SYNTHESIS OF A-TYPE ZEOLITE AND ITS GEOMETRICAL CHARACTERISTICS

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Abstract: Synthetic zeolite type A were synthesized from $NaAlO_2$ and Na_2SiO_3, NaOH using the method of hydrothermal processing. The textural characteristics of the zeolites were studied by adsorption of n-hexane and benzene vapor. According to that the specific surface of the zeolite (S_{BET}) was 800-1025 m^2/g, while the average diameter of the pores was 0,8-1,2 nm, the average size of the micropores was 0,22-0,34 cm^3/g. Also, the phase composition of synthetic zeolites was studied by X-ray diffractometry, and surface marfology by scanning electron microscopy methods.

Key words: Zeolite, sol-gel technology, mesoporous, sorbent, comparative surface area, pore volume, pore diameter, capillary condensation, diffractogram.

The intensity of modern industrial and manufacturing processes leads to the unplanned use of non-renewable natural resources. As a result, the release of various toxic organic compounds into the environment in industrialized countries leads to the globalisation of environmental processes [1]. In its turn it requires to prepare adsorbents with high sorption properties for the capture of exhaust and toxic gases by synthetic methods, or to increase their selectivity by modifying the natural zeolites. Therefore, the modification of natural zeolites and the synthesis of new ones are one of the actual problems.

At the same time, the synthesis of zeolites, which are used for the purification of natural gas, oil, petroleum products from additives and drying them and preparation of new adsorbents based on the improvement of their preparation technology is one of the actual problems of today [2].

Within the framework of these works, A-type zeolites with nanometer-sized pores were synthesized using sol-gel technology and hydrothermic processing methods.

In preparation of synthetic zeolite, as the source of SiO_2 the solution of Na_2SiO_3 salt, as the source of Al_2O_3 the $NaAlO_2$ were used. In the process of synthesis, 2M solution of NaOH was added to the dry salt $NaAlO_2$ and at a temperature of 40°C, stirred for 30 minutes and a uniform colloidal suspension was obtained. To the resulting colloidal suspension, an aqueous solution of Na_2SiO_3 was added and the solution has been mixed for 2 hours in a thermostat. The resulting gel was washed several times in distilled water and dried for 4 hours at a temperature of 100°C. The physical and chemical properties of the prepared zeolite were studied.

The texture characteristics of the zeolite were studied by adsorption of hexane vapor using sensitive quartz spiral construction of Mak-bin-Bakra (Figure 1). Based on obtained sorption isotherm, using the linear equations of BET the size of the specific surface of zeolite (S_{BET}, m^2/g), the average diameter of the pores (D, nm) and saturation adsorption (a_s, mol/kg) were calculated.

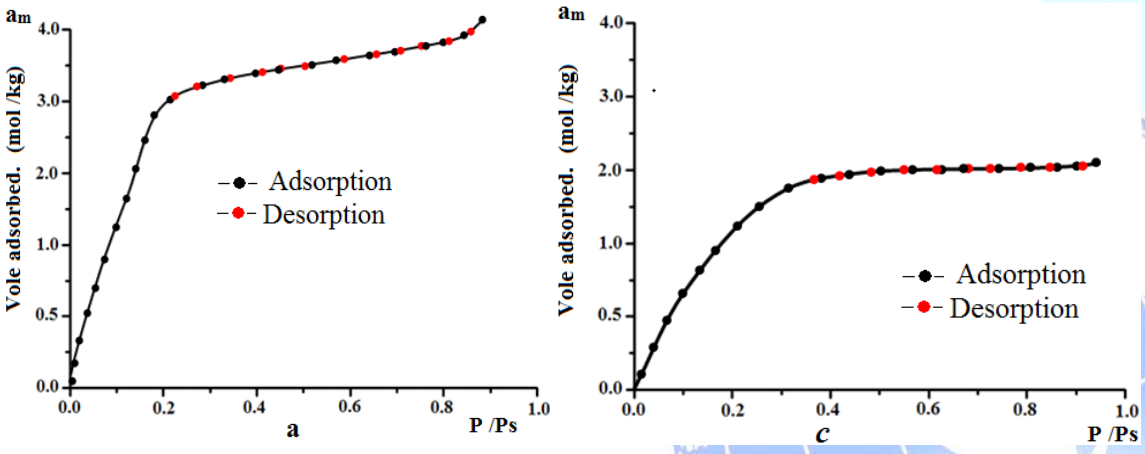

Figure 1. Adsorption/desorption isoterm of hexane (a) and benzene vapor (b) to zeolite

From the figure, it can be seen that the relative pressure sharply increases up to p/p_0=0,2 and approaches the saturation state at p/p_0=0,9. It shows that the sorption isoterm belongs to Type I according to the classification of IUPAC. In benzene vapor adsorption isoterms (b), the increase of the relative pressure observed at p/p0=0,1 and saturation at 0,7.

