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SYNTHESIS OF POLYIMIDES OF POLYCHLORINATED CYCLIC DICARBOXYLIC ACIDS ON THE BASIS OF DIENE-DIENOPHILIC BISIMIDES ON THE DIELS-ALDER REACTION

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The conditions for the synthesis of N-aminoimides of polychlorinated cyclic dicarboxylic acids has been studied and the possibility to obtain hinge-ladder polyimides by the Diels-Alder reaction has been demonstrated.

Keywords: Diels-Alder reaction, bisimides, polyimides, acylation, bisimidodienes.

There exist many methods of producing of polyimides (PI) synthesis [1], however they are based mainly on a two-stage procedure [2]. Besides the hinged polyimides obtained by the known methods do not possess 100% imidization due to an incomplete conversion of poly-amidoacidic links [1–3].

Polymerization by the Diels-Alder reaction is one of the promising and developing directions in the preparation of polyimides of various structures that promotes wide modification of their chemical composition and properties.

In this work the synthesis of polyimides with the using of N-aminoimides of mixed diene-dienophiles of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6- (V *a, b, c*) and 2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acids (VI *a, b, c*) and maleic anhydride is described.

The acylation of N-alkyl(aryl)aminoimides of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (HCBCHDCA) (I *a, b, c*)

and 1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]-undec-2-ene-7,8-dicarboxylic acid (HCTCUDCA) (II *a, b, c*) with maleic anhydride in the environment of DMF at 150°C leads to obtaining N,N'-maleinalkyl(aryl)substituted imides of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (III *a, b, c*) and *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]-undec-2-ene-7,8-dicarboxylic acid (IV *a, b, c*).

The obtained bisimides (III *a, b, c*) and (IV *a, b, c*) were brought into the reaction with a mixture of pyridine and acetic anhydride in DMF solution aiming at the preparation of diene-dienophile bisimides, N, N'-maleinalkyl(aryl)substituted imides of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V *a, b, c*) and *endo, exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI *a, b, c*). The reaction proceeded with heat evolution and temperature increase to 50°C. Then the mixture was stirred again for 2 h at 110–120°C.

The structure of bisimidodienes (*V a, b, c*) and (*VI a, b, c*) has been proved by IR and UV spectroscopy. In the IR spectrum of bisimidodienes (*V a, b, c*) and (*VI a, b, c*) there are observed the characteristic absorption bands in the field of 1710–1780 cm^{-1} for the imide cycles, 1600–1610 cm^{-1} for the C=C, 750 cm^{-1} corresponding for the C–Cl bonds vibrations (Figure 1).

The UV spectrum of bisimides (*V a, b, c*) and (*VI a, b, c*) contained the absorption bands characteristic of a diene system in the region 285 nm. The presence of the diene system in bisimides of diene-dienophiles (*V a, b, c*) and (*VI a, b, c*) was confirmed by their polycondensation in the presence of hydroquinone for 4–6 h at 150°C.

In the process of polycondensation by the Diels–Alder the choice of the solvent in solution plays a decisive role [5, 6]. We have studied several

aprotic solvents (DMF, DMA and DMSO). The reaction was carried out at 150°C and a duration of 6–8 hours. It was found that with increasing in the solvent polarity the viscosity and the yield of polyimide is increased. The greatest yield of polymer is reared when using DMA as solvent. It reaches 90–95 %.

To determine the optimal conditions for the synthesis of polyimides, the influence of the concentration of the initial monomer, the temperature, and the duration of the reaction on the course of polycondensation of diene–dienophilic bisimides (*V a, b, c*) and (*VI a, b, c*) has been studied.

In the IR spectra of polyimides VII and VIII there are the characteristic absorption bands the field of 1712, 1780 cm^{-1} for the C=O, 600–750 cm^{-1} corresponding for the C–Cl bonds vibrations (Figure 2).

Fig. 1. IR spectrum of bisdiene *VI a*.

Fig.2. IR spectrum of polyimides VII and VIII.

In the solutions of polyimides VII and VIII in determining $[\eta]$ the polyelectrolyte effect is not observed (Figure 3). Therefore, the molecular mass (MM) of the polyimides was judged by the reduced viscosity η_{re} of the reaction solution.

