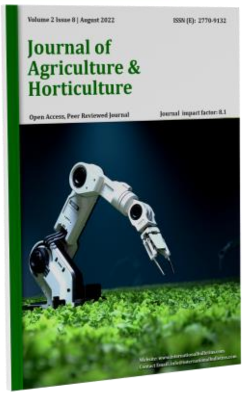

ACTUAL CONTACT AREA AT INTERACTION OF POLYMERIC MATERIALS WITH RAW COTTON

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Abstract: The article discusses the mechanism of frictional interaction of polymeric materials with pulp. The essence of the method lies in the fact that the FCA of polymeric materials with cotton is composed of elementary contact areas characterized by an average width bi and a length ℓ under the influence of a normal load G to cotton, the distribution pattern and magnitude of which are adequate with similar parameters for a single fiber in a strained state -deformed state under normal load G.

Key words: polymer, pulp, cotton, frictional interaction, actual contact area, load.

It is known [1–4] that one of the main factors determining the mechanism of frictional interaction of materials is their factual contact area (FCA), which has not been quantitatively studied for a polymer – cotton pair [5]. Also, the processes of deformation by solid foreign substances present in cotton, the surface of polymeric materials and the engagement of cotton fibers with irregularities in the surface of the counterbody have not been sufficiently studied. This makes it difficult to quantify the individual components of the friction force and identify their share and dominant influence on the value of the total force of the frictional interaction.

Researches have shown that the frictional interaction of cotton with polymeric materials differs significantly not only from the friction of two solids, but also from the friction of cotton with metal surfaces, which is primarily due to the structural and mechanical features of the interacting materials, especially cotton, as a highly dispersed heterogeneous fibrous substance with a high bulk deformability [6-8]. As can be seen from the results of the study (Table), the FCA of polymeric materials with raw cotton is 1-5% of the nominal area and is distributed unevenly across it. The amount of FCA and the uniformity of its formation are significantly affected by hard impurities in cotton, especially its seeds, through which the fibers are contacted with the surface of the material, where the most saturated contact spots are observed and, consequently, high actual pressure, leading to mechanical damage to the cotton fibers, seed crushing and surface wear of polymeric materials. It should be noted that the most important property of the contacting bodies, which determines the FCA value of polymer materials with cotton, is their elastic modulus, an increase in which leads to a decrease in FCA and, consequently, to a decrease in the adhesive component of the frictional interaction force. An increase in the moisture content of cotton leads to an intensive growth of FCA, and an increase in weediness leads to its decrease, which is explained by a change in the viscoelastic properties of the pulp.

The results of mathematical modeling of the process made it possible to develop a methodology for calculating the determination of relative FCA, the logical scheme of which is shown in fig. The essence of the method is that the FCA of polymeric materials with cotton is composed of elementary contact areas characterized by an average width bi and a length ℓ under the influence of a normal load G to cotton, the nature of the distribution and the magnitude of which is adequate with similar parameters for a single fiber in a stress-strain state under normal load G.

The areas of elastic and plastic contact interaction of the studied pairs are determined depending on their mechanical properties and on the friction regimes causing changes in the heat and electrophysical parameters of the frictional interaction. Moreover, in the area of elastic contact, the wear of the surface layer of polymeric materials occurs according to the fatigue mechanism in the area of plastic contact, mainly by abrasion, and at high values of cotton moisture, by the corrosion-mechanical mechanism of material destruction.

The deformation component of the frictional interaction force mainly depends on the hardness of the polymeric materials and is determined by the value of the relative incorporation of solid foreign substances and micropolar limbs of seeds into the polymeric material with the formation of new roughnesses with parameters different from the initial ones. The magnitude of the roughness parameters and the nature of their distribution substantially depends on the hardness of the polymeric materials. The introduction of fillers with high hardness in a small amount (up to 10 mass parts) increases the anisotropy of the mechanical properties of composite materials and, consequently, leads to an increase in the roughness of their surface.

An increase in cotton clogging promotes growth in the deformation component of the frictional interaction, increasing the unevenness of contact pressure.

Table

Relative FCA during frictional interaction of some polymeric materials with raw cotton

Type of material	The values of the relative FCA % at various pressures P10 (MPa)						
	1	5	10	20	30	40	50
High density polyethylene	0,02 0,08	0,13 0,45	0,24 0,95	0,52 2,12	0,79 3,22	0,95 3,91	1,22 4,92
FAED-20 based composite	0,02 0,07	0,12 0,48	0,20 0,82	0,51 2,10	0,76 2,91	0,93 3,62	1,02 4,35
Polycaproamide	0,02 0,07	0,10 0,46	0,18 0,79	0,44 1,91	0,65 2,82	0,81 2,86	0,93 3,22
Pentaplast	0,02 0,06	0,10 0,38	0,17 0,68	0,42 1,64	0,62 2,52	0,76 2,62	0,88 2,95
Understood butyral	0,01 0,05	0,08 0,34	0,18 0,71	0,34 1,41	0,51 2,03	0,65 2,31	0,74 3,02
Composite based on ED -16	0,01 0,04	0,07 0,25	0,16 0,63	0,25 1,21	0,45 1,36	0,58 1,68	0,66 2,26

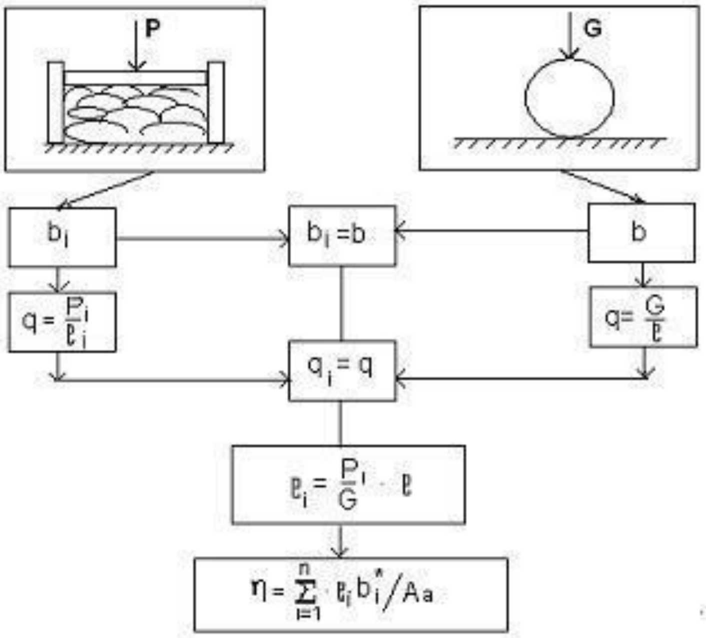

Fig. The logical scheme of the calculation method FCA polymer materials with raw cotton

Under certain conditions of frictional interaction, when the height of the surface roughness is comparable to or greater than the fiber diameter, the fiber engagement force on the surface roughness becomes dominant, and it determines the nature and regularity of the frictional interaction and mechanical damage of cotton. Moreover, the engagement force depends not only on the ratio of the height of the surface roughness of the counterbody and the diameter of the cotton fiber, but also on the shape and properties of the interacting contacts.

The results of the study and their generalization with previous studies made it possible to develop a method for determining the FCA of materials when interacting with cotton and a method for calculating the individual components of the friction coefficient taking into account the properties of interacting materials, the use of which allows research on the development of materials with given tribological properties at a high level.

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