detailed design calculations can be carried out, workable designs are often developed by trial and error.

3. Many reactions involve shear-sensitive materials, which severely limit the maximum mixing rate and make impeller and reactor design important. Mixing becomes the limiting factor (see item #1).

THE REAL WORLD

1. Real processes involve multiple reactions with multiple heat effects.
2. Most industrial chemical reactions are exothermic and heat transfer is often the most important design criteria.
3. Most bioreactions can only be carried out within a narrow temperature range. Generally, these reactions are relatively non-energetic and temperature control is easily achieved. Like other heterogeneous reactions, mass transfer is usually the most important design criteria.
4. The largest number of different chemical reactions (but not the largest quantity of material) are run in batch reactors, which are especially common in the pharmaceutical, biotech, polymer, and cosmetics industries. Sizes vary from a few liters to over 200,000 liters.
5. CSTRs are the next most common reactors, followed by PFRs and then by hybrid reactor types (fluidized beds, transport beds, trickle beds).
6. Continuous catalytic reactors are common in the petrochemical industries and, by far, the largest quantities of materials are produced in these types of reactors.

ACKNOWLEDGMENTS

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REFERENCES

1. Levenspiel, O., *Chemical Reaction Engineering,* 2nd ed., John Wiley and Sons, New York, NY (1972)
2. Hill, Jr., C.G., *An Introduction to Chemical Engineering Kinetics and Reactor Design,* John Wiley and Sons, New York, NY (1977)
3. Smith, J.M., *Chemical Engineering Kinetics,* 3rd ed., McGraw-Hill, New York, NY (1981)
4. Fogler, H.S., *Elements of Chemical Reaction Engineering,* 2nd ed., Prentice Hall, New Jersey (1992)
5. Schmidt, L.D., *The Engineering of Chemical Reactions,* Oxford University Press (1998)
6. Felder, R.M., and R. Brent, *Chem. Eng. Ed.,* **31**, 178 (1997) ❐

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ChE letter to the editor

Dear Editor:

In the recent paper titled "Permeation fo Gases in Asymmetric Ceramic Membranes" [*CEE*, **33**(1), p. 58 (1999)], by C. Finol and J. Coronas, there was an error in the equation used to calculate the Knudsen number. The correct equation for this clculation is:

$$Kn = \frac{\lambda}{r}, \quad \lambda = \frac{16\,\mu}{5\,\pi P}\sqrt{\frac{\pi RT}{2\,M}}$$

where all the parameters employed in the equation were already defined in the mentioned article. We apologize for any trouble that this mistake may have caused.

Thank you for your consideration.

C. Finol
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