALS AND METHODS

The comparative assessment of the hygienic properties of the samples of the fabric pack for special heat-protective clothing was carried out in the CentexUZ test laboratory of the Tashkent Institute of Textile and Light Industry.

Hygienic properties of fabric pack made of heating layers with different fiber composition were tested. In order to evaluate the effectiveness of the developed packs, a comparative analysis of the thermal resistance of packs with different insulating layers was carried out. Padding polyester, cotton, wool and silk were chosen as the materials of the heating layer in the prepared packs. Attention was also paid to the arrangement sequence of the heating material layers in the test packages.

According to TR TS 019/2011 technical regulation, the total thermal resistance of the pack should not be lower than 0.50 $^{\circ}C{\bullet}m^2/W$, considering the air temperature of the special clothing for low temperatures, the time of continuous operation in cold weather, the air permeability of the outside fabric and the severity of the work to be performed.



Thickness of the pack

Fig. 1. Dependence of the total thermal resistance of test packs with different composition on the content of the fabric pack

1 – pressed wool; 2 – wool + cotton; 3 – wool + padding polyester; 4 –batting; 5 – cotton; 6 – cotton + padding polyester; 7 – cotton + silk; 8 –padding polyester

From Fig. 1 it can be seen that the fabric pack consisting of 100% pressed wool has a higher total thermal resistance compared to other thermal insulation fabrics.

The positive features of the woolen heating layer material are its durability and longevity. Unlike many traditional insulation fabrics, wool can be used for a long time and does not lose its positive qualities during washing. The results of the study show that the most important properties of the wool filler are preserved.

Thereby, the results of the conducted research allow choosing the optimal composition of the package of special clothing materials. The analysis showed that the thermal resistance indicators of the material package, which composition consists of 100% pressed wool, are much higher than other test samples.

At the next stage, studies were conducted on choosing the optimal thickness of the package of materials with the selected composition. Samples of different thicknesses of the material package were prepared, the composition of which is 100% pressed wool. The hygienic properties of the prepared test samples were studied depending on their thickness. Six variants of packs with different thicknesses were prepared, and the limits of their thickness variation were determined based on the analysis of the literature [1; 2; 7].

RESULT AND DISCUSSION

In order to determine the thickness of the samples of the fabric packs, a TTM device was used, which allows measuring textile fabrics with a thickness of 0.1 to 400 mm with an accuracy of ± 0.001 mm. The thickness of the samples of the fabric pack was carried out under a pressure equal to R=196 Pa (2 gs/cm^2). As an indicator of the thickness of the samples of the material package, the average of six measurements was taken as the arithmetic value with rounding of 0.01. The measurement results are given in Table 1.

Table 1

Results of experiments conducted in the "CentexUZ" testing laboratory in order to determine the thickness of fabric pack samples

No.	Measurement results, mm						Average value, mm
	1	2	3	4	5	6	
1	17.96	17.06	17.11	17.99	17.97	17.01	17.52
2	20.80	20.84	20.89	20.82	21. 03	21.08	20.87
3	26.32	26.39	27.16	26.54	26.62	27.35	26.73
4	31.35	31.55	32.0 9	31.43	31.51	31. 57	31.46
5	39.91	39.11	39.32	40.41	40.33	40.22	39.88
6	45.24	44.46	44.56	45.34	43.67	43.82	44.85

Scientific research [1; 2; 6-7] have shown that the most important parameters in evaluating the hygienic properties of clothing intended for cold weather conditions are their total thermal resistance, hygroscopic property, moisture permeability and air permeability. Therefore, these indicators were adopted when evaluating the hygienic properties of the selected fabrics.

The total thermal resistance of packs was calculated according to the following formula:

$$R_c = \frac{\delta}{\lambda}, \quad [m^2 \cdot {}^0C/W] \qquad (1)$$

where:δ isthickness of fabric pack, mm; λis thermal conductivity coefficient of fabric, W/degree, m.

The dependence of the total thermal resistance of the fabric pack on their thickness is shown in Fig. 2.

Table 2.

