Drug release is constrained by the rate of this opposing movement at the surface of the device. Kinetics of Case II transport is defined by the constant speed at which this boundary moves, the swelling process is linear with time and therefore initially first-order release. When the swelling and drug diffusion fronts meet at a centre point, release becomes independent of time. Equation 6 below defines this mechanism (Ritger and Peppas 1987b).

Equation 6: Ritger and Peppas explanation of drug release from a thin polymer film dominated by Case-II relaxation

$$\frac{M_t}{M_\infty} = \frac{2k_o}{C_o l} t \qquad 6$$

In this equation, k_o represents a Case-II relaxation constant, l is the thickness of the film, and C_o is a constant concentration.

A *burst* release phase may be observed in swellable hydrogel formulations. This can be both advantageous and limiting depending on the desired application and release profile (Huang and Brazel 2001). It involves a large concentration of release from the surface of the device over an initial short period of time and reduces the drug concentration of the overall formulation. On formulating hydrogel based devices appropriate consideration must be made for this occurrence.

Drug release from many hydrogel formulations is influenced by both diffusion and swelling simultaneously and therefore these two processes must be fully considered. This results in non-Fickian behaviour and is classified as anomalous transport with an exponent value of $0.5 < n > 1$ for planar geometries. The driving force of the drug release process in such circumstances can be determined by calculation of the *Deborah* number derived by Brazel and Peppas, a ratio of polymer relaxation and solvent diffusion into the system as in Equation 7 (Brazel and Peppas 1999).

Equation 7: Diffusional Deborah number (Brazel and Peppas 1999)

$$D_e = \frac{\lambda}{\theta} \qquad 7$$

λ represents polymer relaxation time and θ, solvent diffusion time. Should $D_e > 1$ or <1 diffusion is Fickian, when $D_e = 1$ anomalous transport is defined. The swelling interface number (S_w) is also relevant as it relates the penetration of the surrounding solvent to that of solute diffusion and is shown in Equation 8.

Equation 8: Swelling Interface number derived by Peppas and Franson

$$Sw = \frac{v\delta r}{D} \qquad 8$$

Considering the defining exponent value associated with the mechanism of anomalous transport lies between the exponent values for Fickian diffusion and Case