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Structural and catalytic properties of sodium and cesium exchanged X and Y zeolites, and germanium-substituted X zeolite

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Abstract

The conversion of isopropanol in a fixed bed flow reactor was used as a test reaction for a number of faujasite-type zeolites which were modified in order to increase their basicity. Samples included a CsY zeolite with an intact faujasite structure and an exchange degree of nearly 100% prepared by solid-state ion exchange, a CsNaY obtained from CsY through exchange with aqueous NaCl solution, a CsNaX obtained from NaX and aqueous CsCl solution, and a Na(Ge)X, with Si replaced by Ge. At 623 K, an isopropanol partial pressure of 5 kPa in He, and a total feed flow of 90 ml/min, a catalyst mass of 50 mg, initial yields were as follows: NaY: 62% propene, CsNaY: 78% propene, NaCsX: 10% propene, 0.37% acetone, Na(Ge)X: 8% propene, 11% acetone. Conversion in the presence of CsY was <1%. CO₂ adsorption and infrared (IR) spectroscopy were used to probe basicity, and Na(Ge)X was the only sample to form monodentate carbonates upon CO₂ adsorption (bands at 1477 and 1428 cm⁻¹). Further characterization with X-ray diffraction (XRD), transmission electron microscopy (TEM), thermal analysis, nitrogen sorption, and isopropanol sorption was necessary to properly interpret catalytic results by identifying samples which contained impurities, had blocked pore systems, or decomposed partially during activation or reaction.