Hygienic properties of fabric pack of different thicknesses selected for special clothing

No.	Thickness of the fabric pack, mm	Total thermal resistance, m^2°C/W	Hygroscopic ability, %	Moisture transfer, %	Air permeability, dm^3/m^2 s
1	17.52	0.107	13	90.29	49.36
2	20.87	0.243	13	91.01	41.03
3	26.73	0.321	13	91.52	34.30
4	31.46	0.415	14	92.98	29.77

5	39.88	0.496	15	93.19	19.53
6	44.85	0.547	19	96.32	10. 13

The calculated and tabulated values of F-criterion were 425.85 and 5.32, respectively ($F_{calc}>F_{0.95}$), which indicates the reliability of calculations for equation (1).

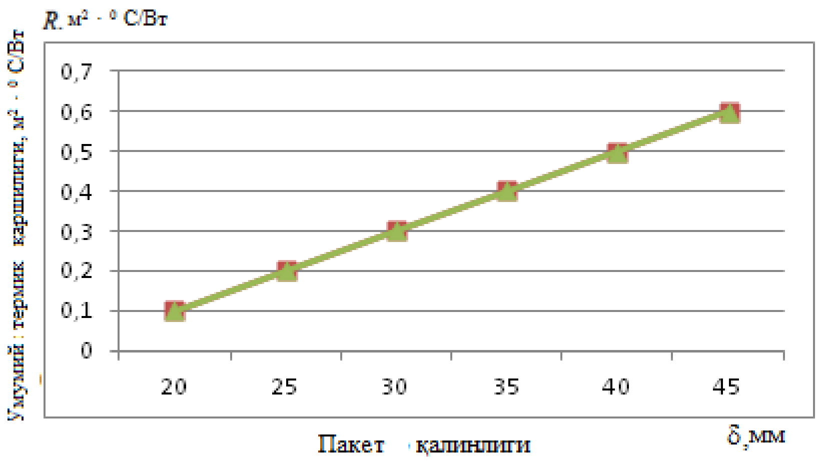


Fig. 2. Dependence of the total thermal resistance of the fabric pack on thickness

The worker sweats when he performs heavy work, so the moisture permeability of the clothing fabric pack plays an important role in the formation of thermal conditionof the person. The main methods of removing moisture from the surface of the human body are the removal of moisture through the air layer under the clothing and the absorption of moisture because of direct contact of the wet body with the fabric. The ability to release steam and moisture from the clothing area is characterized by its hygroscopic ability. The hygroscopic ability of the test samples was carried out in accordance with GOST 3816-61. The hygroscopic ability of the fabric pack was determined according to the following formula:

$$W_г = \frac{m_в - m_c}{m_c} 100\%, \ \% \qquad (2)$$

where $m_в$ isthe wet mass of the sample, g; m_c isthe dry mass of the sample, g.

The test results are given in Table 2. The dependence of the hygroscopic ability of the fabric pack on their thickness is shown in Fig. 3. The calculated and tabulated values of F-criterion were 1148.16 and 5.32, respectively ($F_{calc}>F_{0.95}$), which indicates the reliability of calculations for equation (2).

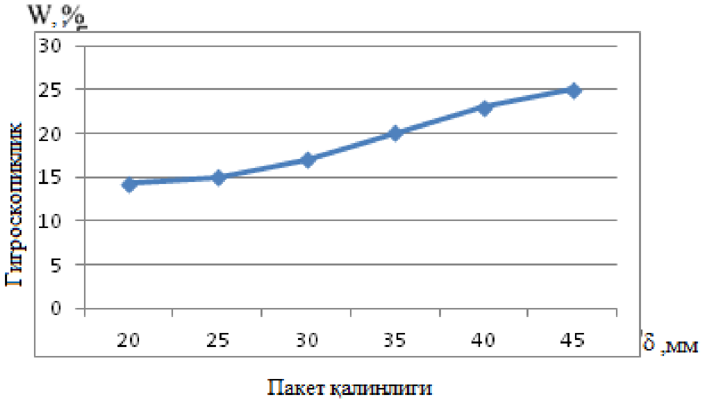


Fig. 3. Dependence of the hygroscopic ability of the fabric pack on thickness

The moisture transfer index of the fabric pack is determined by the following formula:

$$W_o = \frac{m_в - m_{с.э.}}{m_в - m_с} 100\%, \ \% \qquad (3)$$

where $m_{сэ}$ ismass of the sample kept in a dry desiccator for 4 hours, g.

