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STUDY OF PHYSICO-CHEMICAL PROPERTIES OF SULPHUR, NITROGEN AND PHOSPHORUS-CONTAINING OLIGOMERS

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Abstract. *In this paper the synthesis of oligomers containing sulfur, phosphorus and nitrogen were studied of optimum conditions. The obtained oligomers were used as polyethylene fillers, and the effect on the physicochemical properties of polyethylene was studied. Also, the thermal stability of polyethylene filled with fillers after the addition of fillers was analyzed using TGA and TDA analyses. According to the obtained results, it was found that these oligomers improved the thermal physical-chemical properties of polyethylene.*
Key words: *phosphorus-containing oligomer, nitrogen-containing compounds, viscosity, oligomers.*

Introduction.

The main modern world trend in the development of any type of products is the creation on its basis of a wide range of models, types, brands, modifications that ensure the effective development of a rapidly growing modern economy, expanding the scope of products that increase the volume of its output. This trend is fully typical for modern, especially thermoplastic polymer materials. The development of modern technology requires all new materials with predefined properties, but the creation and development of new polymers does not practically occur[1,2]..

The main goal, which is pursued when filling polymers, is to reduce the cost of products based on them. In the vast majority of cases, the introduction of fillers leads to an increase in the brittleness of the resulting composite material and a catastrophic decrease in its frost-resistance, which is particularly pronounced at high volume fractions of the filler. At the same time, the maximum possible degree of filling for polymers processed from the melt is limited by the value of the viscosity of the melt and, as a rule, does not exceed 40%.

Filling always leads to difficulties in the molding of articles, which is associated with an increase in the viscosity of the melt compared to the melt of the unfilled polymer [3,4].

In general, the complex of properties of filled polymers is determined by the combined effect of a number of factors, the most significant of which are: the nature of the thermoplastic and filler, the shape and size of the filler particles, the mutual arrangement of the filler particles and the change in their local density over the sample volume, and the filler concentration [4,5].

The nature of the thermoplastic and filler primarily determines their compatibility when molding the composite material. If the polymer and the filler are incompatible, the resulting product will have reduced mechanical characteristics, since applying the load will destroy the adhesive bond,

which results in the separation of the matrix from the filler particles. If the adhesion work achieved by the contact of the polymer and the filler is large, then the load applied to the composite material will be distributed more or less evenly without significant stress concentration at the polymer-filler interface. At high strength of polymer-filler adhesion bonding, it is possible to produce composites with relatively high mechanical characteristics [6,7].

Experimental part

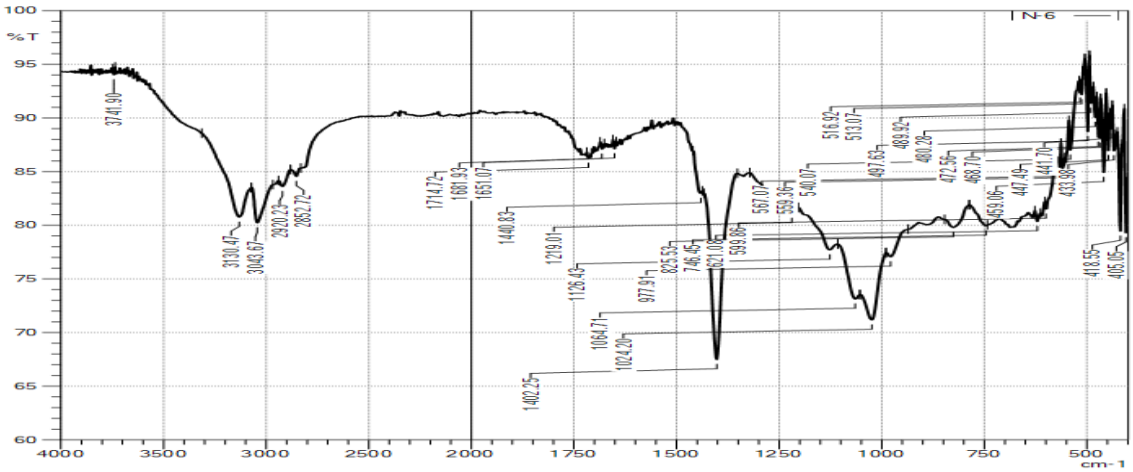
This work is devoted to the preparation of effective fillers based on sulfur, nitrogen and phosphorus-containing oligomers for polyethylene.

