Derivation of:

$$\frac{1}{F/M} = \frac{Y_H SRT}{1 + b_{H,T} SRT}$$

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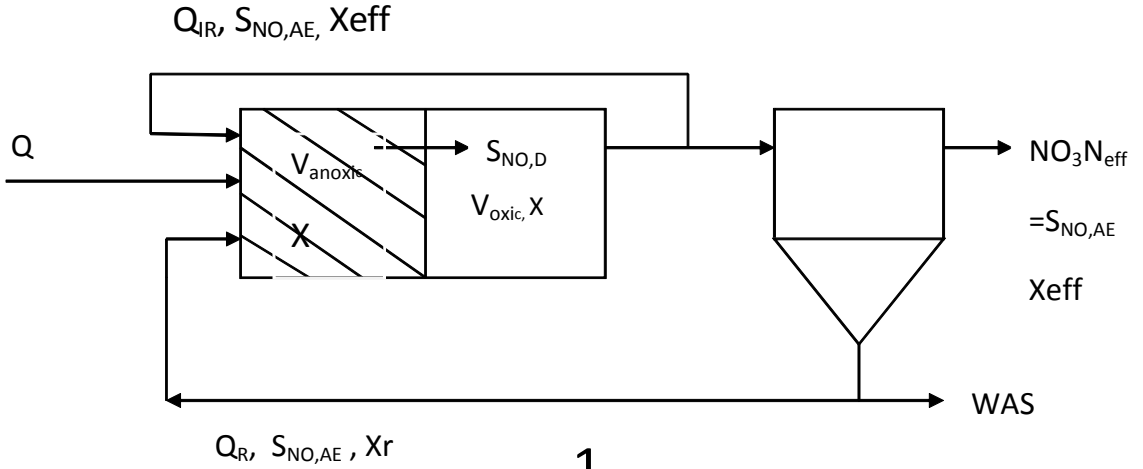
Rate of substrate utilization:



$$r_{su} = \frac{\mu_H}{Y_H} X_{BH} = -\frac{Q(S_0 - S)}{\forall_T} \quad \text{.....1}$$

$$r_g = \mu_H X_{BH} - b_{H,T} X_{BH} = Y_H r_{su} - b_{H,T} X_{BH} \quad \text{.....2}$$

Making a microorganism mass balance for a completely mixed flow reactor with recycle:

$$\forall_T \frac{dX_{eff}}{dt} = Q_{in} X_{in} - (Q_W X_{BH} + Q_{eff} X_e) - \forall_T r_g \quad \text{.....3}$$

(0 0)

At steady-state, and for $X_{in}=0$, substituting r_g from Eq 2 in Eq3;

$$\frac{Q_W X_{BH} + Q_{eff} X_e}{\forall_T X_{BH}} = Y_H \frac{r_{su}}{X_{BH}} - b_{H,T} \quad \text{.....4}$$

$$\frac{1}{SRT} = Y_H \frac{r_{su}}{X_{BH}} - b_{H,T} \quad \text{.....5}$$

Substituting r_{su} from Eq1;

$$X_{BH} = -\frac{Q(S_0 - S)}{\forall_T} * \frac{Y_H SRT}{1 + b_{H,T} SRT} \quad \text{.....6}$$

$$\boxed{\frac{1}{F/M} = -\frac{\forall_T X_{BH}}{Q(S_0 - S)} = \frac{Y_H SRT}{1 + b_{H,T} SRT}} \quad \text{.....7}$$

From definiton of SRT;

$$\boxed{P_{X,T} = \frac{\forall_T X}{SRT} = \frac{Y_H Q(S_0 - S)}{(1 + b_{H,T} SRT)}}$$

Dependence of $S_{NO3Neff}$ on Internal Recirculation (IR)