The test results are given in Table 2. The dependence of the moisture transfer index of the fabric pack on their thickness is shown in Fig. 4. The calculated and tabulated values of F-criterion were 533.08 and 5.32, respectively ($F_{calc}>F_{0.95}$), which indicates the reliability of calculations for equation (3).

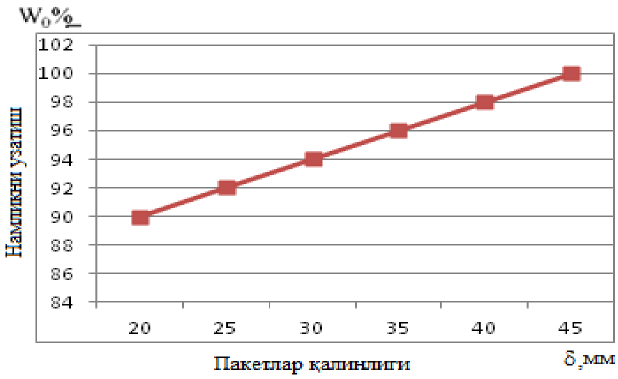


Fig. 4. Dependence of the moisture transfer of the fabric pack on thickness

The air permeability of the fabric pack was determined according to GOST 12088-77 [6] at a pressure change of 49 Pa on the AP-360 SM device. The air permeability of each sample was calculated according to the following formula:

$$B = \frac{V_{cp} \cdot 10000}{S}, \ dm^3/m^2s \qquad (4)$$

where V_{cp} isaverage air flow per sample, dm^3 s; S isthe area of the test sample, m^2.The results of the tests are given in Table 2. Processing of the results was carried out by the method of least squares [8]. The calculated and tabulated values of F-criterion were 65.03 and 5.32, respectively ($F_{calc}>F_{0.95}$), which indicates the reliability of calculations for equation (4). Air permeability of the material package as a function of their thickness is shown in Fig. 5.

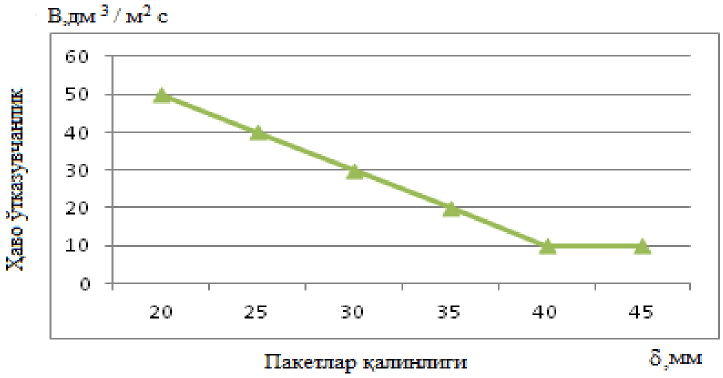


Fig. 5. Dependence of the air permeability of the fabric pack on thickness

CONCLUSION

Derived results allow choosing the optimal thickness of the fabric pack for the special clothing for workers of refrigerating section. The analysis of the research results of the fabric packs showed that the total thermal resistance of the samples with a thickness of 30 mm is R=0.38 $m^{2} \cdot {}^{0}C/Wm$ and fabric pack of this thickness can be recommended for special clothing of workers of refrigerating sections working at low temperatures 0°to5°C.The total thermal resistance of samples with a thickness of 35 mm is R=0.51 $m^{2} \cdot {}^{0}C/W$, fabric pack with such a thickness is recommended for the preparation of special clothing for workers of refrigerating section working at low air temperatures from 0° to -15°C. Thereby, at the next stage, in the development of special clothing construction for cold storage workers, it will be appropriate to use packages of materials with a thickness of exactly 30 mm and 35 mm.

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