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Modification of secondary low density polyethylene (SLDPE) with shell-shaped limestone

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A B S T R A C T

Low-density polyethylene has a good balance of flexibility, strength, barrier properties, and cost and can have a wide combination of properties. Low-density polyethylene has high clarity, is chemically inert, and has good impact strength and excellent tear and stress crack resistance. Low-density polyethylene (LDPE) has applications in sterile blister packs for drug packaging. Linear low-density polyethylene (LLDPE) is used in films and packaging due to its flexibility and toughness.

High-density polyethylene (HDPE) is typically translucent and less flexible than LDPE. Due to its higher crystallinity, it has better chemical resistance, stiffness, and strength than LDPE. Surgical and medical instruments use the vast majority of HDPEs. Like LDPE, HDPE exhibits good chemical and stress crack resistance, radiation resistance, and impact strength.

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I. Introduction

Low density polyethylene is produced by a high pressure process, and has a mix of long and short branched chains and around 50-65% crystallinity, making it translucent in appearance. It is soft and flexible with good elongation before breakage and good puncture resistance. It has a fair moisture barrier and poor oxygen barrier and softens at around 100°C (lower for some grades), making it an economical polymer to process and readily heat sealable, but of course unsuitable for cook-in packs. In common with all the polyolefins, it is non-polar and must be surface treated prior to printing or laminating [2, 3].

Low density polyethylene (LDPE) is a high branched PE. Its high ramification confers a low density to the molecule as well as a lower hardness, stiffness and strength than high density polyethylene, but with higher ductility. It is semitransparent, and only thin foils can be transparent. That strong ramification hinders the packing of the molecules, diminishing the crystallinity of the material.

The development of new polymer compositions is due to the modification of the existing polymers on the basis of multi-component systems. Fillers are one of the main components in the preparation of low density polyethylene (LDPE) coatings and other polymeric materials. The fillers change the physical and mechanical properties, regulate sustainability and reduced the cost of polymer compositions. Considering these, as local mineral fillers were used the cockle-shell and chalky-shaped limestone. This type of fillers were collected by large quantities in the form of a residue in the limestone industry of Azerbaijan Republic. Every year this type of residues was accrued 10-15% of natural stone production.

Currently, the chemical composition, properties, classification, conditions of grinding, dehydration and the processes of incorporation into polymer compositions have been of natural mineral fillers of limestone. The natural mineral fillers of polymer materials is useful in several ways.

The use of polymer compositions of limestone-type fillers reducing their cost, along with improving

the properties of compositions, allow for the expenditure of these products and consequently for the environmental improvement.

II. Experimental Materials and Preparation

Preparation this type of fillers is related to the selection, grinding, drying, and separation of fillers from stone production enterprises. During research it was used chalk-shaped and shell-shaped limestone samples from the Garadag field. It was selected white type of chalk-shaped and grey type of shell-shaped limestone in this place.

Methods

The samples of limestone were selected, mixed and granulated to a small dispersion in the roller mill. The specific surface of the powder filler of nitrogen vapors was 0.8-1.0m^2/gr by the adsorption in low-temperature. Granulated fillers are dried because they have a moisture content of 10-40% (mass). The drying process was carried out at 105-110^{0}C during 14 hours and the main moisture mass is removed within 6-10 hours. Adsorption does not require expulsion of moisture at 100-150^{0}C (Figure 1).

After drying the limestone was dissolved. The output of powdered limestone was 82-98% (mass). The size of particles is approximately 60 mkm. This data allow the use of the Garadagh shell-shaped limestone for modification of secondary