The investigations of the influence of the monomers concentration on η_{re} showed that η_{re} polyimides based on diene-dienophilic bisimides (V *a, b, c*) and (VI *a, b, c*) depends on the bi- and tricyclic fragment and is a curve with a maximum of the corresponding initial mono-

mers (Figure 3). The optimum monomer concentration is 20 mas %. Increasing the concentration above the optimum leads to a decrease in the MM polyimide.

The influence of the reaction temperature on the MM polyimide is shown in Figure 3, where η_{re} increases with increasing temperature: at 130°C η_{re} 0.10–0.15 dl/g, at 140°C 0.22–0.26 dl/g, at 150°C 0.36–0.38 dl/g, respectively, temperature increase to 160°C leads to a decrease in η_{re} to 0.30–0.25 dl/g.

Fig. 3. Dependence of η_{re} on the concentration of polyimides on the basis of the diene-dienophiles: 1 – VII, 2 – VIII.

Fig. 4. Dependence of η_{re} of 0.5% solution of polyimides on the basis of the diene-dienophiles: 1 – VII, 2 – VIII.

Fig. 5. Dependence of η_{re} on temperature of polyimides on the basis of the diene-dienophiles: 1 – VII, 2 – VIII.

Fig. 6. Dependence of η_{re} on of duration of polyimides on the basis of the diene-dienophiles: 1 – VII, 2 – VIII.

Optimal duration of the reaction reached at 150°C for 6–8 hours. Increase the duration leads to a decrease in η_{re} .

Thus, the study of the formation of polyimides VII and VIII on the basis of the diene–dienophilic bisimides (V *b*, *c*) and (VI *b*, *c*) in DMA showed that the greatest value of η_{re} is achieved when the concentration of monomers in 20 mass % at 150°C for 6–8 hours (Figures 5, 6). The yield of polyimides under these conditions is 90–95%.

The obtained PI are well soluble in polar solvents (DMF, DMA, N-methylpyrrolidone, DMSO and pyridine). They are heat-resistant up to 300–360°C. The loss in mass PI of this temperature is 5–6%.

Hence our research demonstrated the possibility to obtain hinge-ladder polyimides with the desired spatial structure.

Experimental part

IR spectra of synthesized compounds were recorded on a spectrophotometer UR-20 from mulls in mineral oil [7]. UV spectrum were obtained on a spectrophotometer Specord UV-Vis from solutions in methanol, concentration $1.5 \times 10^{-4} \text{ mol l}^{-1}$. As internal reference we used CCl_4 . Molecular mass was determined by the method [7] of melting with camphor.

The purity of compounds was checked by TLC on Silufol UV-254 plates, eluent benzene–dichloroethane–AcOH, 8:3:1, development under UV irradiation [8].

The reduced viscosity η was measured using Ubbelohde viscometer with extrapolation of the values $\eta_{re/c}$ (at 25°C) of the polymer solution in DMF to the zero concentration [9].

Anhydride of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid was prepared by the procedure [10].

Anhydride of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid was prepared by the procedure [11].

N-Substituted cyclic imides of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (I *a*, *b*, *c*). To a solution of 0.01 mol of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid anhydride in 50 ml of

DMF was added at stirring 0.01 mol of an appropriate diamine in 10 ml of DMF, the mixture was stirred for 6 h at 150°C, cooled to room temperature, and poured in ice water. The precipitated crystals were filtered off, washed with water several times, dried, and analyzed.

N-(2-Aminoethyl)imide of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (I *a*). Yield – 91%, m.p. – 133°C (benzene), R_f – 0.71. IR spectrum, ν , cm^{-1} : 3350 (NH_2), 1720, 1780 (C=O), 1601 (C=C), 680–750 (C-Cl). Found, %: C 31.61, H 1.98, Cl 36.58, N 7.70. M 413. $\text{C}_{11}\text{H}_8\text{Cl}_6\text{N}_2\text{O}_2$. Calculated, %: C 47.48, H 2.96, Cl 34.80, N 4.58. M 413.09.

N-(6-Aminohexyl)imide of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (I *b*). Yield – 94%, m.p. – 143°C (benzene), R_f – 0.68. IR spectrum, ν , cm^{-1} : 3420 (NH_2), 1780 (C=O), 1606 (C=C), 650–680 (C-Cl). Found, %: C 37.92, H 3.09, Cl 44.88, N 5.41. M 468. $\text{C}_{15}\text{H}_{16}\text{Cl}_6\text{N}_2\text{O}_2$. Calculated, %: C 38.41, H 3.43, Cl 45.35, N 5.97. M 468.99.

