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# Preparation and Research of Antibacterial Polypropylene Composition Materials Based on the Cyclic Bisimides

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**ABSTRACT:** The antibacterial composition materials based on PP have been obtained from cyclic bisimides as biologically active additives, their physical-mechanical and antibacterial properties have been studied. It was found that the antibacterial additives in the amount of 0.5% did not affect the physical-mechanical properties of composition materials based on PP or slighly influnce on formation of antibacterial properties. Carrying out of fungicidal properties of obtained new antibacterial composition materials allows them to be used for the production of resistant products from fungus.

**KEY WORDS:** antibacterial polymer additives, antibacterial composition materials, cyclic bisimides, fungicidal properties, polypropylene

## I. INTRODUCTION

All the polymers produced in the world, 90% consists of polyethylene, polypropylene (PP), polystyrene and polyvinyl chloride, of which 20% belongs to PP. From polymer-containing thermoelastic pallets by PP modification, high-strength plastics, ecologically clean products, and so on are responsible for such a wide variety. PP has been rapidly launching applied in electronics, electrical engineering, instrumentation, automotive industry, transport and construction.

The simplicity of the PP processing and utilization technology compresses pushes plastics such as ABC, polystyrene, polyvinyl chloride on the World Market [1].

These polymers are often used in the form of composite materials (CM) in medicine, agriculture, household, etc such as mechanical rigidity, impact strength [2].

The exposure of PP products to biocorrosion bacteria and microbes limits their application. The polymer materials, including PP materials, and antibiotic supplements are included to prevent biocarrosis [3].

Synthesis of organic compounds of antibacterial properties and obtaining of antibacterial composite materials using them as antibacterial polymeric additives is an important problem [4].

The purpose of the article is to obtain antibacterial PP composite materials by using cyclic bisimides as antibacterial additives during the extrusion phase of PP-based composite materials.

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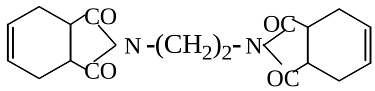
## II. EXPERIMENTAL PART

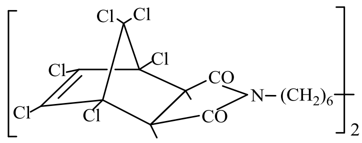
**Initial items**: Experiments used KMG (Russia) PP based PPG 1035-08 manufactured by STAVROLEN LLC, which stores 70% $Mg(OH)_2$ as a filler.

The following bisimides were used as antibacterial polymer additives:

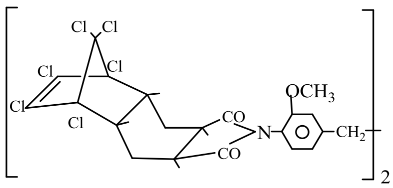
**A.** N,N´-(2-aminoethyl) bisimide of cis-cyclohex-4-ene-1,2-dicarboxylic acid. M.p. 146-147°C (benzene), $R_f$ 0.68. İR-spectrum $cm^{-1}$: 1715, 1780 (C=O), 1608 (C=C), 680-750 (C-Cl).



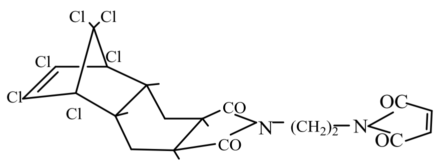
**B**. N,N´-(6-Aminohexyl) bisimide of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-en-2,3-dicarboxylic acid, m.p. 132°C (chloroform+hexane), $R_f$ 0.66. İR-spectrum $cm^{-1}$: 1710, 1780 (C=O), 1606 (C=C), 680-710 (C-Cl).



**C.** N, N '-(3,3-dimethoxy-4,4'-diphenylmethane) bisimide of endo, exo-1,2,3,4,11,11-hexachlorotricyclo [6.2.1.0$^{5,10}$] undec-2-ene-7,8-dicarboxylic acid, m.p. 172°C (hexane), $R_f$ 0.67. İR-spectrum $cm^{-1}$: 1717, 1780 (C=O), 1602 (C=C), 650-740 (C-Cl).



**D.** N-[(2-maleinimide) ethyl] bisimide of endo, exo-1,2,3,4,11,11-hexachlorotricyclo [6.2.1.0$^{5,10}$] undec-2-ene-7,8-dicarboxylic acid, m.p. 400°C (chloroform), $R_f$ 0.67. İR-spectrum $cm^{-1}$: 1717, 1780 (C=O), 1600 (C=C), 650-770 (C-Cl).



