Here, D represents diffusivity of drug in the bathing fluid, Q the drug release after time t, τ the tortuosity factor of the capillary system, A the total amount of drug filled in the matrix, ε the porosity of the matrix, and C the solubility of the drug in bathing fluid.

Many a times, the release of drug is a two-stage process; a fast release in the initial stage followed by a second stage of slower release (Fig. 19.9). Kockish et al. (2005) and Po et al. (1990) studied various other models (as given below) apart from Hiquchi model for drug release.

In certain cases there is a stage zero, which indicates delay in release of drug from microspheres. This stage precedes the first actual release phase.

$$\text{Zero}-\text{order release}\,\frac{M_t}{M_\infty}=kt$$

($\frac{M_t}{M_\infty}$, here M_t is the fraction of the original drug load released at time t)

$$\text{First}-\text{order release}, \ln\left(1-\frac{M_t}{M_\infty}\right)=-kt$$

Hixson-Crowell model (drug release from systems with limitations in dissolution rate)

$$\sqrt[3]{\left(1-\frac{M_t}{M_\infty}\right)}=-kt$$

Baker-Lonsdale model (drug release from spherical shape matrices with diffusion rate limitation)

$$\frac{3}{2}\left[1-\left(1-\frac{M_t}{M_0}\right)^{\frac{2}{3}}\right]-\frac{M_t}{M_0}=kt$$

Studies by Radin et al. (2009) of release data for vancomycin and bupivacaine showed difference in release behavior of these drugs from microspheres and granules. They concluded that a diffusion-controlled release model like Higuchi's is more appropriate for describing release behavior of both drugs from granules, whereas Baker-Lonsdale model is more suitable for predicting release of vancomycin from microspheres.

He et al. (2010) reported on a three-stage degradation behavior of MSNs (Fig. 19.10). The study was carried out in SBF, the first stage showed rapid bulk degradation followed by second stage in which a calcium/magnesium silicate layer is deposited in the mesopores, which greatly reduces rate of degradation and later a third stage, which lasts over days till whole sample was degraded.