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INHIBITORS OF MINERAL SALT DEPOSITION BASED ON AMINOLYSIS-ALCOHOLLYSIS PRODUCTS OF USED PET

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ABSTRACT

The issues of corrosion and mineral salt accumulation are urgent problems, and it was found that the main components of modern multi-purpose inhibitors are organophosphonates and polymers, and their mechanism of action is the adsorption of salt on crystallization microparticles, as a result of which their growth stops, and due to the change in the shape and size of the crystals formed, they adhere to metal and other surfaces. The task was set to conduct scientific research on obtaining inhibitors of this type based on PET-based waste. In particular, special attention should be paid to considering the possibility of creating inhibitory acids based on aminolysis and alcoholysis products of polyethylene terephthalate-containing waste. This is the most economically affordable and most resistant to the effects of oxidizing biocides and polymers. This will allow reducing the cost of water treatment, using local reagents in water treatment, and reducing the anthropogenic load on the aquatic environment [1-3].

Secondary PET is a product obtained by recycling PET waste, including preforms, moldings and bottles. We recycle only production waste, so we get clean raw materials without impurities and impurities in production. Secondary PET granules are produced in colored (blue, green, brown) or colorless (unpainted) form [4-7].

INTRODUCTION

Aminolysis process technique: three-necked flask, thermometer up to 300 °C, reflux condenser, motorized stirrer, flask, heater. In the experiment, the IPET: triethanolamine ratios of 1:0.5; 1:1; 1:4; 1:6 mol el. link/mol were chosen.

Methodology for carrying out the aminolysis process. In a three-necked flask equipped with a stirrer, reflux condenser and thermometer, crushed, washed and dried IPET particles and TEA are added. The temperature is raised to 100 °C for 60 minutes, then to 225 °C for another 60 minutes. After reaching 225 °C, the synthesis is continued for 6 hours. The IPET particles gradually begin to swell, and after one hour after reaching 225 °C, the reaction mass becomes homogeneous. The synthesis products are relatively solid at room temperature, and with an increase in the molar ratio of triethanolamine, the consistency of the product becomes softer.

First, we studied the effect of the ratio of TEA from 0.5 to 6 moles per elementary unit taken for synthesis on the physicochemical properties of IPET. The synthesis conditions were selected based on literature data. In this case, the synthesis temperature was set at 220-225 °C and the duration of the decomposition was set at 6-8 hours (Table 1).

1-table

Physicochemical properties of synthesis products based on secondary PET waste. Synthesis conditions: T - 220 °C; τ - 6 hours

ИПЕТ: ТЕА mol:mol	G_S *mg*KOH/*g*	S_S *mg*KOH/*g*	K_S *mg*KOH/*g*	viscous VZ-4, *s*	Number of drops per Ubollede
1:0,5	459,19	344.14	Insoluble	hard	178
1:1,0	886,81	308	Insoluble	viscous	98
1:4,0	997,25	122	39,65	197	liquid in etc.
1:6,0	1171,5	91.4	18,9	134	liquid in etc.

As can be seen from the data in Table 1, with an increase in the amount of TEA from 0.5 to 6 mol, the amount of hydroxyl groups increases from 459 to 1171.5 mg KON/g. In addition, the Ubbelode droplet temperature decreases from 178 to 98 °C for samples with an elementary unit/mol ratio of 1:0.5 and 1:1 mol, respectively. Starting from a ratio of 1:4, the samples begin to liquidify. Analyzing the results studied, the effect of temperature on the properties of the products was studied, choosing a ratio of secondary PET and TEA as 1:4 mol elementary unit/mol. The temperature range was selected from 200 to 240 °C (Table 2).

2-table

Temperature dependence of physicochemical properties of IPET synthesis products

Temperature, °C	MM Cryoscopy	G_S *mg*KOH/*g*	S_S *mg*KOH/*g*	K_S *mg*KOH/*g*	viscous VZ-4, *s*	Ubollede bo‘yicha tomchilash soni
200	1501.4	577.20	72.8	34,99	240	liquid in etc.
220	1489.5	919.34	114.18	35,87	159	liquid in etc.
240	1456.8	1046.34	146.4	36,55	viscous	45

Thus, as shown in Table 3.2, a decrease in M.M. from 196 to 160, an increase in the number of hydroxyl groups and saponification number from 577 to 1046 mg KON/g, and an increase in the number of KON/g from 72.8 to 146.4 mg KON/g are observed. Accordingly, it should be noted that with an increase in temperature to 240 °C, the viscosity of the samples increases, which is probably due to the occurrence of secondary additional reactions with increasing temperature.

