

Similarly, dissolution behavior of silica-based particles in the form of granules and microspheres was studied by measuring variation in the silicon concentration as function of immersion time. Vancomycin and bupivacaine containing granules and microspheres were synthesized from sols of similar concentration, still their silicon dissolution rates differ from each other. In case of drugs vancomycin and bupivacaine, the granules show initial silicon dissolution rate of 3.4 and 5.1 $\mu\text{g}/\text{mg}/\text{h}$, respectively. However, for microspheres dissolution was delayed for initial 6 h and later this stage was followed by dissolution rate of 0.81 and 1.5 $\mu\text{g}/\text{mg}/\text{h}$ for microspheres loaded with vancomycin and bupivacaine, respectively. Thus, the data indicate lower dissolution rates for microspheres in comparison to that of granules.

19.6.1 Dissolution and Release Kinetics

19.6.1.1 Particle Dissolution

According to Connor et al. in an aqueous solution dissolution of silica occurs at a steady state of silica dissolution—deposition, which can be represented by a first-order reaction.

$$\frac{dC}{dt} = kS(C_e - C) \quad (19.1)$$

The above equation suggests that dissolution depends on diffusion of the solute away from the solid-liquid solution interface. Here, C : silicon concentration in solution, C_e : solubility of silicon, S : surface area of solid phase, t : time, and k : rate constant.

If we consider a solution with neutral pH and a considerable amount of silicon, S is almost constant and at $t=0$, $C=0$; Eq. (19.1) can then be written as

$$\ln\left(\frac{C_e - C}{C_e}\right) = kSt \quad (19.2)$$

The dissolution rate constant k , for the dissolution of microspheres and granules was determined using this equation.

19.6.1.2 Drug Release

Drug release is a phenomenon controlled by diffusion or dissolution or both. Generally, diffusion-controlled drug release is predicted by Higuchi (1963) square root of time model. This model is particularly effective when diffusion-controlled release occurs from porous matrix; in this case, bathing fluid washes out the drug by penetrating the matrix through pores and capillaries.

$$Q = \sqrt{\frac{D\varepsilon}{\tau}(2A - \varepsilon C)}C_i$$