Formula 1

Content placeholder

Formula 2

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Formula 3

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Detailed Explanation

The Thiele modulus (?) quantifies the relative rates of diffusion and surface reaction within a porous catalyst particle: high ? indicates significant diffusion resistance, leading to underutilization of the catalyst interior. The effectiveness factor (?), defined as the ratio of the actual reaction rate (accounting for diffusion limitations) to the ideal rate (if the entire particle were exposed to the bulk reactant concentration), ranges from 0 to 1 — with ? ? 1 indicating negligible diffusion limitation. The nomograph consolidates solutions to the steady-state diffusion–reaction equation for canonical geometries, plotting ? versus ? on logarithmic or semi-logarithmic axes; each curve corresponds to a specific geometry and reaction order (commonly first-order isothermal kinetics). Engineers use it during reactor design, catalyst selection, and scale-up to assess whether observed low conversion or selectivity stems from kinetic limitations or internal diffusion constraints. Advanced versions may include corrections for non-isothermal conditions (via the generalized Thiele modulus incorporating the Arrhenius temperature dependence) or non-first-order kinetics, though most standard nomographs assume isothermal, first-order behavior for simplicity and broad applicability.

Key Components

#	Component

1	Thiele modulus (?) axis
2	Effectiveness factor (?) axis
3	Geometry-specific curves (slab, cylinder, sphere)

Applications

#	Application
1	Rapid assessment of pore-diffusion limitations in fixed-bed reactors
2	Catalyst particle size optimization to balance activity and transport resistance
3	Troubleshooting unexpected low yields or selectivity shifts in industrial catalytic processes

Related Concepts

#	Concept
1	Intraparticle diffusion resistance
2	Weisz–Prater criterion
3	Catalyst deactivation due to pore blocking

Tags

> reaction engineering, catalysis, mass transfer, chemical kinetics, process design