In the IR spectra of the synthesis-aminolysis product (IPET ratio: TEA = 1: 0.5 mol unit/mol, Figure 1), absorption bands are observed for hydroxyl groups at 3445 cm–1, methylene groups at 2957 cm–1, ether groups at 1718 cm–1, aromatic rings at 1555-1505 cm–1, tertiary amine group at 1269 cm–1, and primary hydroxyl groups at 1099, 1017 cm1.

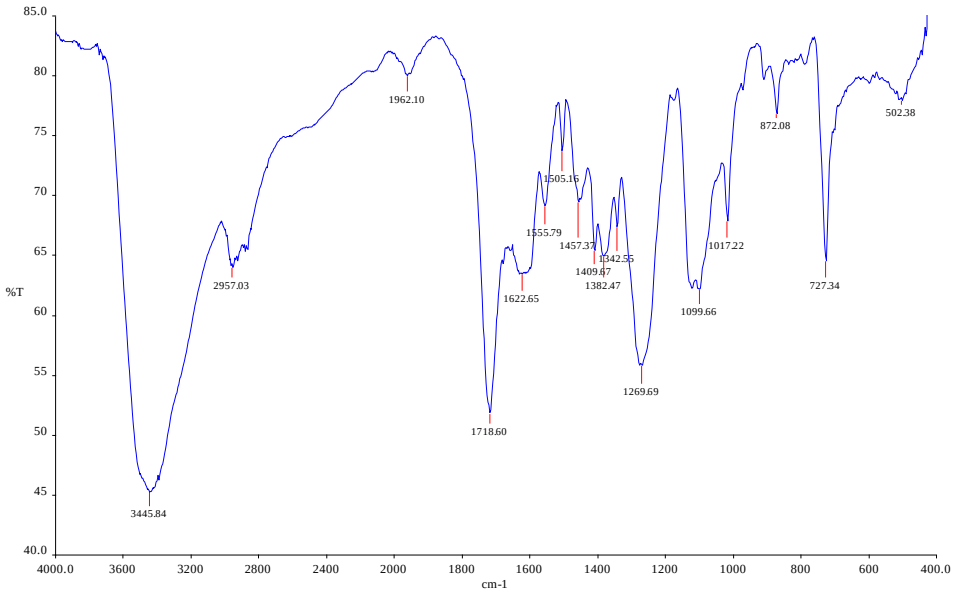

Figure 1. IR spectrum of aminolysis products of IPET. IPET: TEA = 1: 0.5

The presence of tertiary and primary groups in the IR spectra of the synthesized products indicates the occurrence of substitution reactions due to ether groups.

With a further increase in the amount of triethanolamine taken for synthesis, along with the existing functional groups (hydroxyl, ether bonds, aromatic rings), an increase in the intense absorption bands corresponding to tertiary nitrogen and primary hydroxyl groups is observed (Figures 2-4).