N-(2-Aminophenyl)imide of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (I *c*). Yield – 92%, m.p. – 145°C (petroleum ether), R_f – 0.67. IR spectrum, ν , cm^{-1} : 3350 (NH_2), 1780 (C=O), 1601 (C=C), 650–710 (C-Cl). Found, %: C 40.82, H 1.81, Cl 49.06, N 5.41. M 460. $\text{C}_{15}\text{H}_8\text{Cl}_6\text{N}_2\text{O}_2$. Calculated, %: C 39.04, H 1.76, Cl 44.05, N 6.07. M 480.92.

N-Substituted cyclic imides of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo-[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (II *a*, *b*, *c*). Similarly from 0.01 mol of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid anhydride and 0.01 mol of an appropriate diamine aminoimide II *a*, *b*, *c* was prepared.

N-(2-Aminoethyl)imide of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo-[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (II *a*). Yield – 92%, m.p. – 120°C (benzene), R_f – 0.70. IR spectrum, ν , cm^{-1} : 3280 (NH_2), 1720, 1780 (C=O), 1601 (C=C), 600–705 (C-Cl). Found, %: C 43.86, H 2.81, Cl 41.01, N 6.01. M 466. $\text{C}_{15}\text{H}_{14}\text{Cl}_6\text{N}_2\text{O}_2$.

Calculated, %: C 39.58, H 3.00, Cl 47.30, N 6.00. *M* 467.

N-(6-Aminohexyl)imide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (II *b*). Yield – 95%, m.p. 153°C (benzene), *R_f* – 0.69. IR spectrum, ν , cm⁻¹: 3280, 3420 (NH₂), 1720, 1780 (C=O), 1601 (C=C), 602–710 (C–Cl). Found, %: C 42.88, H 3.96, Cl 40.21, N 5.01. *M* 522. C₁₉H₂₂Cl₆N₂O₂. Calculated, %: C 43.62, H 4.23, Cl 40.66, N 5.35. *M* 523.07.

N-(2-Aminoheptyl)imide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (II *c*). Yield – 94%, m.p. – 121°C (benzene), *R_f* – 0.68. IR spectrum, ν , cm⁻¹: 3280 (NH₂), 1720, 1780 (C=O), 1606 (C=C), 600–702 (C–Cl). Found, %: C 43.86, H 2.30, Cl 40.91, N 5.01. *M* 514. C₁₉H₁₄Cl₆N₂O₂. Calculated, %: C 44.31, H 2.73, Cl 41.30, N 5.43. *M* 515.01.

Maleinimidoalkyl(aryl)substituted imides of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (III *a, b, c*). To a solution of 0.05 mol of aminoimide (I *a, b, c*) in 50 ml of DMF was added 0.05 mol of maleic anhydride, the mixture was stirred for 6 h at 150°C, cooled, and poured in ice water. The precipitate was filtered off, washed with water, and dried.

N-[2-Maleimido]ethylimide of 1,4,5,6, 7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid III *a*. Yield – 85%, m.p. – 133°C (benzene–hexane), *R_f* – 0.67. IR spectrum, ν , cm⁻¹: 1710, 1780 (C=O), 1600 (C=C), 680–800 (C–Cl). Found, %: C 38.35, H 1.28, Cl 42.91, N 5.01. *M* 462. C₁₅H₈Cl₆N₂O₄. Calculated, %: C 44.10, H 1.63, Cl 41.10, N 5.60. *M* 463.93.

N-[6-Maleimido]hexylimide of 1,4,5,6, 7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid III *b*. Yield – 99%, m.p. – 123°C (benzene–hexane), *R_f* – 0.46. IR spectrum, ν , cm⁻¹: 1840 (C=O), 1590–1600 (C=C), 650–720 (C–Cl). Found, %: C 48.91, H 2.14, Cl 33.41, N 4.21. *M* 640. C₁₉H₁₆Cl₆N₂O₄. Calculated, %: C 49.32, H 2.53, Cl 33.59, N 4.42. *M* 641.06.

N-[4-Maleimido]phenylimide of 1,4,5,6, 7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid (III *c*). Yield – 95%, m.p. –

181°C (benzene–hexane), *R_f* – 0.68. IR spectrum, ν , cm⁻¹: 1710, 1780 (C=O), 1600–1610 (C=C), 680–750 (C–Cl). Found, %: C 42.01, H 1.04, Cl 39.12, N 4.84. *M* 530. C₁₉H₈Cl₆N₂O₄. Calculated, %: C 42.26, H 1.49, Cl 39.39, N 5.12. *M* 529.

