THE OBJECTIVE OF THIS STUDY IS TO EXAMINE THE EFFICACY OF THE ULTRASONIC WELDING PROCESS FOR JOINING TEXTILE POLYMER MATERIALS.

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A new technological way to connect textile polymeric materials - ultrasonic welding, the results of research welds com- pound textile materials strength of the breaking load.

Ultrasonic welding represents a novel technological approach to the joining of materials, situated between the domains of welding and pressure welding. The scope of applications for ultrasonic welding is more extensive than that of high-frequency and thermal contact welding. The method can be employed to join textiles comprising a range of thermoplastic fibers. The principal advantages of ultrasonic technologies are their simplicity of application, absence of consumables, and ease of automation, which allows for the integration of ultrasonic welding modules into technological lines. The most significant benefit is the environmentally friendly nature of the processes, which renders these technologies an attractive proposition in the context of modern production.

In ultrasonic welding, the materials are subjected to heating in the joint zone as a consequence of their elastic vibrations at an ultrasonic frequency. In this method, materials are bonded by forming a number of welded points of a given size. A distinctive feature of ultrasonic welding is the localized directionality of heat influence, which results in the absence of deformation and stress, as well as the stability of the welding quality. Furthermore, the process does not generate heat or light radiation, and the material is not brought to a molten state. The utilization of ultrasound enables the welding of both homogeneous and heterogeneous materials of varying thicknesses, obviating the necessity for surface preparation. Ultrasonic welding is particularly valuable in that it is the only reliable method of joining a number of materials. The optimal welding time for each product type is determined by the processing of the technological modes. The duration of the ultrasonic exposure varies considerably, from a fraction of a second to several seconds. Furthermore, ultrasonic technology can be employed to weld synthetic leather in the light industry. Artificial leathers are produced by applying a polymer material to a woven backing made of natural or synthetic fibers.

Of the current range of IRs, 70% are PVC-coated leathers. The PVC coating is a multi-component system that includes additives.

The primary objective when joining materials is to create joints that exhibit optimal strength. It is essential that the equipment is capable of producing such seams in an efficient and productive manner. The strength of a seam is defined by a set of parameters, the number and nature of which depend on the type of joining method employed.

The process of ultrasonic welding of synthetic fibrous materials is initiated by the application of mechanical vibrations of ultrasonic frequency to the material, which causes it to deform. This results in the formation of a weld with a certain intrinsic strength [3].

The duration of the welding process is contingent upon the aforementioned variables, namely the thickness of the material, the dimensions of the welding area, the chemical composition, and the concentration of synthetic fibers.

The process of ultrasonic welding of synthetic fiber materials is characterized by the following main parameters:

(a) Vibration amplitude A; (b) Welding force F; (c) Welding time t; (d) Fixed gap σ [4].

In addition, the strength of the welded joint and the productivity of the equipment are influenced by the physical and chemical properties of the welded material. These properties include material density, sound velocity in the material, coefficient of vibration damping in the material, chemical composition, heat capacity, heat permeability, melting point, and so forth. These physical and chemical properties influence the strength of the welded joint and equipment performance. [5] Furthermore, the dimensions of the support, the material thickness, the dimensions of the weld, and the type of weld deformation were considered.

In connection with the aforementioned considerations, an investigation was conducted into the strength of textile material joints subjected to tensile forces. A range of natural textile materials with varying percentages of polyester fibers were selected for the experiments (Table 1).

Table 1 - Textile materials with different compositions

tem No.	Fiber composition of textile materials- fiber composition of textile materials, %
1	45%-cotton, 55%-p/e
2	40%-cotton, 60%-p/e
3	35%-cotton, 65%-p/e

4	30%-linen, 70%-p/e
5	60%-linen, 40%-p/e
6	70% linen, 30% p/e
7	100%-p/e
8	100%-p/e
9	100% p/e

A special device for manual ultrasonic welding UHG1000 is used, which consists of: waveguide, transducer, handle, transducer screw clamp, ultrasonic trigger switch, suspension strap, control element and RF cable. Table 2 shows the technical characteristics of the generator.

Table 2 - Technical characteristics of the sg3510 generator

Parameters	Value
Supply voltage /	230V, ±15%, 50/60Hz
frequency	35kHz
Operating frequency	1000Weff.
Max. output power	max. 50% at 1000W
Response time	290x 310x 105mm
Dimensions (w*d*h)	approx. 3.3kg
Weight (incl. housing)	0,1-3s

Figure 1 shows the HANDY STAR ultrasound equipment and Figure 2 shows the sonotrode (waveguide).

Fig. 1 - HANDY STAR 35kHz 1000W equipment

Fig. 2 - Sonotrodes (waveguide)

The test was carried out in accordance with the requirements of GOST 3813-82. "Textile materials. Fabrics and piece goods. Methods of determination of tensile breaking characteristics" on the breaking machine "Universal testing machine - UXLVM". The physical-mechanical characteristics of the welded seam strength by weft and by backing are presented in Table 3.

Table 3 - Physical-mechanical characteristics of the welded seam

n/a	Fiber composition	Surface density, g/m²	Ultrasonic welding time, sec. welding time, sec	Breaking load of samples fabrics, N
	cotton-45 per cent PE-55 per cent	106	8; 7; 6	91,7
			10; 7; 7	137,3
	cotton -40% PE-60%	118	7; 6; 6	149,4
			8; 9; 9	190,4
	cotton -35% PE-65%	162	10; 7; 6	221,0
			7; 7; 6	211,7
	linen-30% PE-70%	180	7; 9; 7	216,3
			7; 9; 7	157,2
	linen-60% PE-40%	201	9; 7; 7	165,3
			7; 7; 7	431,2
	linen-70% PE-30%	177	9; 6; 6	126,5
			11; 6; 6	128,0
	PE-100%	110	7; 7; 8	329,2
			8; 7; 8	278,2
	PE-100%	1	9; 8; 8	25,9

		43	9; 8; 7	23,2
	PE-100%	1 51	8; 9; 9	105,3
			8; 9; 9	174,8

According to the results of experiments it is possible to establish the influence of mixture composition on the strength of ultrasonic weld; as well as the dependence of weld strength on the time of ultrasound exposure.

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