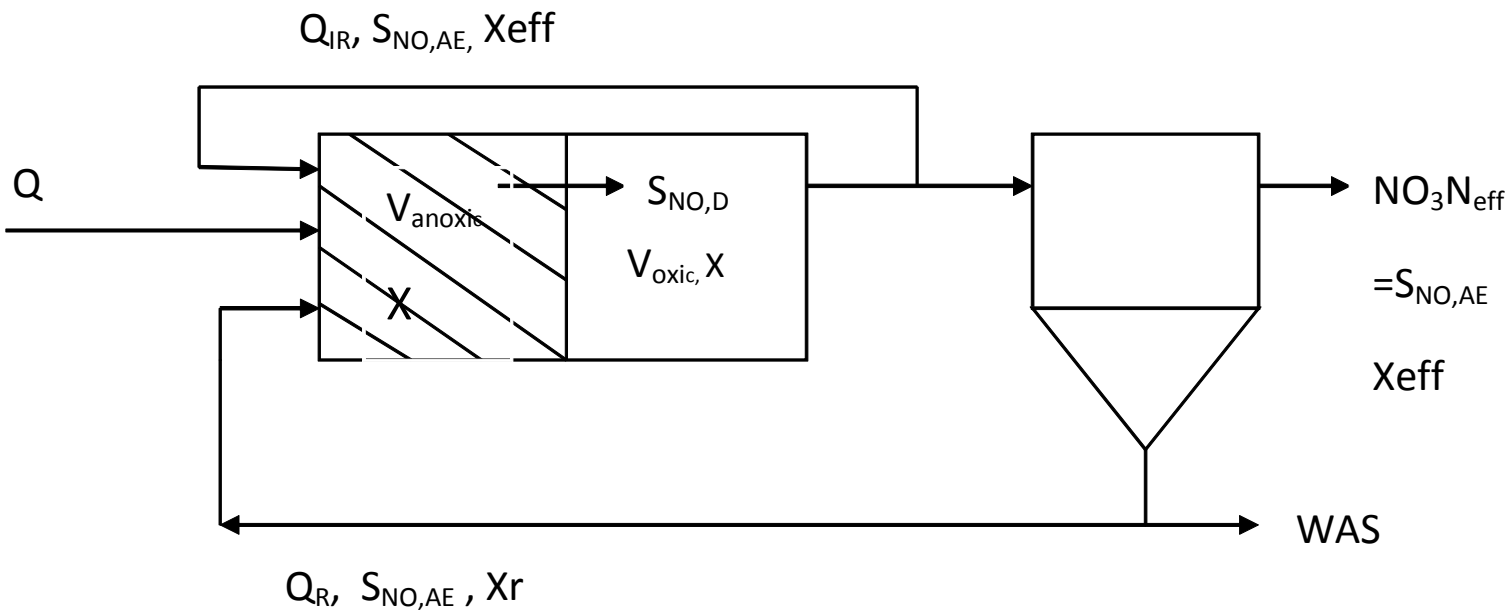
Dr. A. Saatçı

Derivation of Dependence of $S_{NO3Neff}$ on Internal Recirculation (IR)

$$TN_{in} = TKN_{in} + NO_3N_{in}$$

Assume $NO_3N_{in} = 0$

TKN nitrogen to be oxidized = $(TN_{in} - TKN_{eff}) - X_{orgN,WAS} = (1 + R + IR)(S_{NO,AE} - S_{NO,D})$



$$IR = \frac{(TKN_{in} - TKN_{eff} - X_{orgN,WAS})}{S_{NO,AE} - S_{NO,D}} - (1 + R)$$

$$IR = \frac{(TKN_{in} - TKN_{eff} - X_{orgN,WAS})}{S_{NO,AE} - S_{NO,D}} - (1+R)$$

Assume optimized anoxic volume and $S_{NO,D}=0$

$$IR = \frac{NO_X}{NO_3N_{eff}} - (1+R)$$

Nitrate to be denitrifed = $Q(R+IR)*NO_3N_{eff}$