Maleinimidoalkyl(aryl) substituted imides of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo-[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (IV *a, b, c*). In the same way as above from 0.05 mol of aminoimide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid II *a, b, c* and maleic anhydride were obtained bisimide IV *a, b, c*.

N-[2-Maleimido]ethylimide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]-undec-2-ene-7,8-dicarboxylic acid (IV *a*). Yield – 92%, m.p. – 400°C (CHCl₃), *R_f* – 0.68. IR spectrum, ν , cm⁻¹: 1710, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 40.01, H 2.00, Cl 36.86, N 4.92. *M* 530. C₁₉H₁₄Cl₆N₂O₄. Calculated, %: C 42.93, H 2.43, Cl 40.26, N 4.85. *M* 531.

N-[6-Maleimido]hexylimide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]-undec-2-ene-7,8-dicarboxylic acid (IV *b*). Yield – 90%, m.p. – 270°C (CHCl₃), *R_f* – 0.70. IR spectrum, ν , cm⁻¹: 1710, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 50.67, H 4.10, Cl 24.89, N 5.02. *M* 581.60 C₂₃H₂₂Cl₆N₂O₄. Calculated, %: C 47.01, H 3.74, Cl 26.4, N 5.25. *M* 582.21.

N-[4-Maleimido]phenylimide of *endo, exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]-undec-2-ene-7,8-dicarboxylic acid (IV *c*). Yield – 91%, m.p. – 120°C (methanol), *R_f* – 0.68. IR spectrum, ν , cm⁻¹: 1710, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 52.90, H 4.10, Cl 24.89, N 5.02. *M* 576.0. C₂₃H₁₄Cl₆N₂O₄. Calculated, %: C 47.60, H 3.74, Cl 26.4, N 5.25. *M* 579.15.

Maleinimidoalkyl(aryl) substituted imides of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V *a, b, c*). 0.01 mol of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid imide (III *a, b, c*) and 50 ml of pyridine was added while stirring at room temperature to 200 ml of DMF. The reaction

proceeded with heat evolution and self-heated to 50°C. Then the mixture was stirred again for 2 h at 110–120°C. On cooling the mixture was poured in ice water. The precipitate was filtered off, washed with water, and recrystallized from methanol.

N-[2-Maleimido]ethyl]imide of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V a). Yield – 7.9%, m.p. – 146–147°C. R_f – 0.66. IR spectrum, ν , cm^{-1} : 1700, 1780 (C=O), 1605 (C=C), 670–760 (C–Cl). Found, %: C 40.51, H 1.90, Cl 31.09, N 6.72. M 410. $\text{C}_{14}\text{H}_8\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 40.97, H 1.93, Cl 34.50, N 6.81. M 411.01.

N-[6-Maleimido]hexyl]imide of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V b). Yield – 75%, m.p. – 134–135°C, R_f – 0.58. IR spectrum, ν , cm^{-1} : 1710, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 46.18, H 3.41, Cl 30.01, N 6.02. M 466. $\text{C}_{18}\text{H}_{16}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 46.38, H 3.44, Cl 30.42, N 6.00. M 466.11.

N-[4-Maleimido]phenyl]imide of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V c). Yield – 90%, m.p. – 328–330°C, R_f – 0.66. IR spectrum, ν , cm^{-1} : 1715, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 52.89, H 2.89, Cl 34.25, N 6.32. M 402. $\text{C}_{18}\text{H}_{14}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 53.50, H 3.48, Cl 34.80, N 6.93. M 403.99.

Maleinimidoalkyl(aryl)substituted imides of *endo*, *exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI a, b, c) were similarly obtained from bisimide of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo[6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (IV a, b, c).

N-[2-Maleimido]ethyl]imide of *endo*, *exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI a). Yield – 88%, m.p. – 148°C. R_f – 0.6. IR spectrum, ν , cm^{-1} : 1715, 1780 (C=O), 1605 (C=C), 670–760 (C–Cl). Found, %: C 46.11, H 2.88, Cl 30.02, N 5.92. M 464. $\text{C}_{18}\text{H}_{14}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 46.78, H 3.03, Cl 30.55, N 6.03. M 464.09.

