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Letter to the Editor

On effectiveness factor calculations

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Dear Sir,

In a recent publication of Chemical Engineering Science, Lee and Kim (2006) stated that our procedure (Gottifredi and Gonzo, 2005) to calculate effectiveness factor (η) in cylindrical and spherical catalytic pellets is not suitable when Thiele modulus (ϕ) reaches the region of high values (i.e. $\phi \gg 1$).

The authors did not follow previous works (Gottifredi et al., 1981a,b, 1986) but only our last contribution. Our proposed expression is

$$\eta = \frac{1}{\sqrt{(\phi^{*2} + \exp(-a\phi^{*2}))}}$$

with

$$\phi^* = \phi/\rho; \quad \rho = (\sigma + 1)\sqrt{2m_0};$$

$$m_0 = \int_0^1 R(C)\,\mathrm{d}C; \quad a = 1 - 2\alpha R'(1)\rho^2,$$

where, as should had been noticed (Gottifredi et al., 1986), when parameter "*a*" becomes negative it must simply be taken equal to zero or either use the following expression:

$$\eta = (\phi^{*2} + \exp(-a\phi^{*2}))^{-1/2} + \rho_2\phi^{*2}(\phi^{*2} + \exp(-\mathrm{d}\phi^{*2}))^{-2}$$

to predict η values. Of course with this expression third order and second order perturbation solutions are needed for small and large ϕ values, respectively (Gottifredi et al., 1986). But they can be easily found even when catalytic activity is not uniform and when diffusivity is concentration function.

The first option ($a = 0$) is much simpler and produces excellent results with error always smaller than 4–5% in the intermediate region ($0.5 < \phi^* < 2$). When large Thiele modules are involved it coincides exactly with well known Bischoff (1965) expression.

Thus most of Lee and Kim (2006) conclusions regarding our predictions are completely wrong and misleading. Thus they should not be taken into account.

On the other hand, their procedure will never produce a continuous function ($\eta(\phi)$) since at the interception point, arbitrarily defined, first and superior derivatives are not continuous as clearly seen from their graph. Moreover, our procedure is more simple and accurate with the only forcing condition by assuming $a = 0$, when it becomes negative, which implies a minimum error in the second order perturbation term when, $\phi \ll 1$.

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