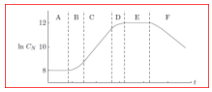
Engenharia Bioquímica

Aula 3

29 de Fevereiro de 2012

Fase exponencial (C)



Sendo μ constante na fase exponencial podemos obter uma expressão para
A evolução do número de células na fase exponencial integrando a equação....

$$\frac{dC}{dt} = \mu C$$

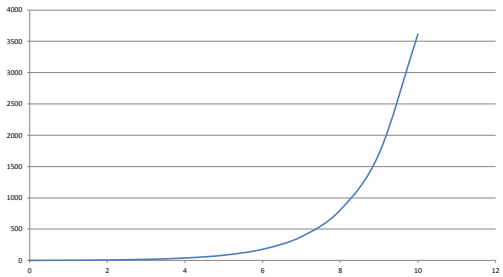
considerando C_0 no início t_0 da fase exponencial..

$$\int_{C_0}^{C} \frac{dC}{C} = \int_{t_0}^{t} \mu dt$$

o que permite obter... $C = C_0 \exp[\mu(t - t_0)]$

$$C = C_0 e^{t\mu}$$

Crescimento exponencial…



Reactor descontínuo

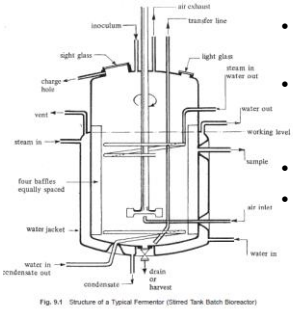
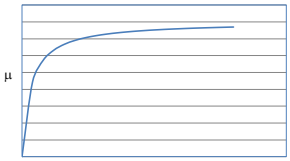


Fig. 9.1 Structure of a Typical Fermentor (Stirred Tank Batch Bioreactor)

- A certa altura alguma coisa acaba….
- O crescimento celular não pode ser descrito como exponencial
- A não ser…
- Na fase de crescimento exponencial

Monod (1942)

$$\mu = \frac{\mu_{max} S}{S + K_s}$$



Monod (1942)

$$\mu = \frac{\mu_{max} S}{S + K_s}$$

$$S \to \infty$$

$$S >> K_s$$

$$\mu = \mu_{max}$$

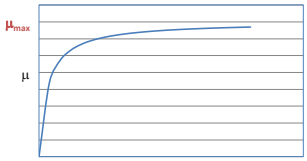


TABLE 2.1. *Some representative values of μ_{max} (obtained under the conditions specified in the original reference) for a range of organisms*

Organism	μ_{max} (h^{-1})	Reference
Vibrio natriegens	4.24	Eagon (1961)
Methylomonas methanolytica	0.53	Dostalek *et al.* (1972)
Aspergillus nidulans	0.36	Trinci (1969)
Penicillium chrysogenum	0.12	Trinci (1969)
Fusarium graminearum Schwabe	0.28	Trinci (1992)
Plant cells in suspension culture	0.01–0.046	Petersen and Alfermann (1993)
Animal cells	0.01–0.05	Lavery (1990)

Monod (1942)

$$\mu = \frac{\mu_{\max} S}{S + K_s}$$

$$S = K_s$$

$$\mu = \frac{\mu_{\max} K_s}{K_s + K_s}$$

$$\mu = \frac{\mu_{\max} K_s}{2K_s}$$

$$\mu = \frac{\mu_{\max}}{2}$$

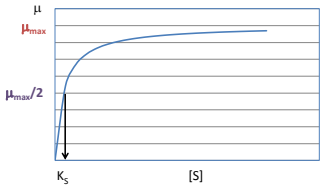


TABLE 2.2. *Some representative values of K_s for a range of micro-organisms and substrates*

Organism	Substrate	K_s (mg dm^{-3})	References
Escherichia coli	Glucose	6.8×10^{-2}	Shehata and Marr (1971)
Saccharomyces cerevisiae	Glucose	25.0	Pirt and Kurowski (1970)
Pseudomonas sp.	Methanol	0.7	Harrison (1973)

Reactor batch

$$\frac{dC}{dt} = \mu C$$

Mas...

$$\mu = \frac{\mu_{\max} S}{S + K_s}$$

$$\frac{dC}{dt} = \frac{\mu_{\max} S}{S + K_s} C$$

$$\frac{dC}{dt} = \frac{\mu_{\max} S}{S + K_s} C$$

Atenção! O substrato vai sendo reduzido e a biomassa ,C, vai aumentando...

$$S + \ldots \rightarrow C + \ldots$$

$$Y_{C/S} = \frac{\Delta C}{\Delta S} = \frac{dC}{dS}$$

Coeficiente de Rendimento (g/g)

$$\frac{dC}{dS} = Y_{c/s} \Leftrightarrow dC = Y_{c/s} dS \Rightarrow \frac{dS}{dt} = -\left(\frac{1}{Y_{c/s}}\right)\frac{dC}{dt}$$

$$\frac{dS}{dt} = -\left(\frac{1}{Y_{c/s}}\right)\frac{dC}{dt}$$

$$\frac{dC}{dt} = \frac{\mu_{\max} S}{S + K_s} C$$

$$\begin{cases} \dfrac{dC}{dt} = \dfrac{\mu_{\max} S}{S + K_s} C \\ \dfrac{dS}{dt} = -\left(\dfrac{1}{Y_{c/s}}\right)\dfrac{\mu_{\max} S}{S + K_s} C \end{cases}$$

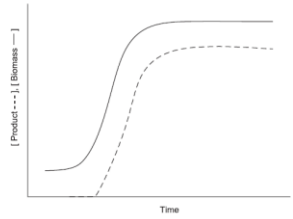


Figure 4.3 *Growth associated product formed during the period of active culture growth*

Table 4.1 *Examples of commercially produced primary metabolites*

Microorganism	Primary metabolite	Commercial use
Saccharomyces cerevisiae	Ethanol	Alcoholic beverage
Corynebacterium glutamacium	Amino acids – glutamic acid and lysine	Food industry – flavour enhancer
Ashbya gossipii and *Eremothecium ashbyi*	Riboflavin	Food industry – vitamin
Aspergillus niger	Citric acid	Food industry – flavour enhancer and preservative
Xanthonomonas campestris	Xanthan gum	Food industry – food additive and rheology modifier
Pseudomonas denitrificans and *Propionibacterium shermanii*	Vitamin B_{12}	Food industry – vitamin

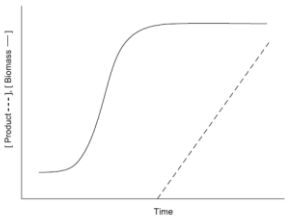


Figure 4.4 *Nongrowth associated product formed during the period of nonculture growth (stationary phase)*

Table 4.2 *Examples of commercially produced secondary metabolites*

Microorganism	Primary metabolite	Commercial use
Penicillium chrysogenum	Penicillin	Antibiotic
Streptomyces erythreus	Erythromycin	Antibiotic
Streptomyces griseus	Streptomycin	Antibiotic
Cephalosporium acrimonium	Cephalosporin	Antibiotic
Gibberella fujikuroi	Gibberellin	Antibiotic
Tolypocladium inflatum	Cyclosporin A	Antibiotic