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STUDYING THE STRUCTURAL AND PHYSICAL PROPERTIES OF POLYVINYL CHLORIDE THAT IS ENCASED WITH MINERAL FILLERS

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Abstract:
The problem's origin. Numerous scientific studies on the application of mineral fillers in the creation of composite materials are currently being carried out in our Republic. One of the most crucial responsibilities of the modern period is the employment of mineral fillers to shield polymer materials and constructions from fire and other harsh conditions.
Purpose of work. The purpose of the work is to obtain thermally stable and mechanically strong thermoplastic composite materials by filling polyvinyl chloride with basalt mineral.
Methodology. Physico-mechanical properties of polypropylene compositions filled with oligomers containing nitrogen, phosphorus and metal, bending resistance, impact resistance were determined by the Sharpie method, and the fluidity index was determined by the viscometry method.
Scientific news. Physico-mechanical and thermophysical properties of polyvinyl chloride filled with basalt fibers were studied.
The results obtained. To obtain composite materials based on basalt mineral from polyvinyl chloride, the amount of filler was taken from 1 mass part to 5 mass parts. The physico-mechanical properties of the obtained composite materials showed that an increase in the amount of filler leads to a decrease in the fluidity of the material. Based on the results, the optimal amount of basalt-containing fillers in the composite material is 5 parts by mass.
Combustion properties of the obtained materials were determined according to the oxygen index, thermophysical properties according to the DTA method.

Keywords: polyvinyl chloride, basalt fibers, atomic force microscopy, physical and mechanical properties.

Features
Enhancement of the thermal, mechanical, and physical characteristics of polymer composite materials using fillers containing basalt.

Introduction
The modern economy is causing a rise in the demand for thermoplastic polymer materials, but manufacturers are unable to meet the demands of consumers for polymer materials used in various

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fields [1]. Adding various mineral additives to polymers can lead to a substantial improvement in the quality of polymers and the properties of composite materials based on them, which can lead to the expansion of their range and scope. [2-5].
The expansion of polymer material applications is possible due to the increasing number of mineral fillers available for polymers. Furthermore, in order to progress the modern economy, it is necessary to produce polymer composite materials that possess both high properties and low prices. To enhance the properties of composite materials, it is advantageous to utilize inexpensive and effective fillers, such as basalt and basalt fibers.
The refractory nature of basalt, its ability to tolerate temperatures between 9000 and 14000 degrees Celsius, its mechanical and chemical resistance, its high thermal insulation qualities, its chemical neutrality which allows it to withstand the effects of harsh acidic and alkaline environments—and its non-radiation-accumulating nature are some of its special qualities. The mineral basalt has no negative effects on people or animals and is beneficial to the environment [6].

Materials and methods

The thermoplastic composite material based on polyvinyl chloride was determined as a research object in accordance with GOST 11645-73 at temperatures between 463 and 503 K and with a load of 2.16 kg. The fluid flow index was measured using an IIRT-M brand viscometer with a capillary length and diameter of 8 and 2.09 millimeters. As per GOST 6806-73, the twofold bending method was utilized to ascertain the bending strength of the composite materials.

Discussion of the obtained results

This work addressed the issue of enhancing the mechanical characteristics of composite materials including polyvinyl chloride and basalt rocks.
The goal of the project is to enhance the mechanical characteristics of polymer composite materials that are filled with basalt mineral and polyvinyl chloride [8].
advancement of research on materials based on polyvinyl chloride and having nanoscale modifiers that alter the supramolecular packing of polymer macromolecules and, consequently, their mechanical and physical characteristics. The mechanism of the physicochemical interaction between mineral fillers and nanoscale modifiers included in polyvinyl chloride was investigated.

Experimental part

It is crucial to research the physico-mechanical and chemical properties of novel functional groups that are added to the polyvinyl chloride macromolecule from both a scientific and practical standpoint [9].
This experiment used basalt from the Asmansay mine in the Jizzakh region; Table 1 below lists its composition. The republic's need for mineral fibers is entirely met by the development of basalt rocks from the Asmansay mine in the Jizzakh region, which it ships overseas [7].

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Table. The chemical makeup of the Asmansoy mine's basalt Table 1.