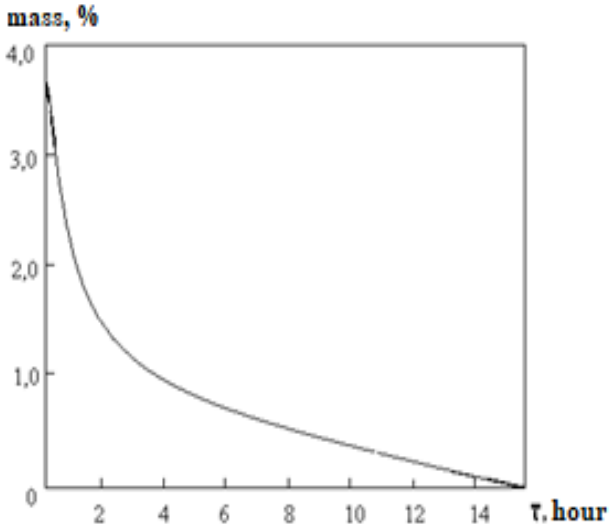

Fig. 1. Drying kinetics of Garadagh shell-shaped limestone, 105^{0}C

LDPE. The main ingredient size of particles is ranging from 6 to 20 mkm in mixtures.

In addition, the chemical composition of the shell-shaped limestone of the Garadagh field is particularly close to the chalk-shaped limestone, which is used as a filler in the polymer industry. In the manufacture of low-thickness products, these fillers are mixed together with plasticizers to prevent contamination [4].

The main physical and mechanical properties of compositions in different quantities were determined (Table 1).

Table 1. Physical and Mechanical Properties of LDPE (16603-011) which was in exploitation and modification

Pressing, %	Heat resistance according to Vika, ^{0}C	Module of flexibility in bending, MPa	Solidity, MPa	Relative extension, %	Fracture resistance, MPa	Flow rate of polymer alloy, 190^{0}C, load 2,16 kg. gr/10 min.	Names of indicators	
3,0	105	98	18	600	12,2	1,1	Primary LDPE	
-	-	42	25	260	7,7	0,075	During exploitation	
0,5	105	70	20	340	8,1	0,4	1	Modified LDPE
0,5	107	71	20	340	8,4	0,4	2	
0,3	110	68	22	320	9,6	0,3	3	
0,1	118	65	22	300	10,3	0,18	4	
0,1	120	60	23	290	10,7	0,12	5	

It has been shown in table that some properties of LDPE (16603-011) during exploitation are improving. This improvement is primarily due to the composition of shell-shaped limestone. The reason is that it contains many metal oxides [5].

The functional - OH, -COOH groups of secondary LDPE, chemically are linked to metal oxides at high temperatures (150-180^{0}C) during mixing and extrusion. Improvement of the properties of LDPE during exploitation is explained by the interaction.

Fracture durability of secondary LDPE increases to 1.8 Mpa in 20-25 mass of filler. At the same time, the increasing of the flow index of alloy and the relative extention indicates that LDPE is plastic. According to the price of these instructions, a modifying amount of shell-shaped limestone was taken 20÷25 mass.

III. Conclusion

After exploitation, the LDPE becomes fragile and its agility module decreases from 98 to 42 MPa. Adding shell-shaped limestone to Secondary LDPE with stearin acid significantly reduces its fragility and increases the agility module to 74 MPa. Generally, the fragility of LDPE makes it difficult to handle during exploitation.

Modification of mineral fillers during exploitation destroys the weak bag structure of secondary LDPE and increases elasticity of polymer.

According to Vika, the increasing of heat resistance is explained by the formation of new bonds in the polymer-filler system. The heat resistance in the optimum number of fillers according to Vika is 110-118 ^{0}C, which is 13^{0}C higher than the original polymer [6].

The results have been shown the modification of LDPE (16603-011) during exploitation with shell-shaped limestone (mineral filler) within 6 months in Absheron are effective. At the same time, the increasing of shell-shaped limestone in the composition to 20÷25 mass, allows for more use than sludge and seolite fillers (6÷8 mass).

LDPE is widely used in packaging like foils, trays and plastic bags for both food and nonfood purposes. It is also used as protective film on paper, textiles and other plastics. For instance, one of the most famous applications is in milk cartons, where it forms part of a system of different plastic layers. Other applications are wrapping foil for packaging, plastic bags (the soft type that does not crackle), garbage bags, tubes or ice cube plastic bags [3].

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