Inversion of the Optimum Radius of Biological Flocculus in the Reactor of the Water Decontamination

Kean Liu Bo Han Jiaqi Liu

(Department of Mathematics ,Harbin Institute of Technology, Harbin,China)

In ordinary water-disposing reactor, the biological floccules always integrate, so biological floccule can be looked as a unit model. The biological floccule grows with time varying, the volume becomes big, the biological membrane becomes think, the pervasion becomes bad, inter biology dies, and the reactor's decontaminate ability decrease. Properly controlling the volume of biological floccules can improve the reactor's efficiency. How to obtain the optimum radius of biological floccule and how to onlinely control the radius of biological floccule is a meaningful research. In a period of time, suppose that

1) Each biological floccule approximates a spheroid
2) The density of biological floccule does not change with time and size
3) The whole biological floccule is supposed to have a mean phase the biology chemistry reaction in the biological floccules is only the function of local environment.

Using the spherical biological floccule as the unit and getting a thin layer from biological floccule unit,we can get materiel mathematical model

$$D\left(\frac{d^2C}{dr^2}+\frac{2}{r}\frac{dC}{dr}\right)=r_0$$

the boundary condition is

$$\frac{dC}{dr}\Big|_{r=0}=0$$
$$C\Big|_{r=R}=C_0$$

where D is the diffusing coefficient in the biological floccule membrane, C is the concentration of main body liquor r_0 is the dislodge rate of the biological floccule volume, R is the radius of biological floccule, C_0 is the concentration of matrix.

Where

$$r_0=\frac{1}{Y}\frac{m_{\max}C}{K_S+C}X$$
$$r_0(C_0)=\frac{1}{Y}\frac{m_{\max}C_0}{K_S+C_0}$$

at this time ,the reaction is confined in the membrane, biology well die. Where x is the animalcule concentration, y is the productivity coefficient (the productivity of animalcule in the a unit volume), Ks is the saturation constant, Max is the maximum of incresing rate of microbe.

When the radius of biological floccule r is available, (1) ~ (3) constitute the nonlinear boundary value problem of ordinary differentali equations.

But the radius of biological floccules R is just what we want to solve and we expect to improve the reactor's efficiency by controling the radius R. If we add an control condition:

$$C\Big|_{r=0}=d$$

then (1) ~ (4) constitute a geometry invese problem to confirm the boundary value R. where is a small positive number

Discretizing equations and the boundary condition and to selecting the properly step t, the problem becomes the one to obtain a integer n to satisfy $C_n=C_{n+1}$.

Therefore the inverse problem is reduced to an optimization problem below

$$\min(\;|C_n(r) - C_{n-1}(r)|\;)$$
$$\text{s.t.}\quad C_{n-1} > 0$$
$$C_n = d > 0$$

Numerical simulations are carried out .The numerical results indicate trh effectiveness of the model and methods.