Regime Change in Simultaneous Wave Diffusion and Reaction

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The damped wave diffusion and relaxation equation generalizes the Fick's law and takes into account the accumulation of mass at the surface effects. The problem of simultaneous reaction of the first order and wave diffusion was considered in a semi-infinite medium subject to a constant concentration of reactant at one of the surfaces. The solution to the hyperbolic damped wave diffusion and relaxation equation was obtained using the method of retavistic transformation of coordinates. The solution exhibits some space and time symmetry. The solution is given as a modified Bessel composite function of the first kind and first order for times greater than the dimensionless distance X. When a point in the semi-infinte medium is considered that is at a sufficient distance from the surface (X^2 > 23.13), the concentration undergoes three different regimes. The first regime is the inertial regime, where there is no transfer. The second regime is a rising one, given by the Bessel composite function of the first kind and first order. After the wave front reaches the point under consideration the third regime is given by a falling one and given by the modified composite function. The results at different points in the medium, using a microsoft exel spreadsheet, after expanding the Bessel function to 16 terms are shown as figures. Expressions for the mass inertial lag time was found to be given by;

t(inertia) = sqrt(Xp^2 – 23.1323/[1 – k*]^2)

and the penetration distance for a given time instant is given by;

X(penetration) = (t(i)^2 + 23.1323)[1 - k*]^2)