



METHODS FOR SYNTHESIS OF LTA-TYPE ZEOLITES

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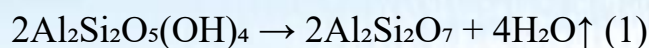
Abstract. This paper describes the framework structure of LTA-type zeolites and a method for their synthesis from anhydrous ingredients (metakaolin, Al_2O_3 , NaOH). It was found that sodium aluminate of cubic and tetragonal crystal systems is required for the synthesis. A model of mechanochemical synthesis of LTA zeolite is proposed.

Keywords: LTA zeolite, metakaolin, sodium aluminate, mechanochemical synthesis, NaOH .

LTA-type zeolites have a cubic aluminosilicate framework ($\text{Si}/\text{Al} = 1$) and are widely used for their ion-exchange and adsorption properties [1–3]. Si and Al atoms alternate in the framework in accordance with Loewenstein's rule [6]. Zeolites are an effective sorbent for treating heavy-metal-containing wastewater from metal processing plants [7]. They are usually obtained by hydrothermal synthesis [4, 5]. This work considers a method based on anhydrous ingredients.

The synthesis is carried out in four stages.

1. *Metakaolin.* Purified kaolin (moisture ~1%) is calcined at 700 °C for 240 min, which gives amorphous metakaolin:



2. *Aluminium oxide.* $\text{Al}(\text{OH})_3$ (98.8%) is thermally decomposed at 500 °C for 250 min:



3. *Sodium aluminate.* Al_2O_3 reacts with NaOH (99.9%) at 500 °C for 60 min, giving white crystalline sodium aluminate:



Sodium aluminate of cubic and tetragonal crystal systems was found to be required for the synthesis.

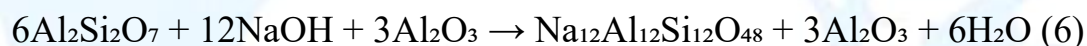
4. *Formation of LTA zeolite.* The components are taken in equimolar ratio. Amorphous metakaolin reacts with alkali:



When sodium aluminate is added to the unreacted metakaolin:



Al_2O_3 added at the end of the experiment is proposed to act as a catalyst for the unreacted metakaolin and NaOH :



All routes give the same product. Al_2O_3 from (5) can be converted back to sodium aluminate via (3), so the overall balance corresponds to (4).

Mechanochemical model. All stages proceed in the solid phase without water, so the reaction rate depends on the contact surface of the components. Mechanical treatment reduces particle size, increases the active surface and creates lattice defects, which accelerates the reaction between metakaolin, sodium aluminate and alkali.



CONCLUSIONS.

1. A four-stage method for obtaining LTA zeolite from anhydrous ingredients (metakaolin, Al_2O_3 , NaOH) was considered.
2. Cubic and tetragonal sodium aluminate was found to be required for the synthesis.
3. All reaction routes (4)(6) lead to the zeolite cell $\text{Na}_{12}\text{Al}_{12}\text{Si}_{12}\text{O}_{48}$.
4. A mechanochemical synthesis model was proposed to accelerate the solid-phase process.

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