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[Content]

Research Spray and Device for Polymer Coatings on Fabric

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Abstract

The paper presents an device for polymer coating. Technologies for the coating and duplicating of the surface of leather and textile materials by the polymeric films have been developed on the basis of experimental device. Research has shown that the formation of the polymer layer is accompanied by the occurrence of such phenomena: the wetting of the surface of the upper parts of the details of clothing; capillary penetration of substances into the structure of porous material and adhesion. Received examples of polymeric coating on the fabric.
KEY WORDS: *spray, polymer, model.*

1. Introduction

Coated fabrics are engineered composite materials, produced by a combination of a textile fabric and a polymer coating applied to the fabric surface. The polymer coating confers new properties on the fabric, such as impermeabilty to dust particles, liquids and gases, and it can also improve existing physical properties, such as fabric abrasion. The fabric component generally determines the tear and tensile strength, elongation and dimensional stability, while the polymer mainly controls the chemical properties, abrasion resistance and resistance to penetration by liquids and gases. Many properties, however, are determined by a combination of both these components, and both base-fabric and polymer must be carefully selected by a thorough consideration of the properties required in the finished article [1]

A coated fabric combines the benefits of the base fabric with those of the polymer with which it is coated. The resulting coated fabric will have many properties which cannot be offered by either component individually, and careful consideration is necessary to select both base fabric and coating polymer. The base fabric provides the mechanical strength of the composite material and supports the layer of coating applied to it. For quality coated fabrics, quality base fabrics are essential. This point is made because newcomers to the industry sometimes believe that the coating can cover fabric defects, and so second quality fabrics may be sent for coating.

1.1 Factors

Unique technologies for the coating and duplicating of the surface of leather and textile materials by the polymeric films have been developed on the basis of experimental device. The proposed technology involves the application of simple polymers, adhesives, molten glues, compositions with nanoparticles which can be distributed as drops or continuous films according to the required characterictics of the surface of material.

The application of polymers for the quality coating depends on: the pressure force at coating polymer;the surface and physical properties of the material; the physical and chemical properties of the polymer; the time of application; the area of contact materials; the temperature of the heating of the polymer; the quantity of polymer.

Research has shown that the formation of the polymer layer is accompanied by the occurrence of such phenomena: the wetting of the surface of the upper parts of the details of clothing; capillary penetration of substances into the structure of porous material and adhesion. The physical properties of a coated fabric depend on the properties of the substrate, the coating formulation, the coating technique, and the processing conditions during coating. The factors responsible for different properties of a coated fabric are given in [2].

1.2 Equipment

We have determined the main physical and chemical attributes of disperse systems that can be put on textile materials on the basis of mathematical modeling of the influence of characteristics of the surface and capillary-porous structure of the materials on the technological processing parameters. Also we have created the program for the choice of the optimal conditions depending on the characteristics of the coating, mono- or multilayers, their durability, elasticity, adhesion strength [2, 3].

The device for implementing of the new technology consists of the module for preparation of polymers, the module for heating and supply of air, dispenser, nozzle, module for the control and measurement. This device, unlike the analogs involves the coating of the polymeric films outdoors, which allows the application of paint, adhesive and duplicating substances for the various apparel garments. Besides, we can use nanoparticles as additives to polymers and production of the composite dispersions with the help of the elaborated device.

Model was developed sprayer polymers and dispersion modeling conducted flare polymer (Figs.1, 2).

