solution (Eq. 1) against the exact solution of Paul and McSpadden (Eq. 8) over a wide range of Q/C_S values (11). The deviations of Lee's solution from the exact solution were consistently one order of magnitude smaller than the deviations obtained upon using Higuchi's equation. Thus, it was concluded that the Lee equation could be applied safely over a wider range of Q/C_S ratios.

The models discussed thus far have described drug release from topical formulations directly into a sink. Although these models are useful in terms of their ability to characterize the diffusional behavior of a drug within a formulation, they do not describe the realistic situation in which a drug diffuses from the vehicle, partitions into, and subsequently diffuses across a resistant membrane (i.e., the skin). To treat situations such as these, Paul and McSpadden also derived an exact solution for drug release from a suspension matrix when a finite mass transfer resistance is encountered between the edge of the releasing matrix and the sink (10). The following equations to describe this case were put forth:

$$M_t = \frac{2C_s}{\text{erf}(\beta)}\sqrt{\frac{Dt}{\pi}} - Q\left(\frac{D}{\omega}\right) \qquad [15]$$

and

$$M_t = \frac{2C_s}{\text{erf}(\beta)}\sqrt{\frac{D}{\pi}}\left(\sqrt{t} - \sqrt{t_0}\right) \qquad [16]$$

where

$$\sqrt{t_0} = \frac{1}{\omega}\left(\frac{Q}{C_s}\right)\sqrt{\frac{D}{2\left(\frac{Q}{C_s} - \frac{1}{2}\right)}} \qquad [17]$$

Here, ω is the mass transfer coefficient, and $\text{erf}(\beta)$ takes the identical form as in Eq. 9. Notably, Eqs. 15 and 16 are asymptotic relationships that are only applicable at long time. The term $\sqrt{t_0}$ is the finite intercept on the $\sqrt{t}$ axis.

Roseman and Higuchi (12) also developed equations for the situation in which finite mass transfer resistance is present; here, in the form of a hydrodynamic boundary layer. In this model, release from a suspension matrix depends upon two distinct processes. The first of these involves an initial zero-order phase of release in which the drug partitions from the matrix into the boundary layer. During this period, diffusion through the boundary layer determines the overall release rate. The duration of this period depends mostly upon the drug's external phase/matrix partition coefficient