

Study of Mixtures of Obtained Products of Chemical Destruction of Pet

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Every year, the problem of environmental pollution from solid household waste, in particular waste from plastic packaging containers (polyethylene, polypropylene, polystyrene, polyethylene terephthalate), is becoming more acute. Scientists from all over the world pay great attention to the development of technologies for cost-effective methods and approaches for recycling these types of waste with the extraction or production of valuable secondary raw materials, including the development of recycling technologies to obtain new ingredients for rubbers and thermoplastics. Plastic waste can be considered as a potential source of valuable raw materials for the chemical industry.

Subsequently, the influence of the resulting products of chemical destruction of PET on the kinetics of sulfur vulcanization of rubbers based on nitrile butadiene rubber and the elastic-strength properties of the resulting vulcanizates was studied .

All rubber mixtures were produced under the same conditions and mixing modes. In rubber mixture 3, zinc oxide was replaced by a PET degradation product, based on previously obtained data on the kinetics of vulcanization of mixtures 1 and 2.

In mixture 6, the Captax accelerator was partially replaced with a PET destruction product, and in mixture 7, the amount of accelerator was taken 2 times less than in the base mixture. When studying the influence of new ingredients on the properties of rubber compounds, the kinetics of vulcanization of manufactured rubber compounds was first assessed.

When adding an oligomer based on terephthalic acid diamide , the T10 and T50 indicators almost double compared to the model mixture , which leads to an increase in the induction period of vulcanization (T10). In the case of T90, the changes are insignificant; the increase in this time is up to 1.5 minutes.

It is worth paying special attention to mixtures with a partial replacement of the common vulcanization accelerator Captax (2-mercaptobenzothiazole). In the case of using a halved amount of accelerator, the T10 and T50 indicators increase by 50%, and when captax is partially replaced with a PET destruction product, these indicators remain at the level of the model mixture, which confirms the accelerating effect of the used destruction product on sulfur vulcanization of rubbers based on nitrile butadiene rubber.

Subsequently, the elastic-strength properties of the obtained vulcanizates . Table 1 shows data on the tensile strength and elongation at break of the resulting mixtures.

Table 1 Elastic-strength characteristics of rubbers based on nitrile butadiene rubber with the addition of degradation products of PET and oligomer based on it

Mixture	f_p , MPa	e, %	Hardness
Model	22.6	283	81.3
2	16.60	265	80.2
3	18.70	356	81.1

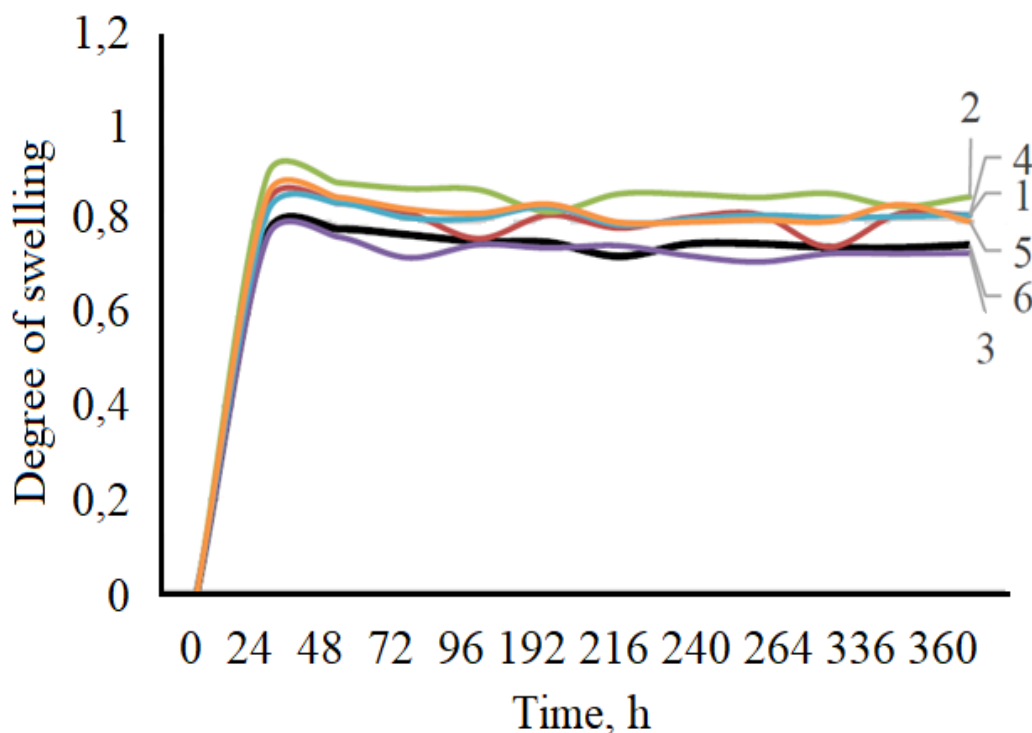


4	18.85	375	80.5
5	18.19	661	74.4
6	17.75	703	75.1
7	18.97	735	75.5

As can be seen from Table 1 of mixtures 3 and 4, where the additive was an oligomer based on PET degradation products, the relative elongation at break, in comparison with the model mixture, increased by 7-2 and 93 percent, respectively, which indicates the plasticizing effect of the oligomer based on PET degradation products. However, it is worth noting that in this indicator the oligomer is inferior to the common plasticizers currently used in the polymer industry, such as dioctyl phthalate (DOP, mixture 5), dioctyl sebacate (DOS, mixture 6) and dibutyl phthalate (DBP, mixture 7).

