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DEVICES USED IN THE TECHNOLOGY OF BASALT MODIFICATION

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Abstract: In recent years, the demand for materials based on polymer composite materials (PCM) has been increasing daily. This is due to the fact that PCMs are competitive with metals. Currently, it is possible to add various types of additives to PCMs to enhance their strength, resulting in reinforced materials with significantly improved mechanical durability and resilience.

Keywords: polyvinyl chloride, fillers, composite materials, drum-type electromagnetic separator, modification, screen (grohot), basalt, plastication time, flowability

It is well known that most of the fillers used in products based on polyvinyl chloride (PVC) are expensive and imported, so finding alternative raw materials is of great practical significance. One noteworthy filler identified through current scientific research is natural basalt. Natural basalt, primarily composed of volcanic minerals, contains compounds such as SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, and K_2O. It can be used as a raw material for producing PVC-based composite materials. Using natural basalt as a filler in PVC not only reduces production costs but can also improve some of its technological properties, particularly its thermal stability [120; pp. 32–38. 121; pp. 7–108. 122; p. 246].

To use basalt, it is first ground in a ball mill. The ground basalt particles should be around 1–2 microns in size. Studies and experiments have shown that unprocessed and unmodified basalt cannot be directly used as a filler in polymer composite materials, especially those intended for functional applications. This is because basalt contains between 5% and 13% iron oxides, which negatively affect the overall properties of polymer composites. For the production of composite polymer materials, the iron oxide content in mineral fillers should not exceed 2%. Therefore, basalt needs to be screened using an electromagnetic separator. After screening, the iron oxide content is reduced to 2%. In the experiments, the crushed basalt was passed through a drum-type electromagnetic separator before modification (see Figure 4.1.1).

Figure 4.1 – Drum-Type Electromagnetic Separator

When producing PVC-based composite polymer materials, it is required that the added fillers be hydrophobized. Therefore, the basalt powder obtained from the ball mill is modified with gossypol resin in a 2:0.15 mass ratio in a mixer.

Since gossypol resin is an oily substance, it coats the surface of the basalt particles, making them hydrophobic. The mixer has blade-type elements, a volume of 350 liters, a jacketed design, a rotation speed range of 50–2500 rpm, and the mixing process takes 30–35 minutes.

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The technological process of basalt modification is as follows: the basalt powder ground in the ball mill (1) is sent to the mixer (2), followed by the addition of gossypol resin. The quantities are determined according to the working formulation. Before mixing begins, the mixer is preheated to 40–50°C. During the first stage of mixing, the rotation speed is 750 rpm, which is increased to 1800 rpm after 2–3 minutes. The temperature of the mixture rises due to friction between particles and the mixer walls. When the temperature reaches 80±5°C, the process is stopped, and the mixer is cooled to 30–35°C with water. The prepared basalt is then transferred using compressed air to a screen (grohot) with sieves No. 014 and No. 035 (3). The modified basalt that passes through the screen is collected in special containers (4) or sent directly for further processing. The basalt that does not pass through the screen is collected in a separate container (5) and returned to the process [123; pp. 355–359].

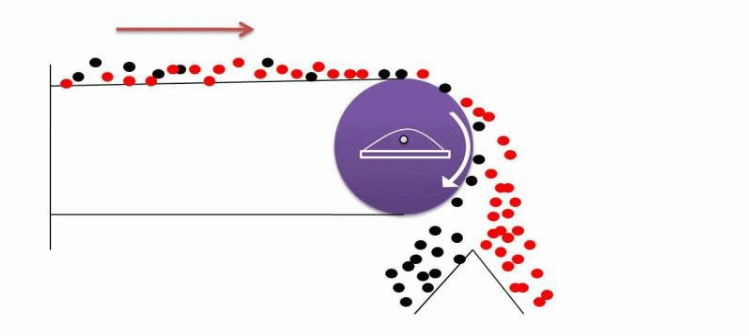

Figure 4.1-Drum-Type Electromagnetic SeperatorBased on this technology, working formulations were developed for producing specific products using the modified basalt as a filler in PVC-based polymer composites. The known Russian Federation technology was used for preparing PVC-based polymer compositions, with the basalt modification section added as a novelty in the technological scheme (see Figure 4.2).

