$$D_s * \frac{\partial^2 C_s}{\partial z^2} - \frac{2 * epsilon * km * (C_s - C_{g,pore} * S)}{r * (1 - epsilon)} = \frac{\partial C_s}{\partial t} \quad \text{....(1)}$$

I.C. $t = 0$, $C_s = Cg1 * S$

B.C. 1 $z = 0$, $\frac{\partial C_s}{\partial z} = 0$

B.C. 2 $z = L$, $-D_s * \frac{\partial C_s}{\partial z} = km1 * (C_s - C_{g,bulk} * S)$

$$D_g * \frac{\partial^2 C_{g,pore}}{\partial z^2} - \frac{2 * km * (C_s - C_{g,pore} * S)}{r} = \frac{\partial C_{g,pore}}{\partial t} \quad \text{....(2)}$$

I.C. $t = 0$, $C_{g,pore} = Cg1$

B.C. 1 $z = 0$, $\frac{\partial C_{g,pore}}{\partial z} = 0$

B.C. 2 $z = L$, $-D_g * \frac{\partial C_{g,pore}}{\partial z} = km2 * (C_{g,pore} - C_{g,bulk})$

$$V * \frac{dC_{g,bulk}}{dt} = -Q * C_{g,bulk} + \{(1 - epsilon) * Atot * km1 * (C_s - C_{g,bulk} * S)\}|_{z=L} + \{epsilon * Atot * km2 * (C_{g,pore} - C_{g,bulk})\}|_{z=L} \quad \text{....(3)}$$

I.C. $t = 0$, $C_{g,bulk} = Cg1$

known = epsilon, Atot, V, Q, Cg1, L (All are constants)
Parameters to be estimated (unknown) = S, Ds, Dg, km, km1, km2, r
Dependent variables = C_s, $C_{g,pore}$, $C_{g,bulk}$
Independent variables = z, t

We have data for Cg,bulk w.r.t time (t). Need to fit Cg,bulk. to find the unknown parameters.