Preparation of composition materials and determination of physical-mechanical properties: PP ingredients for obtaining the polymer compositions are mixed and extruded at 160-170ºC temperature. The composition materials are made in a conical two-Ring Laboratory extruder (brand SCZS-10) at high temperature and large displacement voltage. The diameter of the screw of the extruder is 10/22mm, the length is 200mm, the rotation speed is 57cicle/min.. The duration of stay of each composition in the extruder is 10-12 min. made up. The compositions of different ingredients are prepared by the method of rinsing. Then the mixture of the bisimide of cyclic dicarboxylic acid with the finished PP composition material was granulated and the granules were pressed under pressure of 170ºC temperature and 14MPa in hydraulic press in the form of plates with a thickness of 0.52 mm. The obtained boards were cut in the form of a shovel in standard form in accordance with the Doist, and the strength limit and relative elongation in the shearing machine (brand WPM, VEB Rauenstein R-40, Tor-2092) were determined. Thus, on the basis of bisimide of cyclic dicarboxylic acid, antibacterial PP was obtained in different composition [6].

With the addition of the above compounds (0.5%), PP-based CM was obtained in the following composition:

**K 1** polypropylene composition material
**K 2** PP + A (N,N´-(2-aminoethyl) bisimide of cis-cyclohex-4-ene-1,2-dicarboxylic acid)
**K 3** PP + B (N,N´-(6-Aminohexyl) bisimide of 1,4,5,6,7,7-hexachlorobicyclo [2.2.1]hept-5-en-2,3-dicarboxylic acid)

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**K 4** PP + C (N, N '-(3,3-dimethoxy-4,4'-diphenylmethane) bisimide of endo, exo-1,2,3,4,11,11- hexachlorotricyclo $[6.2.1.0^{5,10}]$ undec-2-ene-7,8-dicarboxylic acid)
**K 5** PP + D (N-[(2-maleinimide) ethyl] bisimide of endo, exo-1,2,3,4,11,11- hexachlorotricyclo $[6.2.1.0^{5,10}]$ undec-2-ene-7,8-dicarboxylic acid)

The thermophysical analyzes of the ed CM were performed. The examples were investigated in the Paulik-Paulik-Erdey Q-1500D derivatograph. Weight of the sample is 100 mg, channel sensitivity is TG-100, DTA-250MV, DTG-1mV, T / V-500/5, airflow heating rate is 5° C/min, standard L-Al2O3 [7].

The heat resistance of CM is determined by the Vika method on a device called WPM, VEB Thüringer Industriewerk Rauenstein.

The microbials such as Aspergillus niger, A.ochraseus, Penicillium cuclopium, Cladosporium herbarium, Fusarium moniliforme, and F.oxysporium were used as a culture test to study the antibacterial properties of PP-based KM [8].

## III. RESULTS AND DISCUSSION

The main physical–mechanical parameters of antibacterial PP composite materials containing 0.5% bisimide are given in Table 1.

Table 1. Physical-mechanical indicators of antibacterial CM based on PP

| Examples | Composition | Relative extension | Mechanical strength | | Thermal Resistance, Vika |
|---|---|---|---|---|---|
| | | % | kg/mm$^2$ | MPa | ºC |
| 1-$K_1$ | PP composition material | 30 | 11 | 26.46 | 140 |
| 2-$K_2$ | PP + A | 31 | 11.14 | 25.96 | 142 |
| 3-$K_3$ | PP + B | 33 | 20.12 | 30.65 | 143 |
| 4-$K_4$ | PP + C | 32 | 16.7 | 25.61 | 145 |
| 5-$K_5$ | PP + D | 31 | 16.47 | 24.36 | 142 |

K-1- PP-CM; K-2-PP-CM+A; K-3-PP-CM+B ; K-4-PP-CM+C; K-5-PP-CM+D
As can be seen from the Table, the physical–mechanical properties of the CM, which contain 0.5% antibacterial cyclic bisimide, are much smaller than the PP-based CM, which is actually a measurement error. This is due to the small amount of bismides contained in the PP composition.

Heatphysical analyzes of antibacterial CM obtained were investigated. The results are presented in Table 2.