In the case of adding degradation products of PET and an oligomer based on it, the conditional tensile strength. In this case, this is due to the plasticizing effect of the new introduced components (destruction products of PET and the oligomer based on it). Similar data were obtained using DOP, DOS and DBP.

Subsequently, the kinetics of swelling of rubber compounds in gasoline and toluene based on nitrile butadiene rubber with the addition of terephthalic acid diamide and its oligomer was studied (Figure 1 and 2).

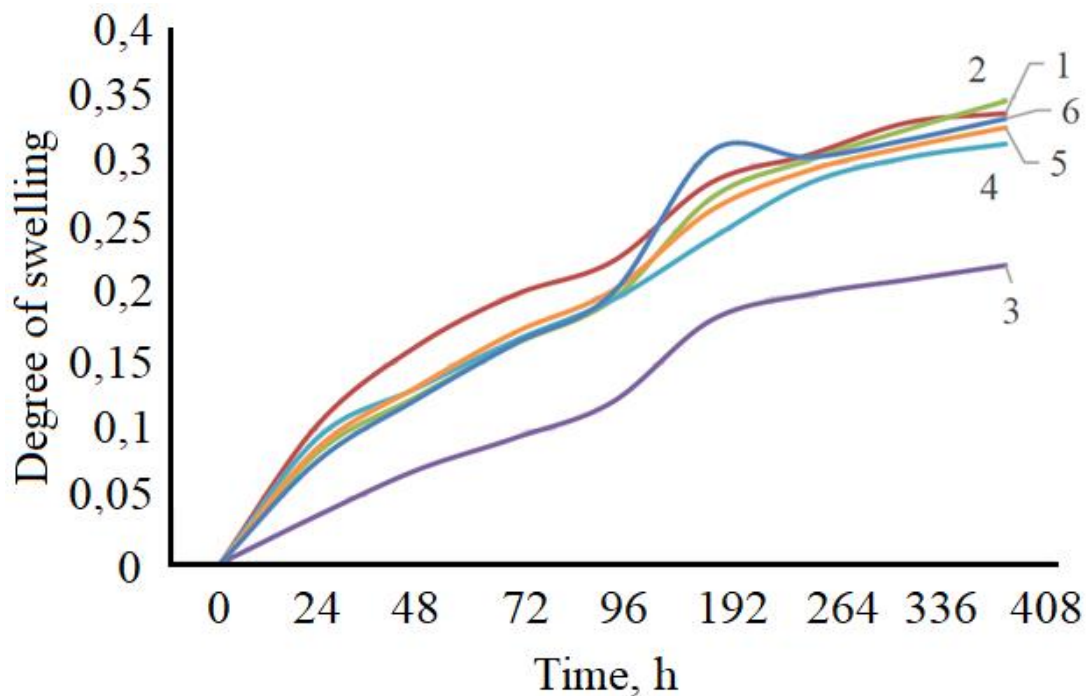


**Fig. 1 – Kinetics of swelling of rubber compounds in toluene
(curve 6 – model mixture number 1)**

Table 2 Amount of toluene soluble component

Mixture	Amount of mixture component soluble in toluene, mass %
Model	1.4
1	2.2
2	3.4
3	2.4
4	0.8
5	2.6





**Fig. 2 – Kinetics of swelling of rubber compounds in gasoline
(curve 6 – model mixture number 1)**

The swelling of the resulting rubbers, with the addition of the degradation product of PET and its oligomer, in toluene has the same character for all 6 mixtures, including the model mixture. However, the amount of the component that dissolved in a given solvent is different.

It is worth paying attention to mixture 4, where the smallest amount of the component dissolved in toluene was observed. Such data may indicate that the oligomer in the mixture may be in a bound state either with the chains of polymer macromolecules themselves, or with other components of the rubber mixture. However, with a higher content of oligomer based on PET degradation products, increased dissolution of the mixture components in toluene is observed, even in comparison with the model mixture. This may be explained by an excess of this component in the mixture and its incomplete binding, or by shortcomings in the preparation mode of this mixture.

When rubber swells in gasoline, it is clearly noticeable that the swelling of mixture 3 differs significantly from other mixtures. It can be seen from the curve that the degree of swelling of this mixture is approximately one and a half times less than the degree of swelling of other mixtures. This type of swelling of mixture 3 in gasoline may be due to the formation of a larger number of cross-links, which significantly reduces the rate of solvent diffusion into the sample. However, taking into account the elastic-strength characteristics of this rubber, we can say that the additional cross-links formed are less strong, as can be seen from the data in Table 2 - the conditional strength of mixture 3 is less than that of the model.

It is also worth paying attention to the swelling curve of the model mixture in gasoline. You can notice a characteristic “hump” on this curve, which indicates that during the swelling process some of the components of the rubber mixture dissolved in gasoline.

However, the subsequent behavior of the sample corresponds to its further slow swelling. In the case of all other samples, this phenomenon was not observed - all samples swelled gradually with a slight acceleration of solvent diffusion into the sample in the region from 95 to 100 hours.

A detailed analysis of the obtained data is carried out in comparison with literature data, which serves as a substantiation of the conclusions of the authors.

As a result of a study of the influence of aminolytic destruction products of PET and an oligomer based on it on the properties of vulcanizates of styrene-butadiene rubber, the accelerating effect of



these ingredients on the process of sulfur vulcanization, in particular the PET destruction products themselves, as well as the plasticizing effect of the oligomer based on the PET destruction product was revealed.

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