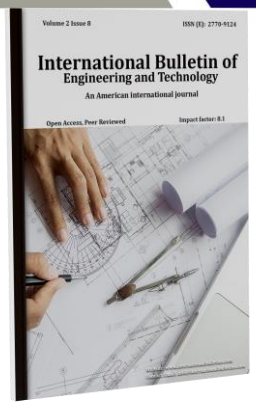

PHYSICAL AND MECHANICAL PROPERTIES OF NON-WOVEN THERMAL-BONDED MATERIALS

S.Patkhullayev
N.Islambekova

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Annotation. The influence of the main technological parameters and the content of modifiers and plasticizers on the physical and mechanical properties of non-woven thermally bonded materials has been studied. The optimal values for the content of binder, plasticizer, modifier, catalyst and thermal bonding conditions have been established

The development of technology for thermal bonding of chemical fibers requires solving the problem of increasing their adhesive ability.

To do this, it is necessary to develop an effective method for modifying the surface of industrial chemical fibers, which will increase the strength of adhesive joints and improve the properties of non-woven thermally bonded materials based on them.

To evaluate the performance properties of fibers and nonwovens produced by thermal bonding, tests were carried out in accordance with standard methods. IR spectroscopy methods were used to assess the physicochemical properties of modifiers.

The most well-known theories of polymer adhesion are considered: adsorption, diffusion, chemical, electrical, which explain in different ways the mechanism of formation of adhesive bonds.

The amount of adhesion depends not only on the presence, but also on the number of bonds between the contacting bodies. In turn, the number of bonds is determined by the contact area between the adhesive and the substrate. The most important factors influencing the strength of the adhesive bond are: temperature, pressure, contact time, polymer compatibility, molecular weight, crystallinity, surface topography, etc. All methods of increasing the adhesive ability of polymers come down to activation, aimed at changing the morphology and energy state of the fiber surface, and modification, based on the introduction of various functional groups into the surface layers of the polymer. Chemical fibers generally have low adhesive ability. One of the promising methods is to modify the surface of chemical silicon fibers with organic compounds, in particular oligovinylethoxysiloxanes.

It has been shown that for the production of non-woven thermally bonded materials with increased physical and mechanical properties, it is relevant to develop new, effective and inexpensive modifiers from domestic raw materials for industrial chemical fibers and binders that increase their adhesive ability.

The effect of processing polypropylene and polyester fibers, as well as the binder - thermoplastic polyamide powder, with organosilicon modifiers and industrial plasticizers - dibutyl phthalate and dioctyl sebacate on their deformation-strength properties - has been studied.

It has been shown that treating chemical fibers and polyamide powder with plasticizers in a small amount (up to 2 wt. %) increases the breaking load by 20% and the elongation at break by 10%. With a further increase in the content of plasticizers, the

deformation-strength properties of fibers and powder deteriorate, which is associated with a significant decrease in intermolecular interaction and viscosity of the fiber polymer and binder. Optimal technological parameters for processing chemical fibers and binders with plasticizers were obtained: a) for polypropylene fiber: DOC content - 2-2 .5 wt.%; b) for polyester fiber: DOS content - 1.5-2% by weight; b) for polyamide powder: DWF content - 1.5-2% wt.

The influence of the main technological parameters and the content of modifiers and plasticizers on the deformation-strength properties of non-woven thermally bonded materials obtained using binders and the autohesive bonding method was studied. It has been established that the dependences of breaking load, elastic modulus, stiffness and elongation at break are extreme. It has been shown that an increase in the binder content in the fibrous web leads to an increase in the number of gluings in the nonwoven material and, as a consequence, an increase in the breaking load and a decrease in elongation at break. Increasing the temperature and pressing pressure to the optimal value also helps to increase the deformation-strength properties of the nonwoven material, which is explained by the increase in the adhesive strength of the adhesives and their quantity in the canvas. With a further increase in temperature and pressure, partial destruction of the binder polymer occurs, a decrease in the strength of the adhesives, or the destruction of some of the adhesives in the non-woven material.

It was revealed that the process of plasticization of the surface layer of fibers intensifies the interdiffusion of macromolecules of the connected fibers, and as a result increases the strength of adhesive bonds and the deformation-strength properties of the nonwoven material. Decrease in temperature. melting of the fiber contributes to an increase in the intensity of thermal movement of its molecules and their segments, which in turn leads to accelerated diffusion and better interaction of contacting surfaces.

