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Catalyst performance testing: bed dilution revisited

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Abstract

A study was performed to investigate the systematic (negative) deviation of the conversion caused by dilution of the catalyst bed with inert particles in gas-solid systems for an irreversible 1st order reaction. Dilution may significantly reduce the conversion due to local bypass effects. Bed dilution does not yield a homogenous activity decrease, but gives rise to a discrete local activity in an inert surrounding. In particular at high dilution, i.e. when using more diluent than catalyst, the effect may become significant. This phenomenon was studied both experimentally with catalytic N_2O decomposition over Co-La-Al mixed oxide, and using a random particle distribution model (RPD model). The experimental and model results agree well although there is some uncertainty due to the value of the average particle size to be used. The best description of the experimental data was obtained using an apparent particle size of 0.30 instead of the 0.18 mm, which may be ascribed to agglomeration. For practical application, the relative deviation in conversion Δ can be well estimated from observable parameters, i.e. the observed conversion $x_{i,dil}$, the volume fraction of bed dilution b, the bed height h_{bed} and the particle diameter d_p. In particular the combination high dilution and high conversion should be avoided in kinetic studies.

Keywords: Catalyst testing; Bed dilution; Laboratory reactor; Kinetics; Modeling; Simulation; N_2O decomposition, Reaction Engineering

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