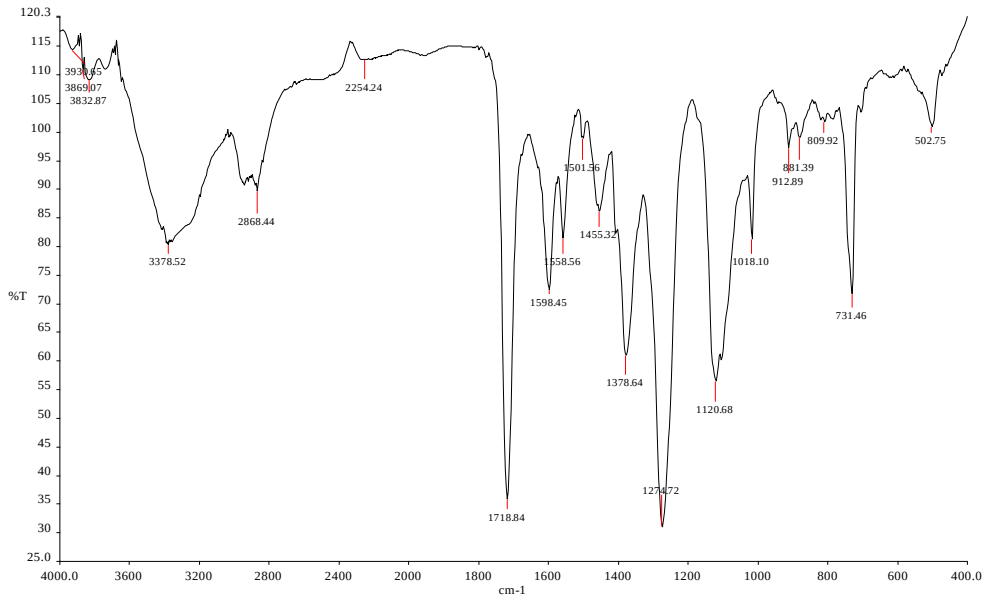

Figure 2. IR spectrum of aminolysis products of IPET. IPET: TEA = 1: 1

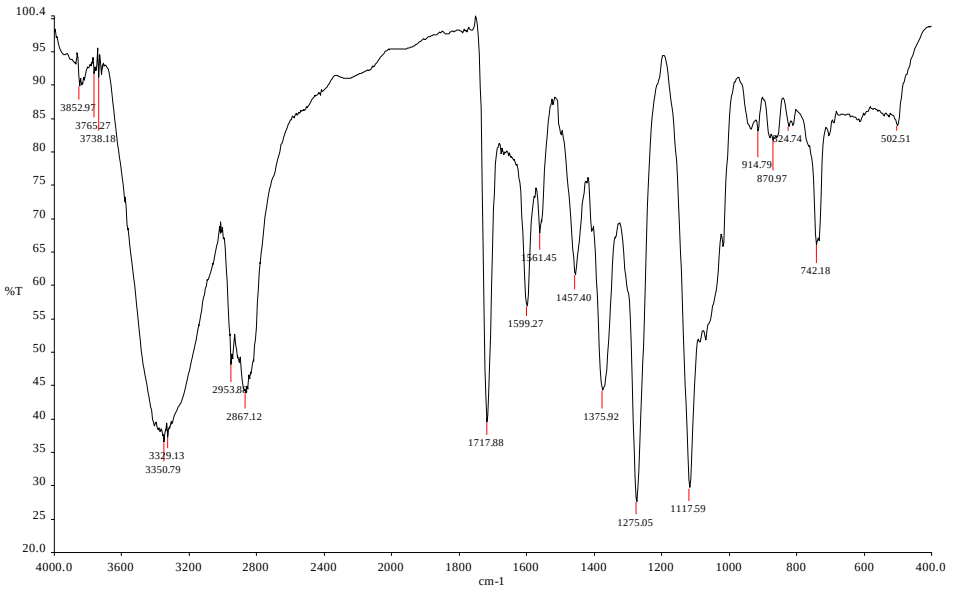

Figure 3. IR spectrum of aminolysis products of IPET. IPET: TEA = 1: 4

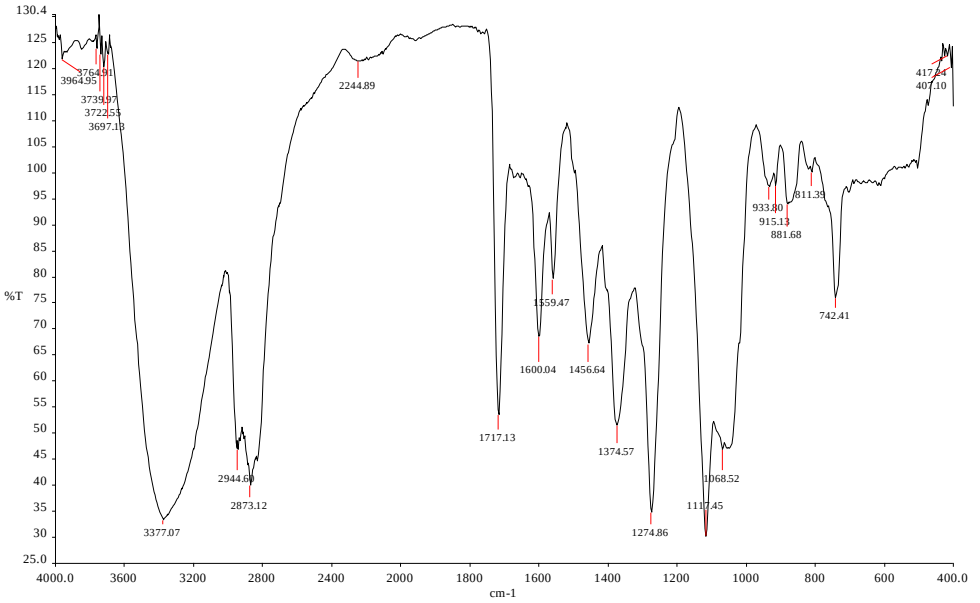

Fig. 4. IR spectrum of aminolysis products of IPET. IPET: TEA = 1: 6

Pure and used alkanolamines aminolysis products of PET in their pure state and in various compositions were tested as inhibitors against the accumulation of mineral salts in the waters of Tashkent (solids 4 - 5 mg⍰eqv/l), Navoi region (solids 8 - 10 mg-eqv/l) and the Republic of Karakalpakstan (solids 11 - 13 mg-eqv/l). The results of the analysis are given in Table 1 below.