Component	Composition, % масс.
	Basalt
Silicon oxide SiO_2	47,0
magnesium oxide, MgO	16,3
Aluminum oxide Al_2O_3	11,2
Iron (III) oxide Fe_2O_3	10,3
Calcium oxide, CaO	8,94
Sodium oxide, Na_2O	1,53
Potassium oxide, K_2O	0,33
Iron (II) oxide FeO	0,16
Titanium oxide TiO_2	0,57
Manganese oxide MnO	0,19
Sulfur oxide, SO_3	0,05 less than
Additives	2,04

In order to create a composite material consisting of polyvinyl chloride and basalt mineral, polyvinyl chloride (PVC) was utilized as a binder and basalt mineral was ground to 140 microns for five hours in a ball mill.

The physical and mechanical properties of 125 and 315 μm basalt minerals were examined in order to determine the effective size of filler particles in PVC-based composite products.

There were 40% of distributed fillers in the polymer matrix. For composite materials made of polyvinyl chloride and basalt mineral, this quantity is the ideal composition [8]. Changes in the polymer's mechanical, chemical, and physical properties were used to assess the filler's impact on the composite material's composition.

The fluid flow index (PTR) was used to determine the rheological characteristics of the composite materials made using polyvinyl chloride and basalt stone. The fluidity index of polymer composite materials diminishes with an increase in basalt content (Table 2); yet, basalt pressure casting is a viable processing method for these composites.

Dependence of the fluidity index of the composition at 2000 C on its composition (particle size ≤140 μm) Table 2.

Composition of the composition, mass.h., per 100 parts by mass PVC	PVC PTR, g/10min
PVC	5,36
PVC +30 basalt	3,22
PVC +40 basalt	2,78
PVC +50 basalt	2,15

The physical and mechanical characteristics of the composite materials were evaluated, and the results indicated that all of the properties of the polymer composite material based on PVC and basalt changed in a positive way when up to 40% of basalt minerals were added to the composition (Table 3). It was also observed that a rise in tensile strength causes a fall in relative elongation.

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Mechanical and physical properties of PCM are compared. Table 3.

Composition composition, parts by mass., 100 parts by mass relative to PVC	Impact resistance kDj\m2	Relative elongation, %	Tensile strength, MPa
PVC	29	1245	9,12
PVC+30 basalt (BT)	41,2	96,6	9,9
PVC+40 basalt (BT)	62,6	35,4	11,6
PVC+50 basalt (BT)	54,9	12	10,9

Dispersed basalt, when added to the polymer composition, has an impact on PCM's flammability. It decreases mass loss when ignited in air by 50% and shortens the composite material's spontaneous combustion duration by two times when compared to pure polyvinyl chloride (Table 4).
The basalt mineral utilized as a filler has the ability to reduce flammability, according to all indicators of the polymer composite material's flammability.

Table 4. The effect of basalt on the flammability performance of polyvinyl chloride

Composition composition, parts by mass., 100 parts by mass relative to PVC	Mass loss during combustion in air, %	Burning time, sec.
PVC	55	236
PVC+40 basalt(BT)	23	123
PVC+50 basalt(BT)	21	112

AFM, or atomic force microscopy, is frequently used to examine the microstructure and topography of different materials. With this technique, the surface of a sample that was produced in the nanoscale range can be formed on a three-dimensional surface. The results obtained indicate alterations in the mechanical characteristics, size, shape, and surface of the particles on the polymer composite material [13]. This technique was used to investigate how changed filler particles affected the polymer surface's shape. The distribution of scattered basalt between polymer macromolecules and the features of their interactions are revealed by the examination and characterization of the modified polyvinyl chloride surface. [14-15].

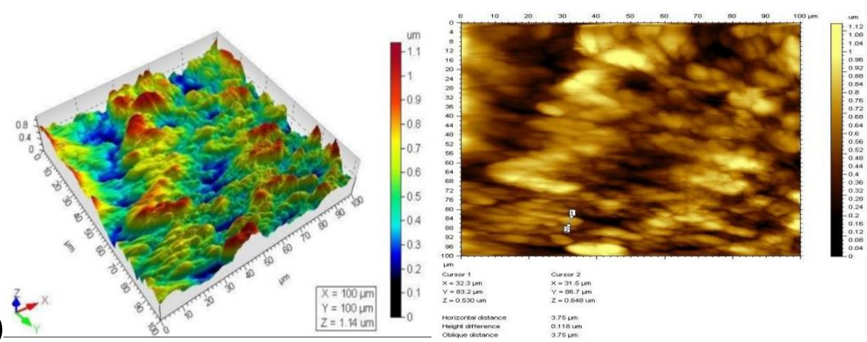
a)

б)

Figure 1. A) - three-dimensional, B) - two-dimensional image of the composite containing PVC+40%BT

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The scanning region measured between 1 and 50 µm. The surface of the composite material with PVC + 40% BT modified with scattered basalt is depicted in Figure 1.

