The oligomerization process was performed at the temperature of 130–180 єC, the rotation speed of the flask on a vacuum rotary evaporator was 75 rev/min and the pressure from atmospheric pressure to vacuum (5 kPa). In 2 hours mixture of zinc oxide used as a catalyst was added in the amount of 1.5% of concentrated hydroxycarboxylic acids weight. The process was being carried out without nitrogen blanket during 5 hours.

Depending on the molecular weight the polymers obtained might be in the resinous and solid state, from light beige to light brown in color.

Synthesis of raw cyclic ether oligomers of LA and GA was performed on a standard laboratory facility of vacuum distillation with the use of the electromagnetic stirrer IKA C-MAG HS 7 at the vacuum of 1–2 kPa. The process of the LA oligomer depolymerization in the lactide took 3,5–4,5 minutes. The experimental data showed that the presence of para-toluene sulfonic acid affected the synthesis of raw lactide.

Cyclic esters obtained according to the vapor temperature can be from to crystals of white to yellow or yellow oily liquid.

The structure of the obtained samples was investigated by infrared spectroscopy. The spectra are characterized by absorption bands of 1750 ~ 1720 $cm^{-1}$ related to the vibrations of the carbonyl group C=O. Vibrations of ester group C–O–C appear in 1150 ~ 1087 $cm^{-1}$. Absorption band of 2970 ~ 2940 $cm^{-1}$, 1455 ~ 1450 $cm^{-1}$ and 1383 ~ 1380 $cm^{-1}$ belongs to methyl groups ($–CH_3$) and methylene group ($–CH_2–C–H$) in the ring ether.

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# ASSESSMENT OF WATER TREATMENT EFFICIENCY FROM AMMONIUM IONS WITH A HELP OF ZEOLITES

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The effective application of softening groundwater method with a help of generator of microbubble treatment and ammonium hydroxide is shown in this paper [1]. This method can be used in order to prepare service water. To prepare drinking water by this method it is necessary to add a new stage of ammonium and ammonia ion removal. According to [2], various methods such as sorption and ion-exchange processes, oxidation, biofiltration and reverse osmosis can be used for ammonium ion removal from water to produce drinking water. Sorption process of ammonia removal from water is not directly used on a commercial scale. However, it is possible to use specific sorption of inorganic sorbent ammonium (for example, zeolites) for local water supply. The aim of this paper is to assess the efficiency of ammonium ion removal from water solution using zeolites.

The natural zeolite samples to be tested were taken from different fields (Chuguevsk, Shivyrtuisk, Kholinsk, Sokirnitsk) with various granulometric composition. The different particle size distribution zeolites (less 0.1 mm; 0.5–1 mm; 1.5–2.5 mm etc.) were taken to make experiments. Water taken from public drinking water supply in Tomsk and treated with a help of generator of microbubble process and ammonium hydroxde was used to make these experiments [1].

**Table 1.** Ammonia and ammonium ion content in water after sorption with the use of zeolites

| Sample of zeolite | Fraction, mm | Concentration after sorption, mg/dm$^3$ | Recovery ratio, % |
|---|---|---|---|
| Kholinsk | less 0.1 | 32.3 | 59.2 |
| | 0.5–1 | 33.7 | 57.5 |
| | 1–2.5 | 33.8 | 57.6 |
| Chuguevsk | less 0.1 | 32.9 | 58.4 |
| | 1–1.4 | 30.2 | 61.6 |
| Shivyrtuisk | less 0.1 | 43.0 | 59.5 |
| | 1.5–2.5 | 58.1 | 26.2 |
| Sokirnitsk | less 0.1 | 24.6 | 73 |
| | 0.7–1.5 | 45.7 | 43.2 |

$NH_4^+$ ion sorption was carried out under static conditions using a magnetic mixer at a speed to 200 r/min. To make the experiment, 2 g zeolite weighed quantity was covered with 200 cm$^3$ of treated water, the initial $NH_4^+$ ion concentration of which was 79.2 mg/dm$^3$. Process of precipitation sorption for each zeolite sample had been carried out for 150 minutes. Having carried out the process of sorption, adsorbate was filtered from sorbent with a help of paper filter "Blue ribbon". Final $NH_4^+$ ion concentration was identified by photocolorimetric method in accordance with All-Union Standard 4192-82 Drinking water.

Methods used to determine mineral nitrogen-containing substances.

The results of carried out experiments are presented in Table 1.

In the basis of results presented in Table 1, we come to conclusion that using of natural zeolite of Sokirnitsk field is the most effective for $NH_4^+$ ion removal from water solutions. Though, $NH_4^+$ ion content in water after sorption with a help of this zeolite considerably exceeds maximum permissible concentration for drinking water. Therefore, it is planning to study sorptions of $NH_4^+$ using porous zeolite modified with NaCl. This work was carried out according to state order "Nauka" 7.1504.2015.

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# MATHEMATIC MODEL OF CATALYTIC DIESEL FUEL DEWAXING PROCESS

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In order to correspond with modern demands of technological development and ecology, and to expand the market channels both for domestic and outside consumers, Russian manufacturers pursue the aims of resource efficiency enhancement and operating optimization. Catalytic dewaxing process has a substantial importance as the process for production of winter and summer diesel fuels with improved low-temperature properties.

This study is focused on the mathematical modeling of the catalytic dewaxing process with further optimization and estimation of diesel fuel low-temperature properties. One of the significant problems being solved in this work is the investiga-