

EXAMPLE 1

Mass balancing:

Liquid from a brewery fermenter can be considered to contain 12.5% Ethanol in water. 220000 lb h⁻¹ of this fermentation broth are pumped to a distillation column on the factory site. Under current operating conditions a distillate of 38 % ethanol and 62 % water is produced from the top of the column at a rate 22% that of the feed rate

- Illustrate the system, systems boundaries and mass flows in and out of the system
- Set-up the mass balances for water and ethanol in kg h⁻¹
- Calculate the composition of the waste and the product stream in% and the rate of ethanol loss in kg h⁻¹

EXAMPLE 2

Elementary composition of *E. coli*

in % of cell dry mass

| | | | |
|----------------|-----|----|-----|
| C | 50 | K | 1 |
| O | 20 | Na | 1 |
| N | 14 | Ca | 0,5 |
| H | 8 | Mg | 0,5 |
| P | 3 | Cl | 0,5 |
| S | 1 | Fe | 0,2 |
| other elements | 0,3 | | |

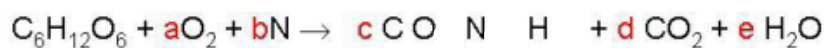
Calculate the molecular mass of biomass related to carbon. Use the information in the table

yield $Y_{X/S} = 0,3$ (g CDM/gGlc)

molecular mass of biomass : 22,06 (g/mol)

1 mol glucose = ? mol biomass

basic equation: glucose → biomass



C-balance:

N-balance:

O-balance

H-balance:

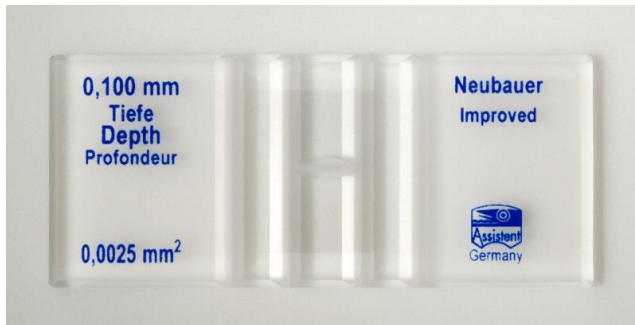
yield coefficient $Y_{X/S} = 0,3$

Solve the stoichiometric equation and calculate the specific oxygen demand per cell mass

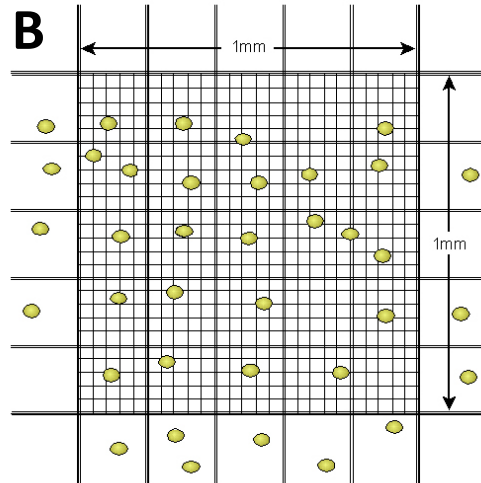
EXAMPLE 3

Mammalian routine culture and passaging

A



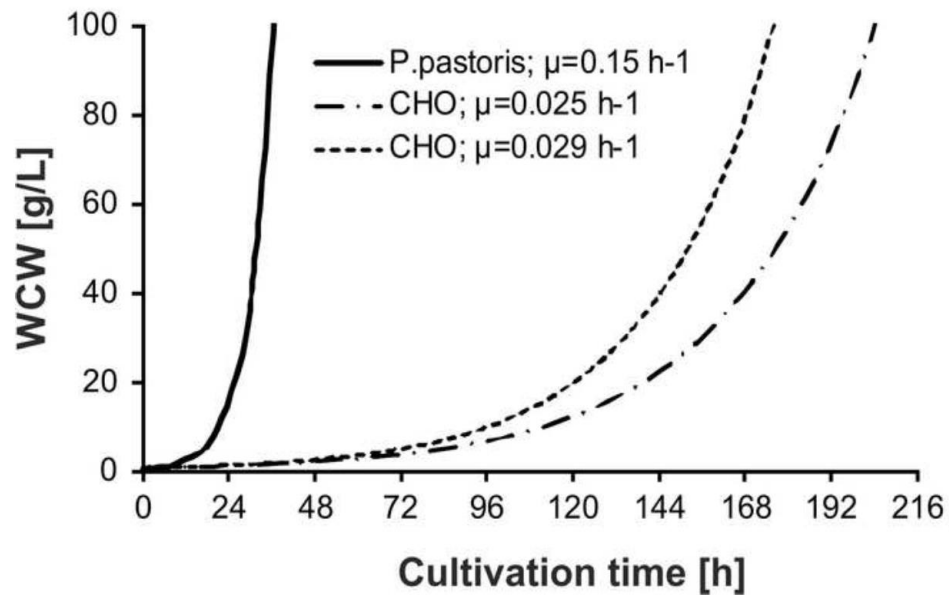
B



Calculate the cell concentration (cell/ml) 3 days after seeding of a CHO culture based on data given in Figure 1A and B. For analysis in the Haemocytometer the sample was diluted (1:5).

For passaging into 20 ml volume the same initial seeding concentration should be used as in the first cultivation. Calculate the required dilution to get the initial seeding concentration for a CHO processes with a growth rates of $0,029 \text{ h}^{-1}$ and the required volume of cell suspension.

EXAMPLE 4



The diameter of a CHO cell with $15\mu\text{m}$ is 3 times the diameter of a pichia cell and both cell types are spherical in shape. Correlate the WCW of 20 g/L (Fig 1C) to cell concentrations (cells/mL) for all three processes shown in the figure.

FOR CALCULATION AT LEAST ONE ASSUMPTION IS REQUIRED!!!

Calculate the number of cells used for inoculation for all three processes

EXAMPLE 4

| Fermentation process design | | |
|---|--------|-------------------------|
| oxygen partial pressure (1atm) | 0,21 | bar |
| Henry coefficient at 35°C | 27,90 | bar·m ³ /kg |
| Saturated dissolved oxygen concentration cO_2^* | | g/L |
| Dissolved oxygen concentration cO_2 (DO: 30%) | | g/L |
| Maximal working volume | 20,00 | L |
| OTR | | g O ₂ /L/h |
| k_La | 800,00 | h ⁻¹ |
| total oxygen transfer | | g O ₂ /h |
| oxygen demand | 1,60 | g O ₂ /g CDM |
| maximal CDM production | | g CDM/h |
| exponential feed | | |
| growth rate | 0,20 | h ⁻¹ |
| maximal final CDM | | g |
| maximal specific CDM | | g/L |
| batch process | | |
| max. growth rate | 0,6 | h ⁻¹ |
| maximal CDM production | | g CDM/h |
| maximal specific CDM | | g/L |

Calculate the missing values in the table