The surface morphology and porosity measurement of the zeolite were studied by the scanning electron microscope Sam EVO MA 10 (Carl Zeiss, Germany). During the analysis, a scanning electronic microscope equipped with energy-dispers X-ray spectrometer was used (EDS Aztec Energya Adyanted X-Act, Oxford Instruments) (Figure 2).

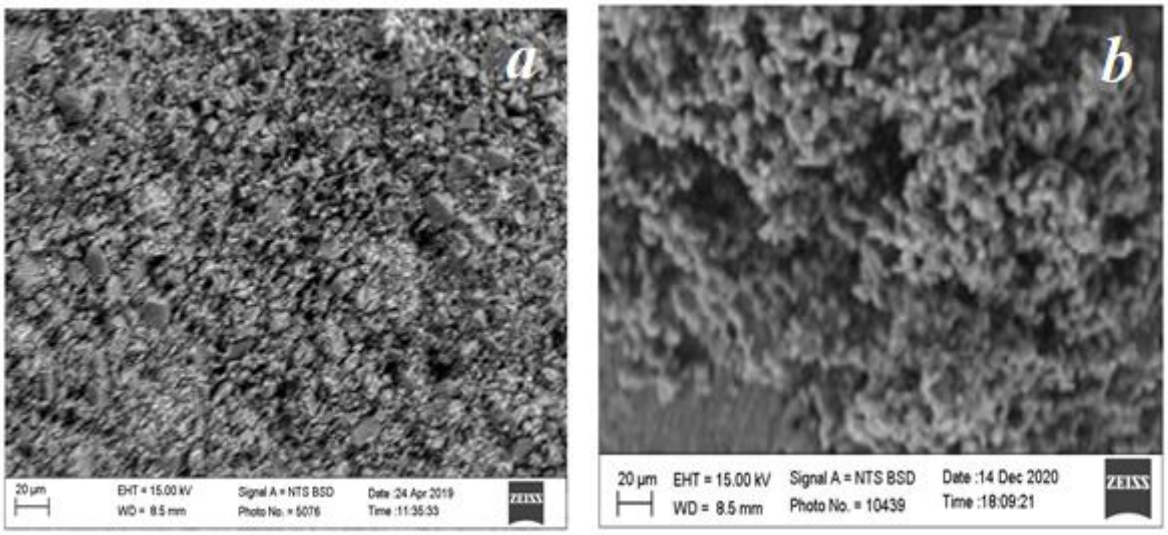

Figure 2. The micrograph of the synthetic zeolites surface taken by SEM

In the process of synthesis the formation of sequenced pores in the zeolite surface from the mutual aggregation of primary particles can be seen from the figure. The phase composition of the zeolites was analyzed by X-ray diffractometric method (Figure 3).

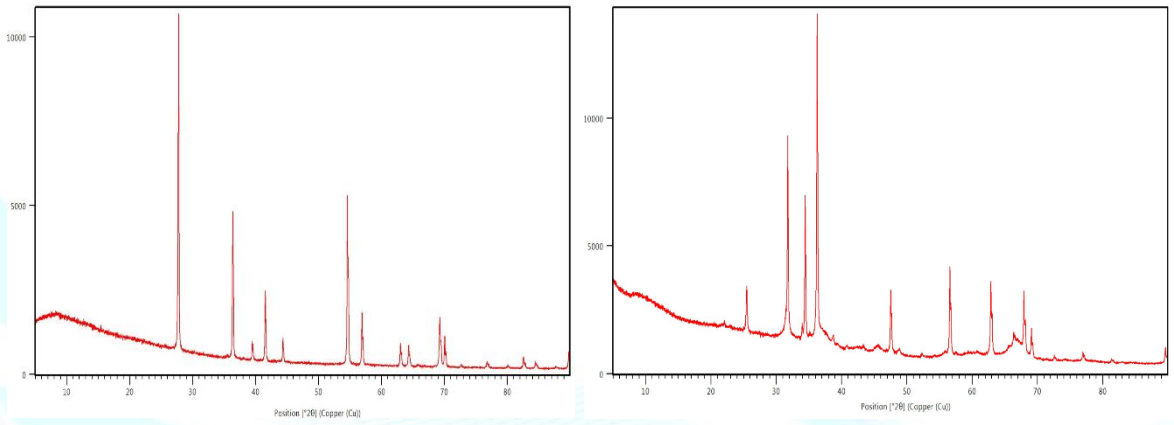

Figure 3. X-ray diffractograms of the synthetic zeolites

The texture characteristics of the synthetic zeolite prepared by the method of hydrothermic treatment were studied. It was determined that the size of the specific surface of the zeolite prepared with the ratio SiO_2/ $1{,}5Al_2O_3$ is 1025 m^2/g, the average

diameter of the pores is 0,82 nm, the size of the specific surface of the zeolite prepared with the ratio $SiO_2/3{,}2Al_2O_3$ is 800 m^2/g. It was also determined that the stability of the A-type zeolites depends on the concentration of alkali and the temperature of the process.

Literature.

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