chemostat\_ss

Simulates steady-state concentrations and growth rate as functions of dilution rate in a chemostat.

It is an example of simulation using SimuPlots algorithm type " Vector" in which an x-axis vector is first built according to the scale specification on the first row in the Variables section (here D from 0 to 1 divided in 1000 steps).

Note that element-wise operations (.\* ./ .^) must be used for vectors.

For models and derivation of the steady state solutions see Fermentation Process Eng., which can be downloaded from www.enfors.eu.

Variables:

D /h Dilution rate

my /h Specific growth rate

S g/L Limiting substrate conc.

Xv g/L Viable cell conc.

DOT %air sat. Dissolved oxygen

S2 g/L Non-limiting substrate conc.

Xd g/L Dead cell concentration

Pe g/L Extracellular product conc.

Pi g/g Intracellular product conc.

Constants:

Yem g/g Biomass yield coefficient on S, excl. maintenance

qm g/g/h Maintenance coefficient

Ks g/L Saturation constant for S

mymax /h Max specific growth rate

kd /h 1st order death rate constant

Yosresp g/g Oxygen consumed per substrate in respiration

DOTstar % DOT in equilibrium with air bubbles

Si g/L Inlet S concentration

delta - Cell recirculation factor

KLa /h Volumetric oxygen transfer coefficient

Yxs2 g/g Biomass yield on S2

S2i g/L Inlet concentration of S2

H %/(g/L) Conversion factor: % air sat. units per gO2/L

alpha g/g Luedeking-Piret constant for growth associated production

beta g/g/h Luedeking-Piret constant for non-growth associated production

Cx gC/gX Carbon concentration in cells

Cs gC/gS Carbon concentration in substrate S

Algorithm:

my=delta\*D+kd;

S=my\*Ks./(mymax-my); Limiting S according to Monod model

S(find(S<=0))=Si; Boundary condition for model

S(find(S>Si))=Si; Boundary condition for model

Yxs=my\*Yem./(my+qm\*Yem); Biomass yield on S incl. maintenance

Xv=D./my.\*Yxs.\*(Si-S);

Xd=kd\*Xv./(delta\*D);

qs=my./Yxs; Specific substrate consumption rate

qo=Yosresp\*(qs-Cx/Cs\*my); Spec. oxygen consumption rate

DOT=DOTstar-qo.\*Xv\*H/KLa;

qp=alpha\*my+beta; Spec. product formation rate

Pe=qp.\*Xv./D;

Pi=qp./my;

Pi(find(S==Si))=0; Boundary condition for model

qs2=my./Yxs2; Spec. rate of S2 consumption

S2=S2i-qs2.\*Xv./D;

my(find(my>=mymax))=0; Boundary condition of model