

Biochemical Systems (C, H, O, N, P...)

- Fermentation with complex media
- Biological wastewater treatment
- Soluble and non-soluble compounds

TOC → Carbon-balance

COD → COD-balance

Kj-N → N-balance

Non-soluble fractions → TS-balance

$$1 \gamma \text{ unit} \equiv \text{e-mole} \equiv 8 \text{ gCOD} = \frac{1}{4} \text{ mole O}_2$$

COD = 0 ← Full COD reaction → $\gamma = 0$
(HCO_3^- , H_2O , H^+ , NH_3 , SO_4^{2-} , Fe^{3+})

Organic Matter $\gamma = 1.5 \cdot \frac{\text{COD}_{\text{gCOD}}}{\text{TOC}_{\text{gC}}} \left[\frac{e_{\text{mole}}}{C_{\text{mole}}} \right]$

Biomass $\text{C}_1\text{H}_{1.8}\text{O}_{0.5}\text{N}_{0.2} \rightarrow$
 $1 \text{ C}_{\text{mole}} = 24.6 \text{ g VSS} = 4.2 \times 8 = 33.6 \text{ g COD}$

Aeration
BOD

$$\frac{\text{BOD}}{\text{COD}} = 1 - Y_{\text{COD}}$$

$$\begin{aligned} \frac{\text{BOD}}{\text{COD}_{\text{Total}}} &= \frac{(1 - Y_{\text{COD}}) \cdot \text{COD}_S}{\text{COD}_{\text{Total}}} \\ &= \frac{(1 - Y_{\text{COD}}) \cdot f_{\text{biodegradable}} \cdot \text{COD}_{\text{Total}}}{\text{COD}_{\text{Total}}} \end{aligned}$$

COD Balance:

$$-1 \cdot S_{[\text{gCOD}]} - Y_{\text{O}} \cdot \text{O}_2 [\text{g}=(-)\text{gCOD}] + Y_{\text{COD}} \cdot X_{[\text{gCOD}]}$$

$$Y_{\text{COD}} = \frac{\text{g}_{\text{COD}} \text{ biomass produced}}{\text{g}_{\text{COD}} \text{ substrate consumed}} < 1$$

$$Y_{\text{O}} = \frac{\text{g}_{\text{COD}} \text{ O}_2 \text{ consumed}}{\text{g}_{\text{COD}} \text{ substrate consumed}} < 1$$

$Y_{\text{COD}}/Y_{\text{SX}}$

Biomass yield

$$Y_{\text{COD}} \left[\frac{\text{g}_{\text{COD}} X}{\text{g}_{\text{COD}} S} \right] \cdot \frac{\gamma_S}{\gamma_X} \cdot \frac{24.6}{\text{MW}_S} \equiv Y_{\text{SX}} \left[\frac{\text{gVSS}_X}{\text{g}_S} \right]$$

$$-\text{COD}_S + \text{BOD} + Y_{\text{COD}} \cdot \text{COD}_S = 0$$

$$1 \text{ PE } \text{gO}_2 \cdot \text{d}^{-1} = \text{g}_{\text{COD}} \cdot \text{d}^{-1} + 4.57 \cdot \text{g}_{\text{Kj-N}} \cdot \text{d}^{-1}$$