Rapid Kinetic Measurements in Ammonia and Methanol Syntheses

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Kinetic measurements in heterogeneous catalysis are essential for the derivation of rate expressions that are necessary for the design of reactors and that can serve for data extrapolation beyond the measured data range. To accelerate the acquisition of kinetic data, the method of quasi-isothermal temperature-programming has been applied to a study of the kinetics of the ammonia and methanol syntheses. Both reactions were performed in a microcatalytic reactor setup near industrial reaction conditions. For the ammonia synthesis, the technique turned out to be a useful screening method for Ru-based catalysts, which allowed power-law rate expressions to be derived rapidly. Moreover, the in situ temperature-programmed surface reaction of N−* with gas-phase H_2 (N−* TPSR) was studied in detail, allowing for its application as a fast method for catalyst screening within the class of unpromoted Ru-based catalysts. However, in the methanol synthesis, the applicability of the quasi-isothermal temperature-programmed method is limited to qualitative catalyst screening because of the methanol adsorbing capacity and the slow change of the state of the working $Cu/ZnO/Al_2O_3$ catalyst.