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STUDY OF THE CONDITIONS FOR THE AMINOLYSIS OF SECONDARY POLYCARBONATE

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Abstract: This article investigates the aminolysis of secondary polycarbonate (IPC) (commonly found in car headlights, rims, polymer roofs, etc.) and monoethanolamine , (MEA) (GOST 10136-77 , produced in the Russian Federation) content of the main substance – 99.5%, density 1.12 g/cm ^{3}The results of studying the aminolysis process with in the presence of a catalyst are presented. Catalyst as sodium hydroxide (NaOH) secondary polycarbonate (IPC) 1% was obtained . The main focus is on isolating urethane and phenolic compounds by performing a monoethanolamine (MEA) aminolysis process on secondary polycarbonate (IPC) and extracting the resulting product. This process was carried out in the ratio of secondary polycarbonate (IPC): monoethanolamine, (MEA) = 1:5 mol/unit . The duration of the aminolysis was carried out for a total of 6 hours at a temperature of 170 o C. The main physicochemical parameters of the resulting product and the results obtained based on infrared spectroscopy analysis are presented.

Keywords: secondary polycarbonate, monoethanolamine, aminolysis product, physicochemical parameters, infrared spectroscopy

Introduction. In today's world, where materials science and engineering are rapidly developing, polycarbonate manufacturers are leading the way in creating innovative solutions to meet the needs of various industries. Polycarbonate is a versatile and durable material that can be used in a wide range of applications from automotive to electronics and medical devices.[1] Poly(bisphenol A carbonate), commonly known as polycarbonate (or PC), is a thermoplastic. It is a polymer formed by the condensation reaction between bisphenol A (BPA) and a carbonyl source, usually phosgene or diphenyl carbonate (DPC). It was developed simultaneously in the 1950s by General Electric and Bayer. With a high glass transition temperature of about 150 and an amorphous nature, it is classified as an engineering plastic with many properties. It has desirable properties such as high impact resistance, good optical clarity, and flame retardancy, making it suitable for use in building panels, optical storage media, containers, safety products, electronics, automobiles, etc. [2] Although this polycarbonate is non-toxic, it is naturally and harmless. It can cause serious environmental pollution and waste of resources. From the perspective of resource conservation and sustainable development, the chemical recycling of discarded personal computers is still an important issue and has attracted wide attention. [3,4] Several chemical methods, including thermal pyrolysis, [5,6] glycolysis, [7,8] hydrolysis [9-11] and aminolysis [12,13], have been widely studied. Some good results with high conversion and high yield have been achieved, but there are many disadvantages such as low purity of bisphenol (BPA), slow reaction rate, non-recyclable catalyst and harsh reaction conditions, which lead to high cost and high energy consumption . After its discovery in 1898, polycarbonate plastic (PC) has been adopted in many plastic industries such as electrical appliances, baby bottles, water dispensers, garden equipment, furniture (office and institutional), sporting goods, medical applications, etc. Polycarbonates (PC) are widely used in the automotive, electrical / electronics and construction industries. Their high heat stability and to the blow endurance such as wonderful physical from the characteristics come came out unique characteristics , as well as their perfect transparency them organic glasses , optical fibers , resistant packaging and others for suitable does .[14,15] Polycarbonates in industry diols phosgenation through working Chemical recycling, which involves converting polycarbonate waste into useful products , seems to be a sustainable solution to the problem. Most chemical recycling methods involve hydrolysis, aminolysis, and alcoholysis. [16].

Research object and methods. The following substances were used in the research: monoethanolamine (MEA) (GOST 10136-77 , produced in the Russian Federation) with a content of the main substance - 99.5%, density 1.12 g/cm ^{3} , secondary polycarbonate pieces.

The aminolysis process was carried out in a three-necked flask equipped with a stirrer, thermometer and reflux condenser. The flask was filled with washed and dried particles (0.3-0.5 mm) of secondary polycarbonate (used car headlights, discs, polymer roofs, etc.) and monoethanolamine (MEA) gr (IPC:MEA ratio=1:5 mol/unit) . The reaction mass was slowly heated to 100 °C , then The temperature was raised to 150°C for 60 minutes and then to 170°C. After the temperature was raised to 170 $^{\circ C}$, the process was carried out for 6 hours. The aminolysis product formed as a result of the reaction was separated into fractions by vacuum pumping. When the vacuum was pumped, the substances were separated into 2 fractions. Initially, the urethane substance was at 140 °C and the The substance bisphenol A was released.

The physicochemical properties of the resulting substances were determined according to the following methods[18]. The IR spectrum of IPC and the IR spectra of Bisphenol A were recorded on the IR spectrum analyzer "IRAffinity-1" received.

