

**Strong metal-support interaction in Pt/TiO₂ induced by mild
HCHO and NaBH₄ solution reduction and its effect on catalytic
toluene combustion**

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In this work, the Weisz-Prater Criterion (Eq.S1) was used to estimate the influence of pore diffusion on reaction rates. It is particularly useful because it provides a dimensionless number containing only observable parameters that can be readily measured or calculated.^{1, 2}

$$N_{w-p} = \frac{\Re R_p^2}{C_s D_{eff}} \quad (S1)$$

Here, \Re is the reaction rate per volume of catalyst, which can be calculated from the molar flow rate and conversion of toluene at a given temperature, and the mass (2×10^{-4} kg) and density (188.7 kg/m^3) of the packed catalyst. R_p is the catalyst particle radius, which has a largest value of $R_p = 2.25 \times 10^{-4}$ m due to the mesh screen. C_s is the reactant concentration at the particle surface. As the catalyst used in this study is in the form of a fine powder ($R_p \leq 225 \text{ }\mu\text{m}$), it may be assumed that external diffusion is not effective in the reaction, and

$$C_s \cong C_0 = \frac{P_{0,C_7H_8}}{RT} \quad (S2)$$

The effective diffusivity D_{eff} is related to the mean free path (λ , m) and the mean velocity (\bar{v} , m²/s) of the gas phase toluene. Here,

$$\bar{v} = \left(\frac{8RT}{\pi M} \right)^{1/2} \quad (S3)$$

$$\lambda = \frac{k_B T}{\sqrt{2} \pi d^2 P_{C_7H_8}} \quad (S4)$$

where k_B is the Boltzmann constant in J/K, $P_{C_7H_8}$ is partial pressure of toluene in Pa, d is the diameter of toluene in meters, and M is the molar mass of toluene in kg/mol. Use of the initial toluene P_{0,C_7H_8} and $T = 473.15$ K, the calculated $\lambda = 1.08 \times 10^5$ nm is much larger than the pore sizes of the catalysts (d_p , 11.0~22.8 nm). Consequently, pore diffusion will be dominated by Knudsen diffusion and

$$D_{eff} \cong D_{Kn} = \bar{v} \frac{d_p}{3} \quad (S5)$$

where D_{Kn} is the Knudsen diffusivity.²

References

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