PhD thesis abstract

Preparation and testing of TiO_2-based sorbents for capturing carbon dioxide

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The aim of this dissertation was to obtain sorbents based on titanium dioxide (Z. Ch. Police S.A., P25 Evonik, Germany), modified with amines (DEA, TEA, TEPA), characterized by higher adsorption capacity for carbon dioxide than the starting material. Crude TiO_2 underwent treatment in an a Teflon-lined autoclave with 10 M KOH or NaOH in order to obtain titanate composite nanorods. The process was conducted at 140°C for 24 hours. Next, after natural cooling, the material was washed with 0.1 M HCl to a strongly acidic pH. Then, the material was washed with dionized water to a neutral pH. In the last step the material was dried at 350°C.

To increase adsorption capacity, the titanate composite nanorods were modified with amines. 2 cm^3 of amine was dissolved in 20 cm^3 of deionized water. The solution was mixed in a magnetic stirrer for 30 minutes, after which 0.5 g of nanomaterial was added and blended for 6 hours at room temperature. Then the material was dried at 80°C for 2 hours.

Next, the obtained adsorbents were analyzed in detail in terms of their crystal structure, phase composition, textural properties and functional groups on the surface. One of the most important analyses was a determination of adsorption capacity; for this purpose, the thermogravimetric analysis was used (TG). The thermogravimetric method was also used for testing the chemical reactions and phase changes that take place during material heating, and for determining stability during cyclic adsorption/desorption.

All the techniques used made it possible to describe all the tested materials in detail. The research proved that the main factors affecting the adsorption capacity for CO_2 are the obtained structures in the form of titanate composite nanorods as well as amine reaction order. The research also showed that the higher pore volume of the obtained composites directly translates into better dispersion of amine conglomerates in the samples. What is more, the tested materials showed stability during cyclic adsorption/desorption.

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