1. **Continuous acetic acid fermentation**

EtOH + *Acetobacter aceti* → acetic acid (under aerobic condition)

● continuous process using *A. aceti* (in stationary phase) immobilized on gelatin beads

● wants to produce 2 kg/hr acetic acid, max tolerable acetic acid concentration is 12%

● aeration rate of 200 gmol/hr

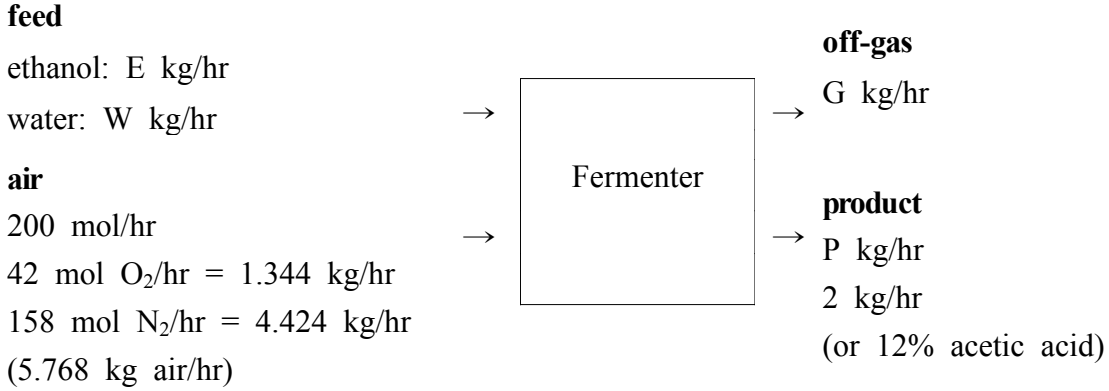
● extra data : - MW: EtOH=46, AcOH=60, O_2=32, N_2=28, H_2O=18
- composition of air: 21% O_2 + 79% N_2
- gas vol % = mol %
- no evaporation of EtOH, AcOH, and H_2O
- O_2 transfer is rapid enough (always aerobic fermentation)

a) What is the reaction equation for this fermentation?

b) What is the minimum amount of ethanol to produce 2 kg/hr acetic acid?

c) Volume composition of gas at the fermenter outlet?

d) Min. amount of water to dilute the ethanol below AcOH inhibition level?



2. **Aerobic bacterial growth on hexadecane as substrate**

$C_{16}H_{34} + 16.28\ O_2 + 1.42\ NH_3 \rightarrow 1.65\ C_{4.4}H_{7.3}O_{1.2}N_{0.86} + 8.74\ CO_2 + 13.11\ H_2O$

(a) Is the stoichiometric equation balanced?

(b) What grams are 1 mole of cells and hexadecane, respectively?

(c) Assuming 100% conversion, what is the yield of cells from hexadecane in g/g?

(d) Assuming 100% conversion, what is the yield of cells from oxygen in g/g?

(e) to produce 2.5 kg cells in a 3000 liter reactor

i) minimum amount of $C_{16}H_{34}$?

ii) min concentration of $C_{16}H_{34}$ in 3 m^3 ?

iii) mim vol of air at 20^oC and 1 atm ? (air = 24.07 l/mol)