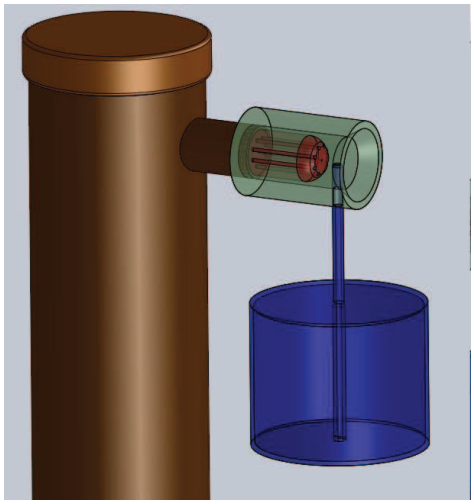

Fig. 1 The virtual model

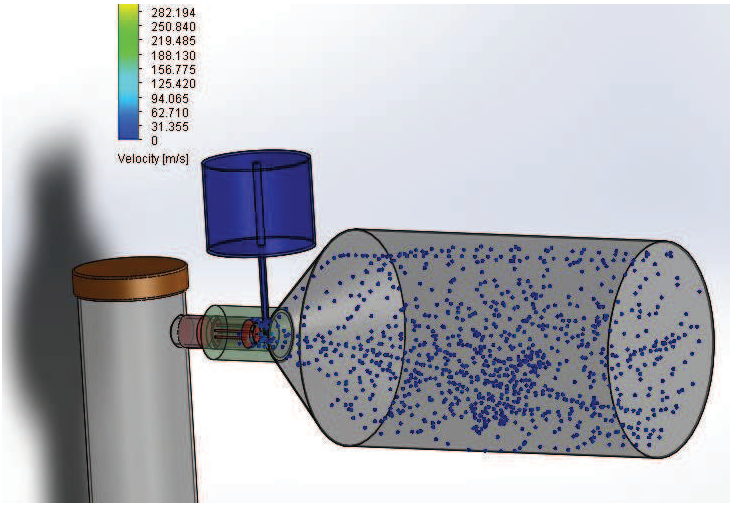

Fig. 2 Modelling of spray

The use of the sharp cooling of disperse systems before supply into the polymers provides the additional opportunity to receive the polymeric microparticles. The diameter of microparticles ranged from 20 to 100 μm depending on the physical and chemical properties of polymer [4].

Specifications of the device (Figs.3, 4):

Working pressure – up to $8 \cdot 10^5$ Pa.
Working temperature – up to 300^0C.
The minimum area of film – 10^{-3} x 10^{-3} m.
The maximum single area of film – 0.3 x 0.3 m.
The maximum granule of polymer – up to 10^{-4} m.
The use of polymers as liquid at the temperature up to 250^0C.

Areas of application:

- the technology has allowed to simplify the process of duplication of leather products and raise their rigidity;
- the technology is suitable for formation of the protective polymeric films on the working clothes;
- the coating of the surface of textile materials and leather by adhesive;
- the putting of paints with additives on the materials;
- the application of adhesive to the surface of textile materials according to surface microrelief;
- the introduction of nanoparticles into the structure of materials and their fixing by polymers;
- the technology allows to change the surface of artificial leather.

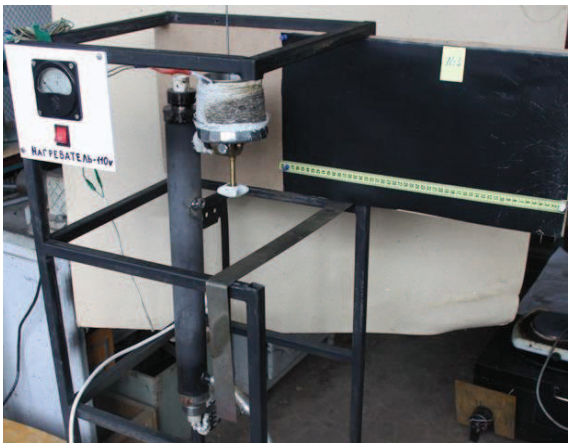

Fig. 3 The device

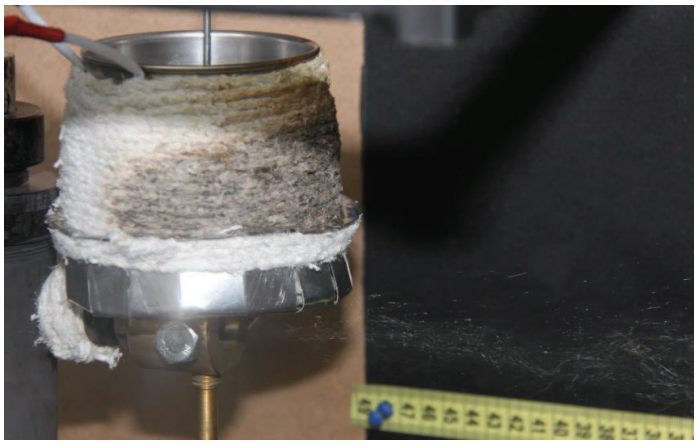

Fig. 4 Process of spray polymer

1.3 Control of Factors

Application of the multi-frequency phase method of measuring the distances to many objects can use for the system of control of depth of polymer film. It has been shown that the multi-frequency basic method of measuring the distances to many objects allows measuring the distances with high accuracy and resolving ability in a limited frequency band [5]. Textile has capillaries and pores in structure. Polymer may input to the capillaries and pores and construct new form. This method can get true information on depth polymer film on fabric and it structure inside. [6]

We use as the electron microscope for research internal structure of the coating.