According to the findings, the PVC+40% BT composite has a surface roughness of 210 nm, while pure polyvinyl chloride has a surface roughness of 100 nm [16].

Based on thermoanalytical investigations, the thermooxidative characteristics of the composite materials developed in this article were examined. It is well known that the decomposition of polymer composite materials including basalt minerals occurs at a temperature greater than that of pure polymers and is typified by the development of ash residue. This demonstrates the composite materials' heat resilience. Chemical alterations that occur during the manufacturing of polymers dictate the complex mechanical and physical properties of composite materials. High temperatures are involved in these processes. The thermal and thermophysical characteristics of polymer composite materials, including heat resistance and melting temperature variation, were investigated in this work.

Differential scanning calorimetry was used to determine the melting temperature and degree of crystallization of polymer composite materials (DSC). Table 5 displays the results that were achieved.

Table 5. Thermodynamic properties of the composite with VX+40% BT content

The structure of the composition	The onset of solubility, To S	Solubility peak, T°S	enthalpy, DN, Dj/g	Degree of crystallization ɑ, %
PVC	160	224	188	55
PVC+30% BT	186	243	198	61
PVC+40% BT	197	245	204	59
PVC+550% BT	209	246	210	58

Using differential scanning calorimetry, thermograms of samples filled with filler were acquired in order to ascertain the polymers' working temperature range (DSC).

The comparison of the diffraction spectra of composite materials by fillers and polymer types revealed that the diffusion rate of the modified fillers included in the composition increased with the interlayer distance of the fillers and filler concentration. Therefore, the length of time the components are mixed and the solution's viscosity determine how much the fillers are dispersed throughout the polymer.

Particle size and shape can be experimentally studied utilizing X-ray phase analysis methods (Debay-Scherrer method) to acquire accurate results. The Debye-Scherrer formula establishes the size of coherent distribution zones (zcr), or nanocrystals: $K\,l \,/\, (B \cos \theta) = \Delta p$

(nm) Δp, or average crystal size K-Scherrer value. The range of K is 0.68 to 2.08. K = 0.94 for spherical crystals with cubic symmetry

L-rays have a wavelength of Cu Ka = 1.54178 Å.

In the FWHM diffractometer, B is the integral length (full width at half maximum) of the reflections. The X-ray diffraction cosine angle is called costh.

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The results of calculating the size of the particles of the PVC+40% BT composite according to the Debye-Scherrer formula Table 6.

№	2theta- scanning angle	FWHM- integral width of reflexes	Dp (nm) average crystallite size	Dp (nm) average
1	8.3	0.5	17.42	15.61
2	8.7	0.6	14.61	
3	21.4	0.65	15.12	
4	24.5	0.64	15.70	
5	26.4	0.66	15.23	

The resulting composite materials have nanosized particle sizes, as determined by the results of X-ray phase analysis.

In order to enhance the mechanical and physical characteristics of polymer composite materials based on polyvinyl chloride, the maximum amount of basalt mineral added as a filler was 40%. The polymers' strength and heat resistance are increased when 40% dispersed basalt is added, according to all of the data that were obtained.

Conclusion

Therefore, using PVC +40% BT maximizes the improvement in thermophysical and physical-mechanical properties of polyvinyl chloride filled with distributed basalts.

Effective heat-resistant polymer materials can be made from composite materials made from polyvinyl chloride, mineral fillers, and surfactants.

Strong adsorption between the polymer base and fillers causes new adsorption layers to emerge at the joints of amorphous components, which explains the phase structure of polyvinyl chloride modified with scattered basalts.

The degree of flammability on the polymer surface decreases when its surface is modified with mineral fillers.

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