

Dynamic simulation of microbial growth in a continuous bioreactor.  
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Operating conditions:

$s_f := 100$  ... Feed substrate concentration

$D := 0.05$  ... Dilution rate

Constitutive relations:  $\mu_m := 0.3$   $K := 50$   $K_i := 0.01$   $A := 0.004$   $B := 0.001$

$\mu(s) := \Phi(s) \cdot \frac{\mu_m \cdot s}{K + s + K_i \cdot s^2}$  ... Monod specific growth rate with substrate inhibition  $s := 0..s_f$

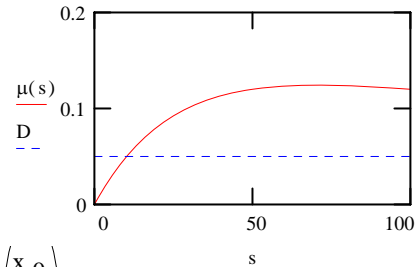
$Y(s) := A + B \cdot s$  ... yield coefficient

Dynamic Equations:

$\text{dxdt}(x, s) := (\mu(s) - D) \cdot x$  ... biomass  $x_0 := 5$

$\text{dsdt}(x, s) := D \cdot (s_f - s) - \frac{\mu(s) \cdot x}{Y(s)}$  ... substrate  $s_0 := 30$

$\text{ydot}(t, y) := \begin{pmatrix} \text{dxdt}(y_0, y_1) \\ \text{dsdt}(y_0, y_1) \end{pmatrix}$  Initial conditions:  $y_{\text{initial}} := \begin{pmatrix} x_0 \\ s_0 \end{pmatrix}$

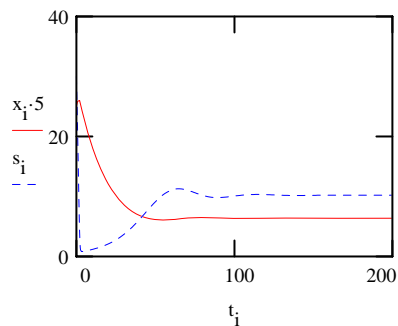


Integrate both ODEs from  $t_0 := 0$  to  $t_f := 200$  in  $N := 1000$  steps

$\text{yout} := \text{rkfixed}(y_{\text{initial}}, 0, t_f, N, \text{ydot})$   $t := \text{yout}^{<0>}$   $x := \text{yout}^{<1>}$   $s := \text{yout}^{<2>}$   $i := 0.. \text{last}(t)$

Operating parameters:  $D = 0.05$   $s_f = 100$   $x_0 = 5$   $s_0 = 30$

Plot of state variables



Phase Diagram

