Polymer composite materials modified with fillers from natural mineral rocks and some of their characteristic properties

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Abstract: *One of the promising areas of modern chemical science is the production of polymer composite materials modified with fillers of various compositions, as well as testing and quality control of such products. Based on this trend, scientific research was conducted to obtain composite materials filled with fillers with a number of excellent properties. Thus, composites containing natural mineral rocks and polyolefins characteristic of the Karabakh region were obtained with different ratios of components and their properties were studied. In addition, the article prepares and presents an overview of a number of scientific studies conducted in this direction. The use of fillers with such compositions as modifiers makes research simple and accessible, since they are environmentally friendly and safe, have low financial costs for purchase and acquisition, and also have a high probability of obtaining a higher quality product. The resulting polymer is obtained in a relatively simple way. Natural mineral fillers are mined in a number of the most beautiful places in our country.*

KEYWORDS: *NATURAL MINERAL ROCK, POLYOLEFIN, HIGH-DENSITY POLYETHYLENE, POLYMER PROCESSING, WASTE OF NATURAL MINERAL ROCK, MELT FLOW INDEX, RELATIVE ELONGATION, TENSILE STRENGTH*

As is known from a number of scientific sources, it is considered promising to add modifiers of various shapes, sizes and properties to polymeric materials in order to obtain excellent properties. The development of composites is one of the most progressive areas of modern chemical science. In this regard, the production of such materials makes each researcher think deeply. Polyolefins (polyethylene, polypropylene, polyvinyl chloride, polystyrene, etc.) are considered promising raw materials due to the ease of processing and operational properties, relative purity and safety for the environment, low cost, availability and the ability to work in a wide range of temperatures [1].

The inclusion of a modifier in the system to improve the properties of the composition improves the quality of the resulting product. Fillers vary in shape, size and properties [2].

Due to fillers, PCM's can compete with other materials in most areas of human activity, such as glass, ceramics, and even metal. The main disadvantages that limit the scope of application of PCM's, as in the case of other polymer-based materials, are relatively low heat resistance and frost resistance, as well as the phenomenon of polymer aging under the influence of various environmental factors [3].

Powdered polymers such as polyvinyl chloride, polyethylene, polyformaldehyde, polytetrafluoroethylene, etc. can also be used as dispersed fillers. They increase chemical resistance, and together with other dispersed and fibrous fillers, they improve wear resistance, friction coefficient, and dielectric characteristics. Their efficiency increases if they do not melt during the production and processing of PCM's, but are preserved as particles of an independent phase [4].

The creation of a new generation of high-performance composite materials using high-density polyethylene (HDPE) as a matrix and natural local mineral rocks as a filler. The goal is to obtain new generation composite materials with high physical and mechanical properties. Thus, carrying out research work towards the production of new generation composites with simple technology and low cost due to processing is considered relevant, economically and environmentally beneficial. To ensure conditions for the fusion of the polymer matrix and mineral rock with each other and achieve parameters characteristic of high performance indicators, a sizing agent synthesized in the laboratory is included in the composition of the filled system [5].

Polymer composite materials were manufactured using high-density polyethylene (HDPE) as a polymer matrix and natural mineral rock from the village of Zulfigarli, Karabakh region, as a filler, and a number of properties of the created composite samples were studied. The studies were continued by introducing a linker appreted in laboratory conditions, provided that the homogeneity of the system was ensured. In the work, HDPE (brand 10803-020) was used - high-pressure polyethylene or low-density HDPE or HDPE at a pressure of 150-300 MPa and a temperature of 150-320^{0}C.

Chemical composition: (%)
MgO-35; Cr_2O_3-0.35; SiO_2-32; CuO-0.2;
Fe_2O_3-9.0; SO_2-0.4; Al_2O_3-0.7; NiO-0.37;
Mineralogical composition:
$(MgFe)_4Si_2O_3(OH)_4$- magniferrosiliconoxylin - 95%
Other mixtures – 5%
Hexane-1 $CH_2=CH-CH_2-CH_2-CH_2-CH_3$
Acrylic acid $CH_2=CH-COOH$

Table 1. *Physico-mechanical properties of composite samples. Without appret*

Polymer matrix – high-pressure polyethylene (HDPE) – (brand - 10803-020)

Filler – natural mineral stone “Zulfugarly” (dispersion – 50 microns)

№	Compound Composition, with %	Tensile force, σ, MPa	Elongation, ε, %	MFI, g/10min
1.	HDPE-100	10.8	547.5	2.8
2.	HDPE-70 Filler-30	12.6	40	2.0
3.	HDPE-60 Filler-40	14.4	24	0.7
4.	HDPE-50 Filler-50	14.9	28	0.6
5.	HDPE-40 Filler-60	15.0	20	0.37
6.	HDPE-30 Filler-70	16.5	8	-

Table 1. shows the physical and mechanical properties of composite samples corresponding to different mass percentage ratios of the components corresponding to a filler dispersion of 50 mkm without a lubricant. In the sample corresponding to the mass ratio of the components included in the composite, HDPE/Filler-30/70%, the tensile strength reaches a maximum value of σ = 16.5 MPa. Accordingly, the value of the relative elongation at break decreases and becomes ε = 8%. The melt flow index is not determined, that is, the composite does not flow.