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Table 2. Heatphysical indicators of PP based CM with 0.5% cyclic bisimide content

| Examples | Composition | $T_{10\%}$ | $T_{20\%}$ | $T_{50\%}$ | $T_{1/2}$, °C | $\tau_{1/2}$, min | $T_{эт}$,°C |
|---|---|---|---|---|---|---|---|
| $KM_1$ | PP comp. | 280 | 328 | 370 | 370 | 63,2 | 155 |
| $KM_2$ | PP comp.+ A | 282 | 330 | 370 | 370 | 63.8 | 159 |
| $KM_3$ | PP comp.+ B | 279 | 332 | 370 | 370 | 63.0 | 162 |
| $KM_4$ | PP comp.+C | 280 | 330 | 372 | 370 | 63.5 | 165 |
| $KM_5$ | PP comp.+ D | 282 | 330 | 370 | 370 | 63.2 | 168 |

The thermochemical properties of the compounds studied were estimated based on mass loss (T10, T20, T50). On the basis of the obtained results, we can conclude that the thermal stability and melting temperature of the studied samples (Tare) are independent or insufficient.

The practical results presented in Table 2 show that the small amount of cyclic bisimides in the composition of PP-based composite materials does not affect the thermophysical properties of the final material.
T1 – 2-half decomposition temperature;
$t_1$ / 2-half decomposition time;
$T_{m.p.}$-melting temperature;
T10%, T20%, T50% – this is the temperature corresponding to 10, 20, 50% mass loss of samples.

The antibacterial properties of the obtained composite materials were investigated. Micrometers such as Aspergillus niger, A.ochraseus, Penicillium cuclopium, Cladosporium herbarium, Fusarium moniliforme, and F.oxysporium were used as the test culture. The presented composite materials were placed in a nutritious environment (fermented malt juice) for 60 days, and fungal cultivation was carried out. At the end of the period, the plastic material was microscopically tested and compared with the initial condition (Figure 1-5).

It has been found that none of the tested plastic materials has undergone any visual or microscopic changes (Fig. 2-5), which can be regarded as an indicator of the resistance of fungi.

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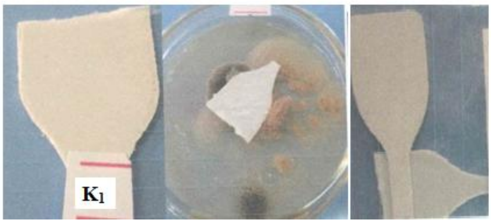
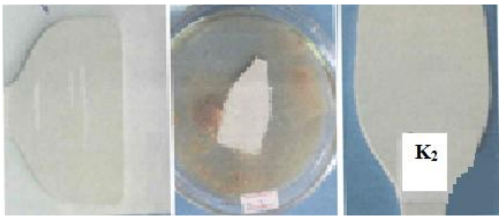
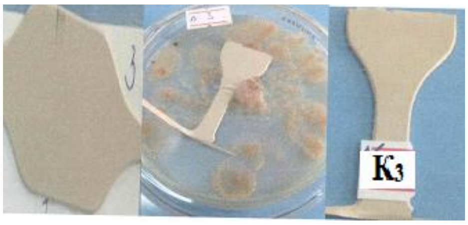


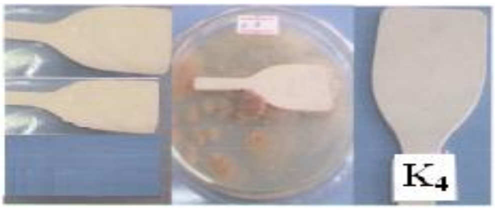

*Pic. 1.* PP composition materials



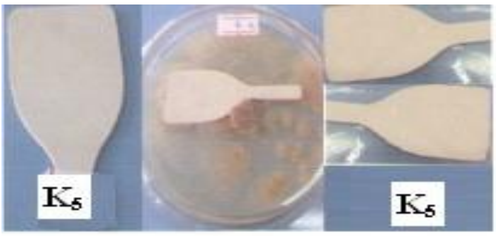

*Pic. 2.* PP + A (N,N´-(2-aminoethyl) bisimide of cis-cyclohex-4-ene-1,2-dicarboxylic acid)




*Pic. 3.* PP + B (N,N´-(6-Aminohexyl) bisimide of 1,4,5,6,7,7-hexachlorobicyclo [2.2.1]hept-5-en-2,3-dicarboxylic acid)




*Pic. 4.* PP + C (N, N '-(3,3-dimethoxy-4,4'-diphenylmethane) bisimide of endo, exo-1,2,3,4,11,11-hexachlorotricyclo $[6.2.1.0^{5,10}]$ undec-2-ene-7,8-dicarboxylic acid)




*Pic. 5.* PP + D (N-[(2-maleinimide) ethyl] bisimide of endo, exo-1,2,3,4,11,11- hexachlorotricyclo $[6.2.1.0^{5,10}]$ undec-2-ene-7,8-dicarboxylic acid)