N-[6-Maleimido]hexyl]imide of *endo*, *exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI b). Yield – 90%, m.p. – 152°C, R_f – 0.58. IR spectrum, ν ,

cm^{-1} : 1720, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 50.43, H 3.91, Cl 26.89, N 4.88. M 519.28. $\text{C}_{22}\text{H}_{22}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 50.78, H 4.24, Cl 27.26, N 5.38. M 520.20.

N-[4-Maleimido]phenyl]imide of *endo*, *exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI c). Yield – 92%, m.p. – 166°C, R_f – 0.62. IR spectrum, ν , cm^{-1} : 1720, 1780 (C=O), 1610 (C=C), 670–750 (C–Cl). Found, %: C 52.89, H 2.89, Cl 34.25, N 6.32. M 512. $\text{C}_{22}\text{H}_{14}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 51.60, H 2.75, Cl 27.70, N 5.46. M 512.14.

Polyimides VII on the basis of N-[6-maleimido]hexyl]imide- (V b) and N-[4-maleimido]phenyl]imide of 1,2,3,4-tetrachlorocyclohexa-1,3-diene-5,6-dicarboxylic acid (V c). A mixture of 0.05 mol of bisimide (V b), (V c) and 0.05 g of hydroquinone in 20 ml of anhydrous DMA was stirred for 6 h at 140°C. On cooling the reaction mixture was poured into ice water. The precipitated crystals were filtered off, washed with water, dried, and recrystallized from methanol. Yield – 92%, m.p. – 304–315°C, R_f – 0.71. Intrinsic viscosity (DMF, 25°C) η 0.22 dl/g. IR spectrum, ν , cm^{-1} : 1710, 1780 (C=O), 1610 (C=C), 680–750 (C–Cl). Found, %: C 54.28, H 2.01, N 4.96, Cl 25.62. $\text{C}_{25}\text{H}_{14}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 54.77, H 2.57, N 5.10, Cl 25.80.

Polyimides VIII on the basis of N-[6-maleimido]hexyl]imide- (VI b) and N-[4-maleimido]phenyl]imide of *endo*, *exo*-2,3,4,5-tetrachlorobicyclo[4.4.0]deca-2,4-diene-8,9-dicarboxylic acid (VI c) was similarly obtained from bisimides (VI b, c). Yield – 94%, m.p. – 328–330°C, R_f – 0.75, η – 0.28 dl/g. IR spectrum, ν , cm^{-1} : 1712, 1780 (C=O), 1608 (C=C), 600–750 (C–Cl). Found, %: C 57.28, H 3.01, N 4.21, Cl 22.98. $\text{C}_{29}\text{H}_{20}\text{Cl}_4\text{N}_2\text{O}_4$. Calculated, %: C 57.83, H 3.34, N 4.65, Cl 23.54.

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DIEN-DIENOFİL FRAQMENTLİ BISİMİDLƏR ƏSASINDA DİLS–ALDER REAKSİYASI ÜZRƏ POLİKLORLU TSİKLİK DİKARBON TURŞULARININ POLİİMİDLƏRİNİN SİNTEZİ

A.İ.Əlixanova

Polixlorlu tsiklik dikarbon turşularının N-aminoimidlərinin sintezi öyrənilmiş və onlar əsasında Dils-Alder reaksiyası üzrə hərəkə-nərdivan tipli poliimiidlərin alınmasının mümkünlüyü göstərilmişdir.

Açar sözlər: Dils–Alder reaksiyası, bisimidlər, poliimidlər, asilləşmə, bisimidodienlər.

СИНТЕЗ ПОЛИИМИДОВ ПОЛИХЛОРИРОВАННЫХ ЦИКЛИЧЕСКИХ ДИКАРБОНОВЫХ КИСЛОТ НА ОСНОВЕ ДИЕН–ДИЕНОФИЛЬНЫХ БИСИМИДОВ ПО РЕАКЦИИ ДИЛЬСА–АЛЬДЕРА

А.И.Алиханова

Изучены условия синтеза N-аминоимидов полихлорированных циклических дикарбонových кислот и показана возможность на их основе получения шарнирно-лестничных полиимидов по реакции Дильса–Альдера.

Ключевые слова: реакция Дильса–Альдера, бисимиды, полиимиды, ацилирование, бисимидодиены.