"DEVELOPMENT OF TECHNOLOGY FOR OBTAINING THE INNER LAYER OF THREE-LAYER COMPOSITE PANELS BASED ON POLYETHYLE-BASED PRODUCTION OF THE SHURTAN GAS-CHEMICAL COMPLEX"

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Abstract: The purpose of this article is to improve the physical and mechanical properties of three-layer composite panels produced at the Shurtan gas chemical complex using primary and secondary different brands of polyethylene granules and obtain highly liquid products.

Keywords: Polyethylene, density, flow rate, tensile strength, tensile strength, Shore hardness, fractional composition

The production of polymer composite materials currently plays a significant role in global industry. It is well known that the construction sector is difficult to imagine today without three-layer composite panels; a key reason for this is the product's wide range of physical-mechanical properties and its various advantages. Today, we see three-layer composite panels being used in a wide range of applications—such as the exterior cladding of ventilation systems and the facades of new or renovated buildings; the facing of balconies, eaves, and canopies; the cladding of gas stations, tunnels, and columns; and various specialized or custom projects. Their advantages include, for instance, a long service life (50 years), insulation and protection, ease of processing, and a wide range of available colors.

Over the past few years, a number of enterprises manufacturing aluminum-plastic profiles—various finishing materials used for the interior and exterior decoration of buildings—have been established in Uzbekistan. Examples include ALCO, ALSTAR, AND-POLIC, and ALUCOBOND. Three-layer composite panels used for the exterior cladding of new and renovated buildings are in high demand.

The aim of the study is to develop a production technology for three-layer composite panels and their internal polymer layer using recycled materials from the Shurtan Gas Chemical Complex; to determine the optimal formulation and polymer grades; to select the processing parameters; and to improve the physicochemical and mechanical properties of the three-layer composite panel.

Currently, all manufacturers in the Republic of Uzbekistan use various grades of polyethylene from the Shurtan Gas Chemical Complex (GCC) to produce three-layer composite panels. At the Shurtan Gas Chemical Complex (a manufacturer in the Republic of Uzbekistan), polyethylene is produced using the SCLAIRTECH technology from NOVA Chemicals Limited (Canada) in accordance with standard TS 17642168-04:2023, covering HDPE, MDPE, and LLDPE grades. The Shurtan GCC produces 16 grades of polyethylene with densities ranging from 0.918 to 0.965 g/cm^3 and melt flow rates between 0.19 and 30 g/10 min. Approximately 130,000 tons of polyethylene granules are produced annually, with over 30–35% of this volume used for the manufacture of three-layer composite panels [1–4].

Experimental section. Recycled polyethylene grades are used in the manufacturing process for three-layer composite panels. Various grades of recycled raw materials are employed to utilize recycled polyethylene and produce highly marketable products. Linear polyethylene grades—LLDPE, MDPE, and HDPE—produced by Shurtan Gas Chemical Complex LLC were selected as the matrix materials (Table 1).

Table 1.

Properties of three-layer composite panels produced using polyethylene feedstock from Shurtan Gas Chemical Complex LLC as the core layer.

№	Polyethylene grades	Density, g/cm^3	Melting index, g/10 min	Tensile strength, MPa	Breaking strength, MPa	Shore hardness, Shore units
1	**Pipe**	0,936 ÷ 0,958	0,27 ÷ 0,56	16 ÷ 30	30 ÷ 31	62 ÷ 67
2	**Film**	0,92 ÷ 0,946	0,23 ÷ 3	10/11 ÷ 18/18	26/28 ÷ 18/51	0
3	**Injection**	0,925 ÷ 0,961	4,9 ÷ 25	10 ÷ 26	26 ÷ 27	52 ÷ 65
4	**Rotational**	0,933 ÷ 0,948	2,7 ÷ 4,0	15 ÷ 20	0	56 ÷ 58
5	**Cable**	0,934	0,38 ÷ 0,72	14 ÷ 15	16	62 ÷ 64

Experimental results and discussion. To achieve the stated objectives—specifically, to determine the optimal formulation based on various grades of polyethylene, select processing parameters, and assess physicochemical and mechanical properties—composite panel samples were produced. To adjust these properties and reduce costs, local raw materials—natural calcium carbonate from the Kitab and Yangiyul deposits—were incorporated into the formulation of the panels' core layer. The particle size distribution, bulk density, and specific volume of the fillers are presented in Tables 2 and 3.

Table 2.

Fractional composition of calcium carbonate

Sieve No.	**Particle size, μm**	**Residue on sieve**	
		gr.	**%**
Sample 1 (Natural calcium carbonate from the Kitab city			
0335	355	0,238	0,24
025	250		0
024	240		0
02	200	0,0517	0,053
0105	105	0,8186	0,83
008	80	2,167	2,2
0056	56	2,758	2,8
005	50	4,728	4,8
Sample 2 (Natural calcium carbonate from the Yangiyul city			
0335	355	--	--
025	250	--	--
024	240	--	--
02	200	--	--
0105	105	--	--
008	80	0,135	13,5
0056	56	0,185	18,5
005	50	0,175	17,7

Sample 1: 10.9% of the analyzed sample, while 89.1% of the analyzed sample passed through sieve No. 005;

Sample 2: 49.7% of the analyzed sample, while 50.3% of the analyzed sample passed through sieve No. 005;

Table 3.

Bulk density and specific volume of Natural calcium carbonate:

№	**Filler**	**Bulk density, g/cm³**	**Specific volume, ml/g**

1	Sample-1	0,92	0,57
2	Sample - 2	0,915	0,54

As a filler for polymer materials, calcium carbonate offers several advantages: a wide range of particle sizes and size distributions, the ease of applying various surface coatings to improve the rheological properties of filled polymer materials, and thermal stability at temperatures up to 550°C.

To determine the most suitable processing method for the raw material and the resulting calcium carbonate/polyethylene composites, melt flow rate testing (Method A in accordance with GOST 11645-2021) was conducted using a 2.16 kg load at a temperature of 190°C (Table 4).

Table 4.

Melt flow rate of the obtained compositions and the base polymer material

Compositions	**Density, g/cm^3**	**MI, g/10 min**
Virgin PE (0 wt%)	0,920÷0,946	0,3÷5
Composition 1 (PE 90 K 10)	1,0	0,25÷4,6
Composition 2 (PE 80 K 20)	1,05	0,23÷4,0
Composition 3 (PE 70 K 30)	1,1	0,2÷3,8
Composition 3 (PE 60 K 40)	1,15	0,18÷3

At a filler content of 40 wt.%, the melt flow rate (MFR) is observed to decrease to 0.6 times that of the base polymer. With further increases in filler content of 10 wt.% and 20 wt.%, the melt flow rate continued to decrease—as expected—to 4.6 and 4.0 g/10 min, respectively, relative to the MFR of the base polymer material.

List of reference:

1. Технология пластических масс/Под ред. В.В.Коршака. Изд. 3-е¬М.: Химия, 1985
2. Энциклопедия полимеров - М.: Советская энциклопедия, 1972.-Т.1
3. Калинчев Э.Л., Саковцева М.Б. Выбор пластмасс для изготовления и эксплуатации изделий: Справ, изд.- Л.: Химия, 1987

4. Nova Chemicals s.a. “Sclairtech basic Engineering Package for 125.000 MTA Linear Polyethylene Plant”, 1997
5. ГОСТ 11645-2021 – “ ПЛАСТМАССЫ. Методы определения показателя текучести расплава термопластов Пластмассы.