Equation 11: Polymer dissolution in an eroding HPMC tablet

$$M_{pt} = M_{p0} - k_{diss} A_t t \qquad 11$$

M_{pt} and M_{p0} are the dry polymer matrix mass at time t and t = 0 respectively, k_{diss} is the polymer dissolution rate constant relative to the surface area of the matrix and A_t is the surface area at time *t.*

The diffusion and water penetration at the surface of the device are accounted for based on the theory of free volume using a Fujita type relationship displayed in Equation 12.

Equation 12: Diffusion of solute and penetration of solvent at the surface of the device relative to the free volume theory

$$D_k = D_{kcrit} exp \left\{ -\beta_k (1 - \frac{C_1}{C_{1crit}}) \right\} \qquad 12$$

In which, β_k is a constant, independent of concentration; D_{kcrit} represents the diffusion coefficients of water and drug at the front of polymer disentanglement. Stipulations of this theory state there must be ideal mixing between the drug, polymer and water and that the volume of the matrix is in fact additive with respect to the individual volumes (Siepmann and Peppas 2012; Narasimhan and Peppas 1996).

As with the aforementioned swellable devices, the diffusion of drug out of the matrix and diffusion of water into the system are accounted for based on Fick's second law, relative to cylindrical geometries with considerations for the radial and axial directions of diffusion as per Equation 13 (Siepmann et al. 1999; Siepmann and Peppas 2012; Narasimhan and Peppas 1996).

Equation 13: Fick's second law of diffusion relative to solute release from a device of cylindrical geometry

$$\frac{\partial C_k}{\partial t} = \frac{1}{r} \left\{ \frac{\partial}{\partial r} \left(rD_k \frac{\partial C_k}{\partial r} \right) + \frac{\partial}{\partial \theta} \left(\frac{D_k}{r} \frac{\partial C_k}{\partial \theta} \right) + \frac{\partial}{\partial z} \left(rD_k \frac{\partial C_k}{\partial z} \right) \right\} \qquad 13$$

In this equations, C_k and D_k are the concentration and diffusion co-efficient for both water (k = 1) and drug (k = 2), r represents the radial dimension of the matrix and z the axial. θ is the angle relative to the dimensions.

Alternative hydrogel delivery devices

SMART systems involve utilizing specific functionalities of the polymer backbone, creating ionisable groups or hydrogen bonds through varying pH or temperature resulting in increased or decreased polymer swelling (Colombo et al. 1996). When swelling is maximised the polymer chains expand and entrapped molecules can be