2. Testing Procedures

For experimental studies selected products from imitation leather and fabric.

The penetration depth in capillary-porous objects characterizes the strength of the adhesive bond strength. The penetration depth depends от diameters of the capillaries and pores in the fabric that create a total area of adhesive contact with the surface detail of the surface structure (Figs. 5, 6).

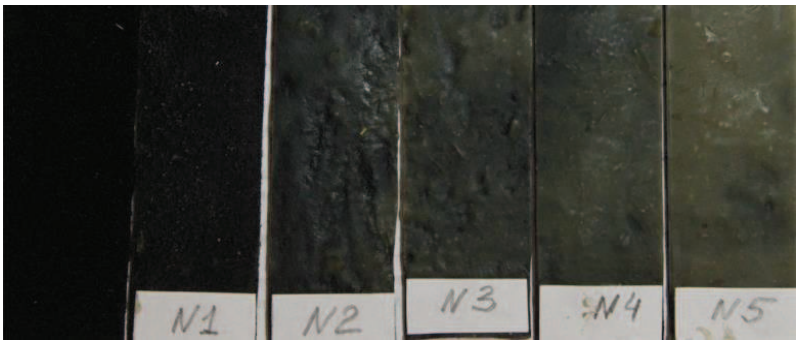

Fig. 5 Samples were coated with a polymer coating of varying thickness

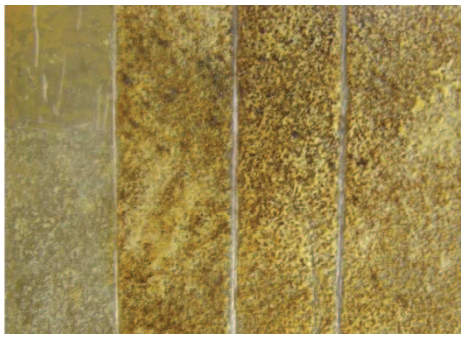

Fig. 6 Surface roughness of different samples

The polymer film forms a solid structure and tissue changes following properties such as moisture resistance, mechanical strength, wear resistance. (Fig.7):

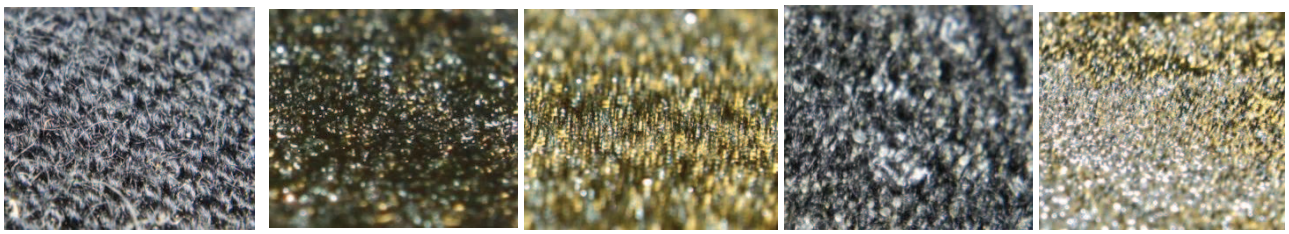

Fig.7 Polymer film on the surfaces fabric

3. Results

To assess the impact of certain technological factors on the adhesion strength of interaction with polymer compositions. Size samples determined according to GOST 15140-78 and showed in Fig. 8.

As a result data obtained, we got regression equation of second order, describing the dependence of adhesion strength of interaction (bonding strength) of certain technological factors:

$$G = 500 + 32,8 \times T + 90 \times P + 0,6 \times T \times P + 0,02 \times T^2 - 12,8 \times P^2 \quad (1)$$

where $T=(T_i\text{-}150)/20$ – compatible temperature of polymer, $P=(P_i\text{-}6)/2$ - the values of air pressure in the ejector chamber.

For qualitative assessment of adhesion at the polymers deposited on the surface of used metallographic microscope MIM-10, which is intended for visual observation and photographing the microstructure of metals and other materials, including textiles (Fig. 9).

Based on the obtained mathematical relationships built image dependence of thickness of sample hardness polymers obtained by experimental method (Fig. 10). As seen from the graph, the theoretical and experimental values almost coincide. The error was less than 5%. Dependences will give opportunity design equipment and technology to develop the coating of polymer on the surface of parts specified values.

