01 Jan 1987

Letters To The Editor

Partho Neogi
Missouri University of Science and Technology, neogi@mst.edu

LETTERS TO THE EDITOR

To the Editor:

In a paper titled "Mechanism of Pore Formation in Reverse Osmosis Membranes During the Casting Process" (**29**(3), May, 1983, p. 402), Neogi presents a quasisteady state model for the growth around a nucleus during the gel formation. He states that the differential equation relating the fractional conversion of polymer to gel (X) with time (t) is obtained as:

$$\left(\frac{x^{-1/3}}{1-x}\right)\frac{dx}{dt} = \left[\frac{48\pi^2(\rho_{po}-\rho_{pe})}{\rho_{pg}}\right]\eta^{2/3}D_p \quad (1)$$

The author then takes the asymptotic solution for large X given below as the solution of Eq. 1:

$$t = -\frac{1\eta(1-x)}{2}\cdot\left[\frac{48\pi^2(\rho_{po}-\rho_{pe})}{\rho_{pg}}\right]^{1/3}\eta^{2/3}D_p \quad (2)$$

It can be verified that Eq. 2 is not the mathematical solution to Eq. 1 for large X. In addition, application of large X solution to calculate the time for 50% polymer conversion to gel τ as done by the author is inappropriate.

Equation 1 may be integrated to give:

$$\frac{\pi}{2\sqrt{3}} - \sqrt{3}\tan^{-1}\left(\frac{2x^{1/3}+1}{\sqrt{3}}\right) - \frac{1}{2}1\eta\left[\frac{(1-x^{1/3})^3}{1-x}\right] = \left[\frac{48\pi^2(\rho_{po}-\rho_{p_e})\eta^2D_p^3}{\rho_{p_g}}\right]t \quad (3)$$

Equation 3 can be used to calculate the time t required for a given conversion X. It is found that gel formation times are in general longer than those predicted from Eq. 2. For example, Eq. 2 underestimates the time t by a factor of: 2.30 at $X = 0.98$; and 3.65 at $X = 0.5$. Therefore, results shown in Figure 4 of his paper do not represent the model estimates. The appropriate relation between τ and pore size estimate may be obtained from:

$$\tau = \frac{1.23}{\left[48\pi^2\frac{(\rho_{po}-\rho_{pe})}{\rho_{pg}}\right]^{1/3}\eta^{2/3}D_p} \quad (4)$$

S. Subrahmaniyam
Chemical Engineering Dept.
Indian Institute of Technology
New Delhi—110016, India

Editor's Note:

This letter had been received in January 1984, and Dr. Neogi's response was received in February 1984. We regret the delay in publication.

Reply:

The numerical error in Eqs. 30 and 31 in the article by Neogi (1983) is acknowledged. The solution of Wert and Zener (1950) when correctly rearranged should have $ln[(1 - X)/2]$ instead of $1/2\ ln\ (1 - X)$ in Eq. 30 and $ln\ (4)$ instead of $0.5\ ln(2)$ in Eq. 31. As shown by Wert and Zener, it provides a satisfactory approximation. Due to uncertainty in the parameters, Neogi (1983) was interested in making only an order of magnitude estimate; neither this premise nor the conclusions drawn change due to the exact solution provided in the above letter. The exact solution, it appears, can be obtained rather simply from Gradshteyn and Ryzhik (1965) after a changed variable from X to $X^{1/3}$.

Literature Cited

Gradshteyn, I. S., and I. M. Ryzhik, "Table of Integrals, Series and Products," Academic Press, 61 (1965).

Neogi, P., "Mechanism of Pore Formation in Reverse Osmosis Membranes During the Casting Process," *AIChE J* **29**, 402 (1983).

Wert, C., and C. Zener, "Interferences of Growing Spherical Precipitate Particles," *J. Appl. Phys.*, **21**, 5 (1960).

P. Neogi
Dept. of Chemical Engineering
University of Missouri
Rolla, MO 65401