Therefore, the modification of known polymers, the development of polymeric composite materials filled with functional additives, or blended compositions, is today one of the priority directions in the development of polymers and composites with predictable properties.
The production of new synthesized highly additive additives for polymeric materials, which have high heat resistance and flame retardant efficiency, stabilization of polymers, ecologically safe and economical for today, is an urgent task[8,9].
Physicochemical properties were studied: density, melting point, solubility, IR spectroscopy, and DSC in sulfur, nitrogen, and phosphorus-containing oligomers. Physico-chemical characteristics of the synthesized high-grade oligomer DAF-6 (Ammophos with sulfur-containing organic compounds) are presented in Table 1

Table 1.
Physico-chemical characteristics of a high-grade oligomer

Indicators	Highly complete oligomer
	DAF-6
Density, g / cm^3 GOST 15139-69	1.40
Mp oC	130
Iхв	0.070
Solubility	dimethylformamide
Appearance and color	viscous substance of brown color

On the NDA-6 IR spectrum in the regions of 2850-1470 cm^{-1} there are absorption bands confirming the presence of -CH_2-groups and absorption bands in the 1650 cm^{-1} region, confirming the presence of the -$COHH_2$ group in the free state. The IR spectrum contains absorption bands in the 3400 cm-1 region corresponding to the primary -$COHH_2$ groups and absorption bands in the 3300-3440 cm^{-1} regions corresponding to the secondary -COHHR groups. The deformation oscillations of all active groups are manifested in the form of strong narrow bands between the usual bands of deformation vibrations -CH_2-CO- in the region 1400-1465 cm^{-1}. The absorption bands in the 800 and 1600 cm^{-1} regions confirm the presence of -NH_2 groups. The presence of groups containing phosphorus P = O and P-O-C in the region of 1000-1180 cm^{-1} is confirmed by a broad intensive band and sulfur-containing compounds in the regions 400-900 cm^{-1}, 1040-1060 cm^{-1} and 1100-900 cm^{-1}[10,11].
In addition, narrow low-intensity bands containing sulfur-containing compound bonds appear in IR spectroscopy in the regions 600-800 cm^{-1} and 1460 cm^{-1}. When considering IR spectra of NDA-6, intensive -CH_2-N- groups with dimmer indices of 1400-1440 cm^{-1} and organic phosphates of 1180 cm^{-1} 1150 cm^{-1} are seen. (Fig. 1).



Picture 1. IR spectrum of sulfur, nitrogen and phosphorus-containing oligomer of DAF-6 brand.

Results and Discussion

The influence of oligomers on the DSC process of a sulfur, nitrogen and phosphorus-containing oligomer of the DAF-6 brand was studied. The weight of the DAF-6 sample does not change to 207 ° C. A single endothermic peak (at 184.1 ° C) is observed on the DSC curve in the temperature range 20 -207 °C, which corresponds to the melting of the sample. Above the temperature of 207 °C, the sample begins to decompose in two stages - up to 265 ° C at a rate of 6% / min, and above 265 °C at a rate of 2.5%/ min, with a total weight loss of 73%. The decomposition reaction is endothermic, the total decomposition energy is -302.7 J / g. Fig.3.

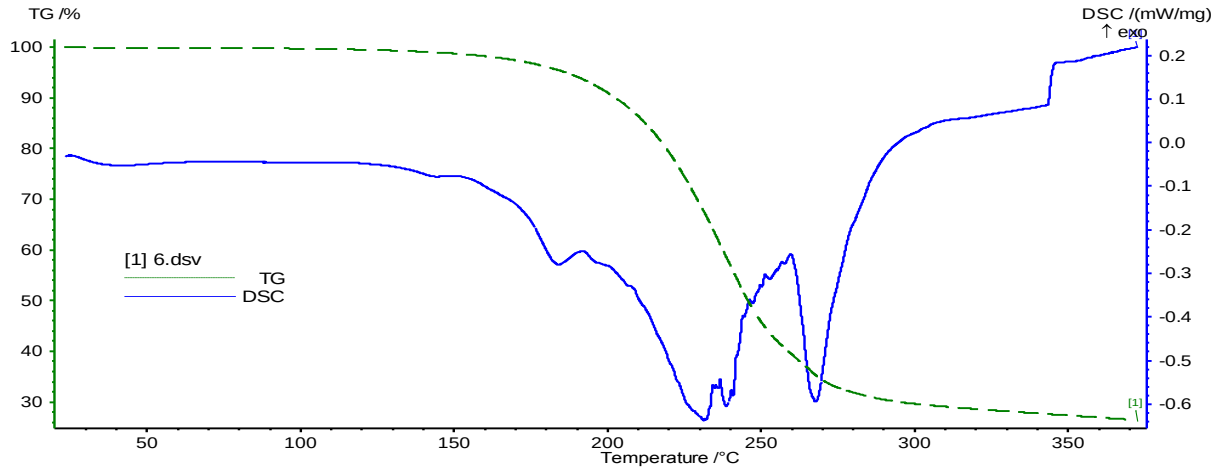


Figure.2. DSC sulfur, nitrogen and phosphorus-containing oligomer DAF-6

Conclusion.

Thus, the characteristic properties of the sulfur, phosphorus and nitrogen containing oligomer were determined by IR spectroscopy and DSC, as a result of laboratory tests and it was proved that the oligomer can be used as high-grade additives for polymeric materials

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