We interpret the data in Table 2. the tensile strength value is 19.2 MPa, with the maximum value obtained in the sample where the components are HDPE/Filler/Appret-30/70/3% by weight. Unlike the system without sizing, the strength increases in the presence of sizing. This is also a direct proof of obtaining a composite with stronger properties. Thus, as the amount of filler in the system increases, it has been proven to be a raw material that provides strength in terms of its strength and surface-active properties. In addition, the presence of a topcoat in a homogeneous system provides compatibility, which leads to an increase in the tensile strength of the resulting composite. Similarly, the relative elongation at break takes on smaller values as the amount of filler in the system increases. In the sample with HDPE/Filler/Appret-30/70/3%, the minimum value is ε = 16%. In samples created with the presence of filler, the value of the alloy flow index decreases as the amount of filler increases. Unlike uncoated samples, in coated samples, despite the component ratio of 30/70/3%, a small flow rate is observed, amounting to MFI = 0.03 g / 10 min. This is explained by both the functionality of the coating and microdefects that can occur in a complex system.

Table 2. *Physico-mechanical properties of composite samples. With appret*

Apprete – Hexene-1 + Acrylic acid (3%)

№	Compound Composition, with %	Tensile force, σ, MPa	Elongation, ε, %	MFI, g/10min
1.	HDPE-100	10.8	547.5	2.8
2.	HDPE-70 Filler-30 Appret-3	13.7	28	0.9
3.	HDPE-60 Filler-40 Appret-3	14.1	22	0.7
4.	HDPE-50 Filler-50 Appret-3	15.0	26	0.23
5.	HDPE-40 Filler-60 Appret-3	16.8	23	0.07
6.	HDPE-30 Filler-70 Appret-3	19.2	16	0.03

Scientific research continued in the direction of developing compositions with complex operational properties, and a number of other properties were studied. At the same time, such properties as heat resistance and elastic modulus in bending according to Vicat were also studied.

Table 3. *Heat-resistant properties of composite samples. Without apprete*

№	Polymer composites, %	Filler, %	Heat resistance according to Vica, ^0C
1.	HDPE-100	-	135
2.	HDPE-70	Filler-30	150
3.	HDPE-60	Filler -40	157
4.	HDPE-50	Filler -50	164
5.	HDPE-40	Filler -60	178
6.	HDPE-30	Filler -70	183

Table 3. shows the heat-resistant properties of the system depending on the mass percentage of the composite samples. As can be seen from the table, when adding a filler made of natural mineral stone to polyolefin, an increase in the heat resistance of the composite is observed with each increase in the mass fraction of the filler. This directly depends on a number of properties of the filler, such as its dispersion, place of production, as well as its shape and nature. Thus, adding a filler made of natural mineral stone to the system increases the strength properties of the system, as well as other quality characteristics.

To improve the properties of the system, 3 mass percent of the sizing agent was added, and the properties were studied in a similar way.

Table 4. *Heat-resistant properties of composite samples. With a apprete (in each sample, the appret is 3 % by weight)*

№	Polymer composites, %	Filler, %	Heat resistanceaccording to Vica, ^0C
1.	HDPE-100	-	135
2.	HDPE-70	Filler-30	155
3.	HDPE-60	Filler -40	167
4.	HDPE-50	Filler -50	160
5.	HDPE-40	Filler -60	179
6.	HDPE-30	Filler -70	191

Table 4. presents the thermal properties of composite samples with different mass ratios in the presence of a sizing agent. Accordingly, when the filler is introduced into the system, the heat resistance properties are improved, and thus the value increases to a maximum of 191^{0}C in the sample corresponding to the ratio of HDPE/Filler/Appret-30/70/3. However, in the sample with HDPE/Filler/Appret-50/50/3%, the heat resistance is relatively low. This is explained by possible defects in the system, since both the polymer matrix and the filler have the same mass percentage. Thus, since the strength of the composite samples created with the apprete is high, their heat-resistant properties are also higher than those of the samples withoutapprete.

As a result of scientific research conducted to obtain composites with high and complex performance properties, polymers based on polyolefins, fillers and finishing materials were obtained and studied using natural mineral rocks of our beautiful country as modifiers. As a result, polymer composites with higher strength and minimal fluidity were obtained. It was found that the highest result was obtained in a sample corresponding to 30/70 mass percent of the polymer filler in the presence of 3 mass percent of the sizing agent. Such materials are considered suitable for use. Therefore, it is considered appropriate to use such polymer composite materials as raw materials in scientific and experimental fields. This is one of the most promising materials from an economic and practical point of view.

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