



SECTION II: KINETICS AND BIOREACTOR DESIGN:

LESSON 10.2. - Bioreactor design – Design Equations - Examples

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AIMS FOR TODAY'S LESSON

10.1 Design equations

10.2 Exercises

10.3 Tank vs Tubular reactor: Comparing efficiency

10.4 Recycle, By-pass and Purge

10.5 Bioreactor association

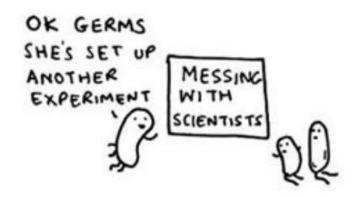
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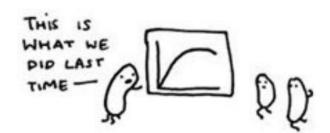
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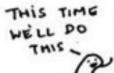
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Handisco de Vitoria

WORKING ON BACTERIA







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KNOW WHICH IS RIGHT!

What does a Greek cow say?



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Example #1:

An enzymatic process where the following reaction takes place

$$A \rightarrow R$$
,

can be described using a first-order kinetic equation:

$$r (mole \cdot L^{-1} \cdot h^{-1}) = 1.2 \cdot [A]$$

This reaction is carried out using a batch reactor where the working temperature is constantly 50°C. The reactant mixture presents an initial concentration of 12 moles/L in A.

What is the reaction time (t_R) needed in order to reach an X_A of

0.802

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Example #2:

One current containing 3 moles/L of substrate and 0.01 g/L of enzyme is fed into a Continuous Stirred Tank Reactor (CSTR). The kinetic parameters corresponding to the equation describing the process (Michaelis-Menten equation) are:

 $K_{cat} = 2 \text{ moles/(min.gE)}$ and $K_{M} = 0.1 \text{ (mole S)/L}$.

Calculate the volume needed to treat a 30 L/min stream so that an output conversion of 99.5% is achieved.

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Example #3:

The growth of an aerobic microorganism is carried out within a 3 L bioreactor working as a continuous stirred tank fed with 0,15 L/h.

If growth can adequately be described using the kinetic model proposed by **Monod**, and **nitrogenous substrate can be considered as limiting nutrient**, calculate both biomass and limiting substrate concentrations when steady state is achieve.

Inlet substrate concentration is 0.4 g/L.

Kinetic parameters for the biological system under the operating conditions are:

$$\mu^{max} = 0.2 \text{ h}^{-1}$$
, $K_N = 0.06 \text{ g N/L}$, $Y_{X/N} = 4.6 \text{ gX / gN}$.

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Example #4:

30 g/h of a certain yeast need to be obtained. The kinetic model describing its growth has been obtained, taking into account that it is **limited by the amount of nitrogenous substrate** present in the fermentation broth.

Calculate the volume of the continuous tank reactor required for this production.

Kinetic model:

$$R_X(gX/L\cdot h) = \mu_m \cdot [N] \cdot [X]$$

$$R_N(gN/L \cdot h) = -Y_{N/X} \cdot R_X$$

Where $\mu = 0.51 / a N h \cdot V = 0.17 a N / a V$

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Example #5:

A 100 L bioreactor consisting in a continuous stirred tank is fed with a 10 L/h current containing 0,75 g/L of a growth limiting substrate.

The kinetic model describing the system has been previously obtained.

Calculate the amount of product generated per hour.

Data:

Kinetic model:

$$\begin{cases} R_X(gX/L \cdot h) = 0.46 \cdot [N] \cdot [X] \\ R_N(gN/L \cdot h) = -0.15 \cdot R_X \end{cases}$$

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Example #6:

A continuous tubular reactor is used in order to carry out the reaction

$$A + B \rightarrow R + S$$

catalyzed by an enzyme. The fed stream contains "A" and "B" in an equimolecular ratio at a 500 L/min flow. The concentration of "A" at the entrance is 0.18 M

In order to achieve an output conversion of 85%, what volume of the reactor is needed?

Although the enzymatic process, the kinetics of the reaction taking place

can be expressed as:

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