A further increase in the plasticizer content leads to a decrease in the cohesive strength of chemical fibers and binders and the strength of their adhesive connections in the material.

The optimal conditions for the production of non-woven thermally bonded materials from plasticizer-treated chemical fibers and binders have been determined. The influence of the content of decavinyl dodecaethoxysiloxane (compound (IV)), as the most effective, on the physical and mechanical properties of non-woven thermally bonded materials from polyester fibers obtained using either polypropylene fibers as a binder has been studied. fibers, or thermoplastic polyamide powder, as well as non-woven materials from polyester and polypropylene fibers obtained by autohesive bonding. Research has shown that the dependences of breaking load, elongation at break, elastic modulus, and rigidity of nonwoven materials on the content of compound (IV) are extreme. In addition to chemical bonds, which increase the strength of adhesive connections at the contact boundary, physical forces (dispersion, orientation, induction) also act.

The optimal conditions for producing non-woven thermally bonded materials with increased physical and mechanical properties from polypropylene and polyester fibers and polyamide powder modified with decavinyl dodecaethoxysiloxane were determined:

a) non-woven material made of polypropylene fibers: modifier content - 0.2% by weight; catalyst content - 1.5% wt, mod.; pressing temperature - 155 °C; pressing pressure - 4.0 MPa; canvas feed speed - 7 m/min;

b) non-woven material made of polyester fibers: modifier content - 0.2-0.25% by weight; catalyst content - 1.5% wt, mod; pressing temperature - 230°C; pressing pressure - 2.0 MPa; canvas feed speed - 7 m/min;

v) non-woven material made of polyester fiber and polyamide powder: modifier content - 0.25% by weight; binder content -45% mass; heat treatment temperature – 1200C; pressing temperature - 130 °C; pressing pressure - 3.5 MPa; canvas feeding speed -7 m/min

g) non-woven material made from a mixture of polyester and polypropylene fibers: modifier content -0.25% mass; catalyst content -1.5% wt, mod.; binder content -35% mass; pressing temperature - 160 °C; pressing pressure - 4.0 MPa; canvas feeding speed - 7 m/min.

A comparative analysis of the physical and mechanical properties of non-woven thermally bonded materials obtained using industrial plasticizers and new oligovinylethoxysiloxanes (table) showed that

Table

Physical and mechanical properties of non-woven thermally bonded materials obtained using various types of binders

Compound	Modifier/plasticizer content	Temperature pressing, °C	Tearing load, N	Rel Length at break, %	Modulus of elasticity, MPa	Hardness, Sn	Air permeability, Dm^3/cm^2	Wet loss coefficient, %
PP	0,25	155	135	15	4,0	4,0	1150	5
PET	0,20	230	140	12	4,0	4,0	950	5
PET+PA powder	0,25	130	115	20	4,5	8,5	850	6
PET+PE	0,25	160	100	20	3,0	4,5	1100	5
PP	2,0	160	60	30	2,5	8,0	1000	10
PET	2,0	235	65	25	1,5	7,0	900	10
PET+PP	2,0	160	75		1,5	8,5	1000	10
PET+PP powder	2,0	130	90	35	3,5	10,0	800	15

that the use of decavinyldodecaethoxysiloxane (compound (IV)) as a modifier of chemical fibers and polyamide powder makes it possible to obtain on their basis non-woven thermally bonded materials with increased physical and mechanical properties: breaking load and elastic modulus increase by 2 - 2.5 times, relative elongation at break, rigidity and strength loss coefficient in the wet state are reduced by 2 times. At the same time, the high breathability and elasticity of nonwoven materials is maintained.

References:

1.Серебрякова Л.А. Оптимизация состава и структуры иглопробивных нетканых материалов из вторичного сырья / Л.А. Серебрякова // Владивосток: Изд-во ТГЭУ, 2008. - 168 с.

2. Лаврушин Г.А. Использование нетканых материалов в качестве утепляющей прокладки / Г.А. Лаврушин, Л.А. Серебрякова, Т.В. Чадова // Швейная промышленность. - 2005, №1. - С.46-48.
3. Серебрякова Л.А. Оценка качества и конкурентоспособности нетканых обувных стелечных материалов из вторичного сырья / Л.А. Серебрякова, И.А. Мохирева, С.Н. Авеличева, // Кожевенно-обувная промышленность. - 2008, №4. - С. 36-37.