Discussion of the results obtained. Using the literature cited above, the reaction for the formation of secondary polycarbonate with amines is as follows:

$$–[O–C(O)–O–R]_n – + HOCH_2CH_2NH_2 \longrightarrow HOCH_2CH_2–NH–CO–OR + HO–R–OH$$

The properties of the synthesized aminolysis products were studied in order to study the composition, percentage, and yield of the products formed as a result of the reaction. The results obtained are presented in Table 1.

Table 1. Refractive index of substances obtained at different temperatures

Temperature (C^0)	Refractive index (n)
100-140 C^0	n=1.4632
140-180 C^0	n=1 .4526

We devoted our further research to determining the structure of the resulting aminolysis products using IR spectroscopy.

The IR spectra of the MEA obtained for synthesis (Fig. 1) show the presence of absorption lines characteristic of the associated NH_{2g} groups at a wavelength of 3323 cm^{-1}: absorption lines characteristic of methylene –CH_2 groups at 2984 cm^{-1}; absorption lines characteristic of NH_2 amide groups at 2915.1694 cm^{-1}. At the same time, absorption lines characteristic of primary –OH groups at wavelengths of 1020 cm^{-1}; absorption lines characteristic of NH_2-–CH_2- chains at 1103 cm^{-1}, and an absorption line characteristic of the deformation vibration of the rotating methylene groups with NH at wavelengths of 600.667 cm^{-1} were observed. In the IR spectra of IPC (Fig. 2), we can see absorption lines at wavelengths characteristic of hydroxyl groups at 3344 cm^{-1}, methylene groups at 2938, 2857 cm^{-1}, aromatic rings at 1532, 1480 cm -1, and acetate groups at 1218, 1080 cm^{-1}.