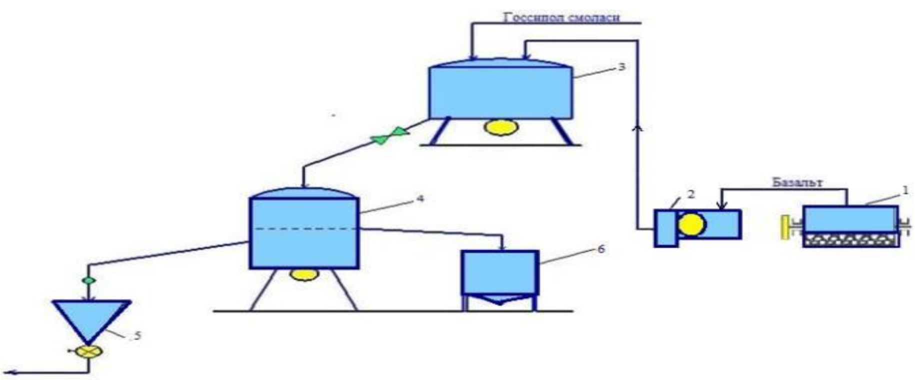

Figure 4.2 – Principal Technological Scheme for Basalt Modification

1 – Ball mill; 2 – Electromagnetic separator; 3 – Mixer; 4 – Screen; 5 – Special container; 6 – Container for unfiltered product.

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Research was carried out using local raw materials produced in the Navoi region for the production of PVC-based sewer pipes. The conventional (standard) and newly developed working formulations for producing 100 mm diameter PVC sewer pipes are presented in Table 4.1.

Table 4.1 – Formulations for Sewer Pipe Production Using Standard and New Recipes

№	Component Name	Standart Recipe(parts by mass).	New Recipe(parts by mass)
1	PVC	100	-
2	PVC	-	100
3	Belgorod Chalk	3,86	-
4	Three-basic lead sulfate(TOSS)	1,0	1,0
5	BMR-9-1 compound	2,0	2,0
6	Stearic acid	0,15	0,2
7	Modified basalt	-	4,0
Technological Indicators			
1	Plastication time(min)	17	8
2	Melt flow index (g/10 min)	0,3	0,2
3	Thermal stability at 190^0C	45	67

The plastogram of this composition was analyzed in detail in Chapter III of the dissertation and compared with the standard recipe.

Based on the above, the basalt modification section can be integrated into the PVC-based composite material production scheme. This ensures continuous production [124; pp. 204–205]. To obtain polymer composite materials based on PVC using modified basalt, the composition preparation process is carried out as follows (see Figure 4.3):

PVC is separated from paper at station (1) and sent to a silo (2) using compressed air from a compressor. Modified basalt (3) replaces Belgorod chalk and is stored in a 190 m³ silo

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and sent to a vacuum weighing unit (4). All components specified in the working recipe are delivered to the hot section of a two-stage mixer (8) for thorough mixing.

The lead sulfate (TOSS) and granular BMR-9-1 compound are sent from the discharge station (16) to the stabilizer dosing section (6, 7) using an electric cart (5). All components are weighed according to the factory recipe and transferred to an electronic-pneumatic bunker scale (8'). After weighing, the mixture goes to a special container (13). The bunker scale has a capacity of 120 liters with measuring ranges of 0–5 kg and 5–20 kg.

According to the recipe, thermal stabilizers are pumped from a special container to the weighing unit (4), capable of handling 10–150 kg. All components then go to the hot mixer. Friction between particles increases the temperature, which is maintained initially by preheating the mixer.

In the first stage of mixing, the rotation speed is low, then increased after 2–3 minutes to 750–1800 rpm. When the temperature reaches 80±5°C, stearic acid and colorant (if required) are added without stopping the process.

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