The dependence allows predict the magnitude of deformation in tension of the material coated depending on the thickness, so you can create new types of clothing to meet the requirements of operation (Fig.11).

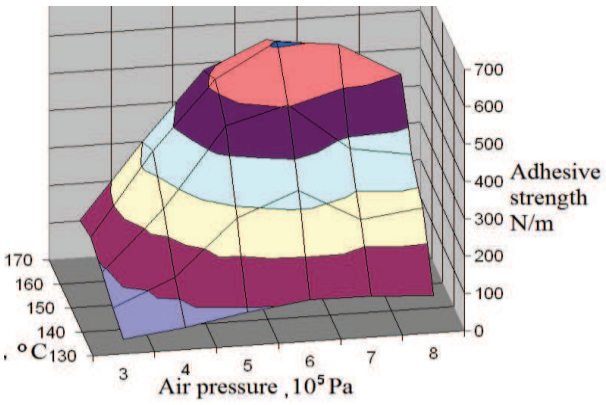

Fig. 8 Dependency of adhesive strength of polymer on temperature (^{0}C) and pressure air spray (10^5Pa)

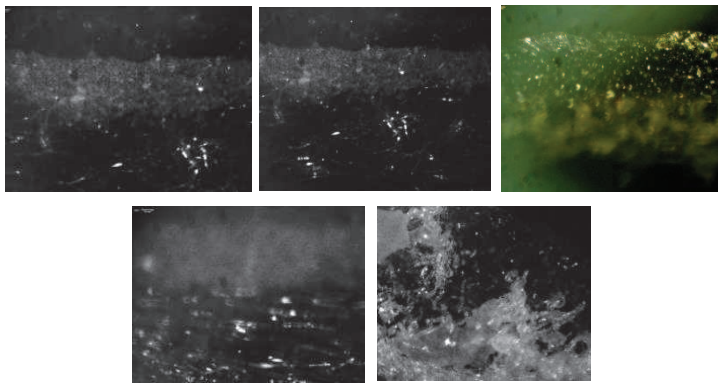

Fig. 9 - Photos sections of samples of components of fabric

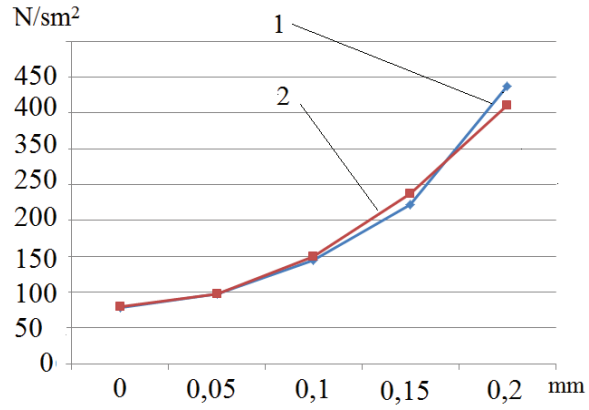

Fig. 10 Effect of thickness of the polymer film of conditional flexural stiffness (1 - experimental data 2 - theoretical data)

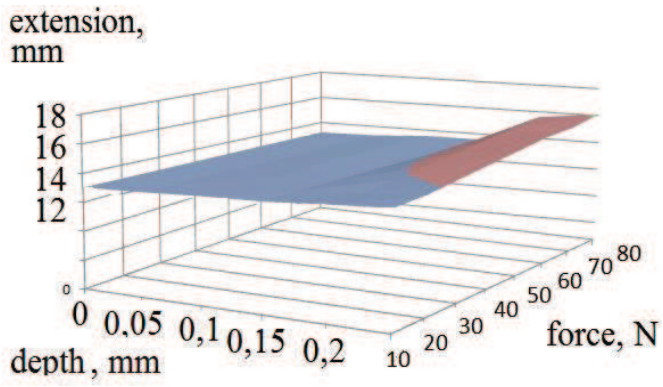

Fig. 11 Graph of stretch material with a certain thickness of the polymer coating on the strength of the load

4. Conclusions

Researches have shown the possibility of applying a layer of polymer on the different structure of fabric considering the desired depth of penetration. The obtained result allows to design the new equipment for polymers coating on clothing materials.

The technology and equipment for the implementation can easily adapt to customer requirements and characteristics of the material. The equipment can be upgraded by additional modules for the production of smaller granules of polymers, transfer of the polymer in liquid state and for pre-inclusions of nanoparticles in the polymer.

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