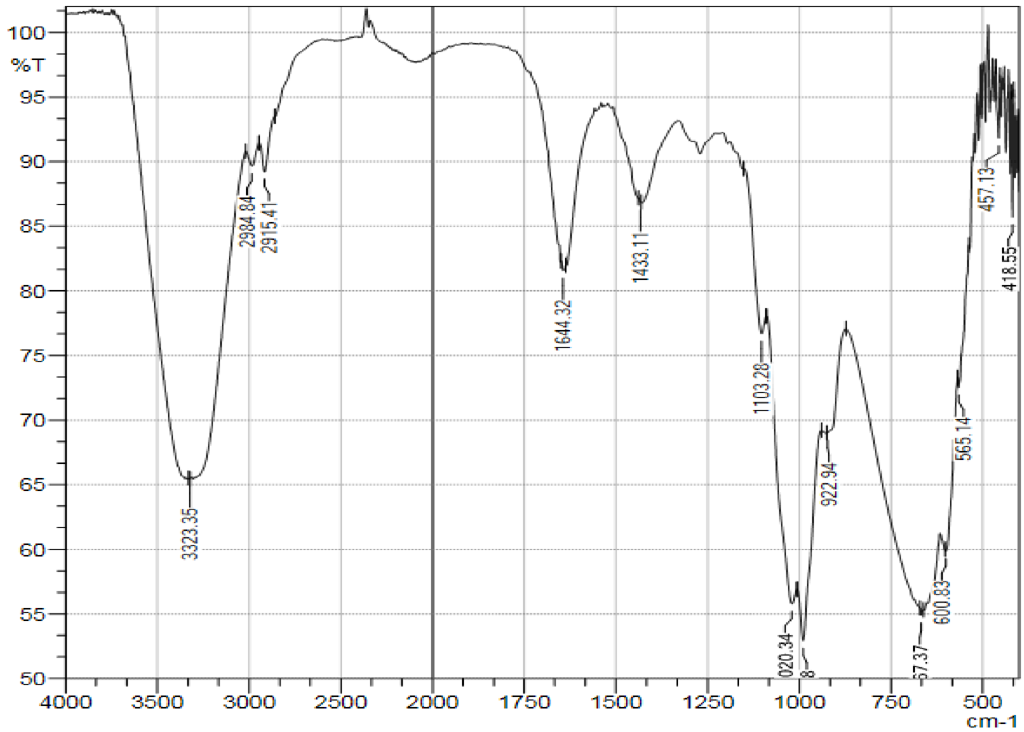

Figure 1. Monoethanolamine IR spectrum

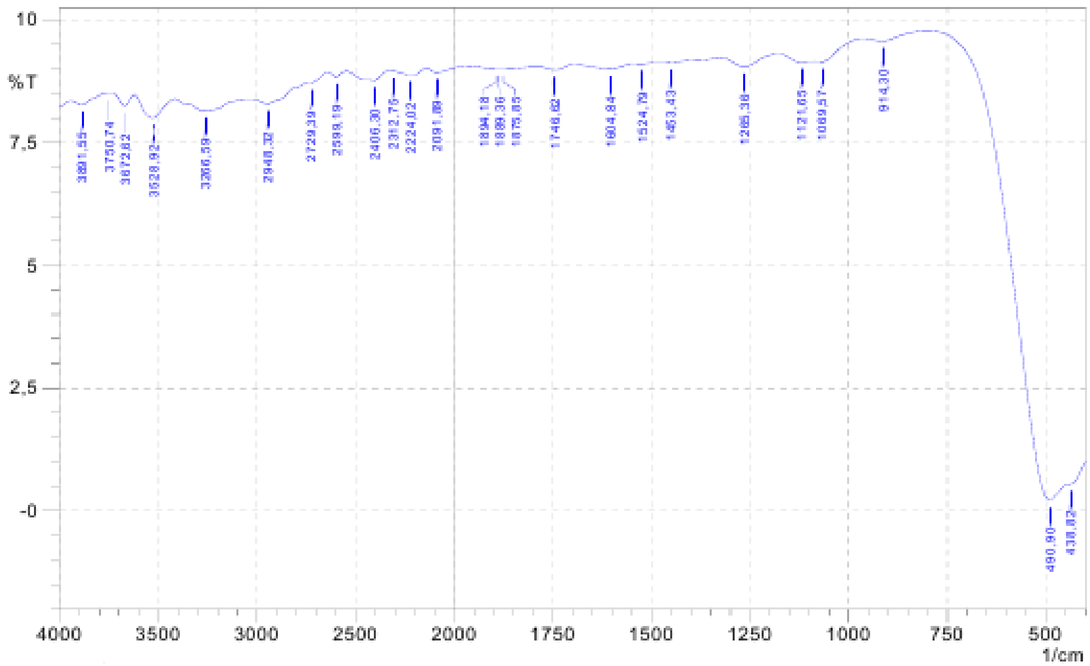

Figure 2. IR spectrum of secondary polycarbonate

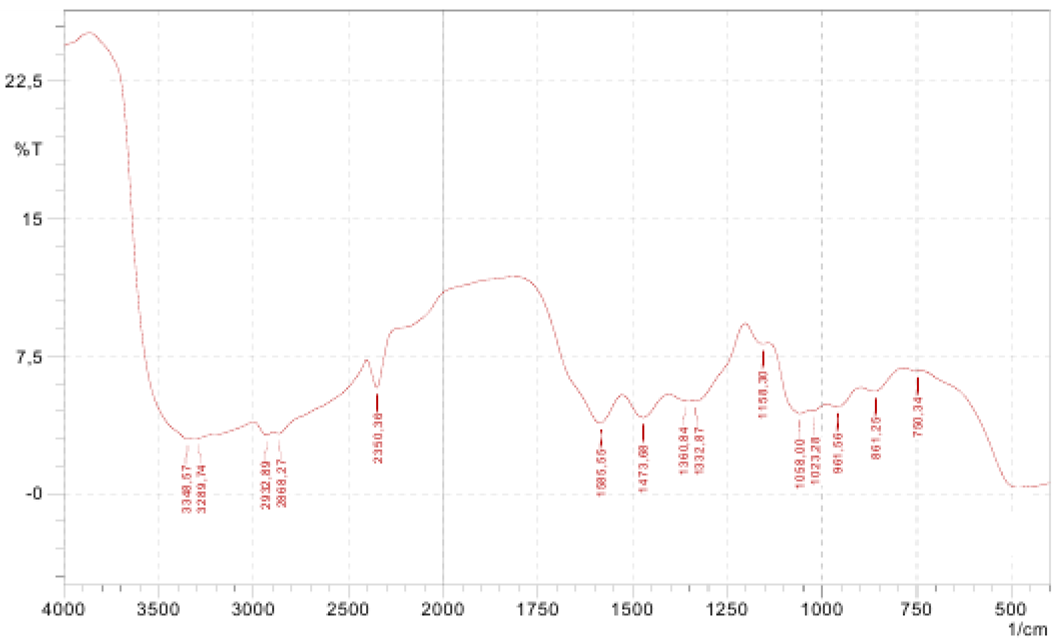

Figure 3. IR spectrum of the isolated phenol

IPC aminolysis product Bisphenol A In the IR spectrum, 3348, 1560, 1585, 750 cm^{-1}) exactly correspond to the spectral lines of phenol or a compound close to phenol. Absorption lines characteristic of the hydroxyl group at 3289,1058 cm^{-1} and an absorption line characteristic of the aromatic group at 1473 cm^{-1} were found.

Conclusion. Thus, the effect of aminolysis conditions on secondary polycarbonate with monoethanolamine in different molar ratios was studied. The IR spectra of the resulting product were analyzed and it was found that the IR spectrum of Bisphenol A coincides with the IR spectrum of the substance we isolated. We found that the amount of hydroxyl groups and acid groups in the final product changes. The composition of the resulting products was clarified. Future studies will be aimed at clarifying the composition and structure of the resulting by-products. Chemical recycling may be one of the ideal solutions to combat the ongoing plastic crisis.

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