Table 1

Efficiency of aminolysis products and compositions based on them in inhibiting the accumulation of mineral salts

	Mineral salt accumulation inhibitor composition	Inhibitor concentration mg/l	Inhibitory effect, %		
			Water hardness, mg/l		
			4 - 5	8 - 10	11 - 13

.	PET: TEA 1:1	2,0 4,0 6,0 8,0	48 50 52 52	45 47 48 50	38 40 42 45
.	PET: TEA 1:4	2,0 4,0 6,0 8,0	80 81 81 82	78 80 81 81	75 77 79 79
.	PET: TEA 1:6	2,0 4,0 6,0 8,0	80 82 82 83	78 79 80 80	75 78 79 79
.	PET: TEA 1:4 + GMTA	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	80 81 82 82	79 79 80 81	76 77 79 79
.	PET: TEA 1:4 + Pentaeritrit	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	80 82 82 83	77 78 80 80	75 75 77 78
.	PET: TEA 1:4 + OEDF	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	92 93 95 95	90 91 93 93	87 88 90 90
.	PET: TEA 1:4 + IOMS	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	91 92 92 93	90 91 91 91	88 90 90 90
.	PET: TEA 1:6 + GMTA	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	77 78 78 78	74 76 77 77	72 74 75 75
0.	PET: TEA 1:6 + Pentaeritrit	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	54 55 56 56	50 51 53 53	48 49 50 50
1.	PET: TEA 1:6 + OEDF	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	60 61 62 62	55 56 58 58	47 49 50 51
2.	PET: TEA 1:6 + IOMS	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	72 73 75 75	68 69 70 70	65 66 68 68
3.	PET: TEA 1:6 + FAA	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	54 56 60 60	52 53 53 53	47 48 50 50

4.	PET: TEA 1:4 + Pentaeritrit	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	67 69 69 70	65 66 67 67	62 63 65 65
5.	PET: TEA 1:4 + OEDF	1,5 + 0,5 2,0 + 1,0 3,0 + 1,5 4,0 + 2,0	88 90 91 97	86 88 90 90	84 85 88 88
6.	PET: TEA 1:4 + IOMS	0,5 + 0,5 1,0 + 1,0 1,5 + 1,5 2,0 + 2,0	90 92 93 93	89 91 92 92	87 88 89 90
7.	PET: TEA 1:4 + MDEA	0,5 + 0,5 1,0 + 1,0 1,5 + 1,5 2,0 + 2,0	80 81 81 81	78 79 80 80	76 78 79 79
8.	PET: TEA 1:4 + OEDF + MDEA	0,5+0,5+0,5 1,0+1,0+1,0 1,5+1,5+1,5 2,0+2,0+2,0	82 83 85 86	80 81 82 82	79 80 81 81
9.	PET: TEA 1:4 + IOMS + MDEA	0,5+0,5+0,5 1,0+1,0+1,0 1,5+1,5+1,5 2,0+2,0+2,0	80 81 82 82	79 80 80 80	77 78 79 80
0.	IOMS-1 (etalon)	2,0 4,0 6,0 8,0	91 92 93 93	90 91 91 91	89 90 90 90
1.	OEDF (etalon)	2,0 4,0 6,0 8,0	91 92 92 93	90 91 91 92	89 90 91 91

The tables show that PET: TEA -1: 4 prevents the accumulation of mineral salts by 48 - 70%. The presence of several hydroxyl and carboxyl groups in the ammonolysis products allows the formation of chelate complexes with calcium, magnesium, iron and other ions.

It can be concluded that the greater the number of hydroxyl groups, the higher the effectiveness of protection against the accumulation of mineral salts. In addition, with an increase in concentration from 1.5 to 4.0 mg / l, the effectiveness also increases.

Among the compositions prepared on the basis of PET:TEA 1:4 ratio of aminolysis products and polyhydric alcohols such as glycerin and pentaerythritol, OEDF and IOMS-1 industrial mineral salt accumulation inhibitors, melamine-based compositions, when added in mass ratios of 1.5 mg/l and methenamine - 0.5 mg/l, show an effectiveness of protecting against mineral salt accumulation of 70 to 80%, depending on the hardness of the water.

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