Accelerating the transition between steady states in chemostat fermentations through the application of bioprocess control

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Problem description

Determination of microbial parameters for metabolic modeling requires chemostat experiments at different dilution rates.

Since transient period preceding steady states can be quite long, experiments become very time- and medium consuming.

Objective

Use simple control algorithm to reduce transient period and thus accelerate the transition between steady states in chemostat fermentations

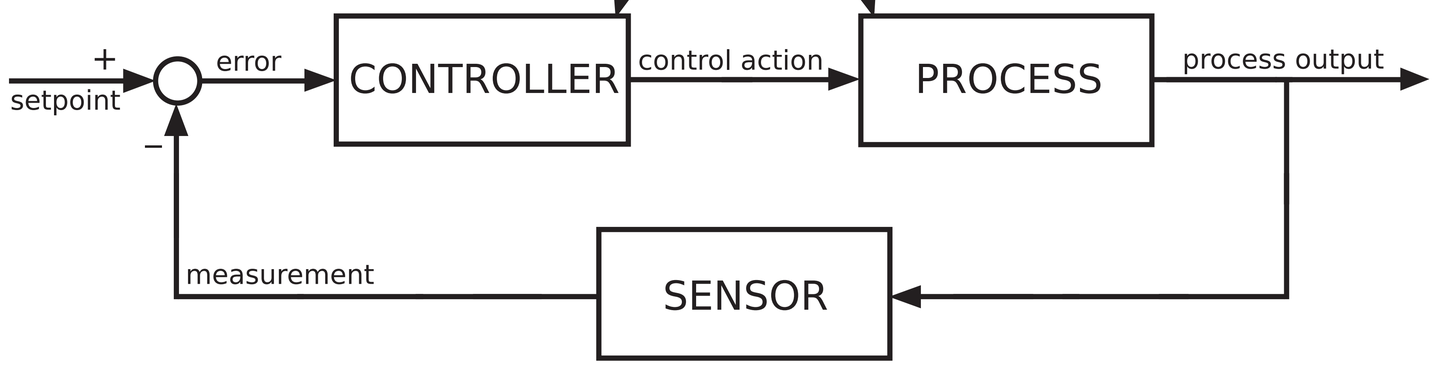
Model-based controller design

PID controller

- was designed *in-silico* using MATLAB/SIMULINK
- biomass concentration controlled variable
- glucose in influent is manipulated variable
- setpoint is an estimate of the new steady state concentration of biomass

Cybernetic model

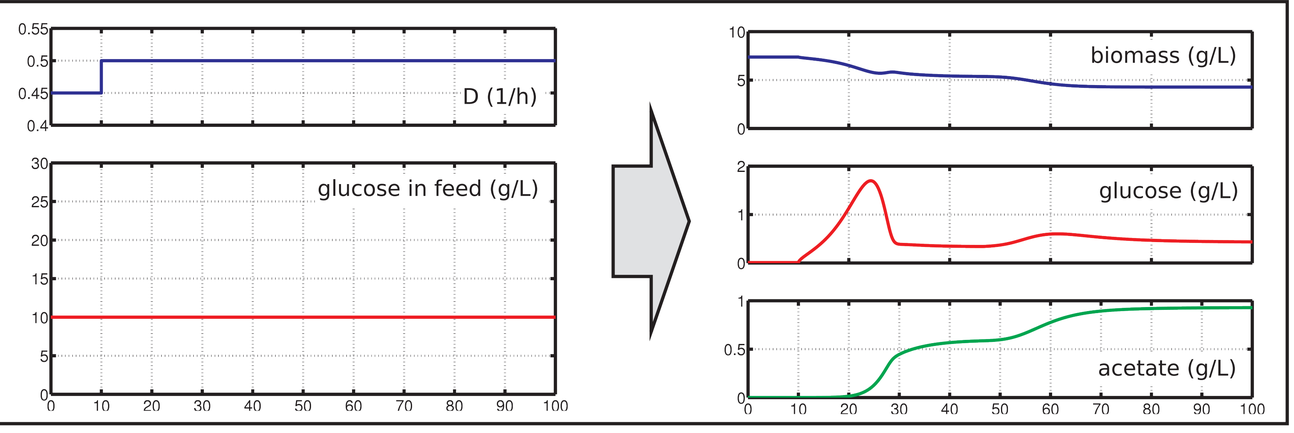
- includes metabolic regulation
- able to describe the transient period
- built for *Escherichia coli* with acetate as only fermentation product
- calibrated with batch data from literature



Simulation results

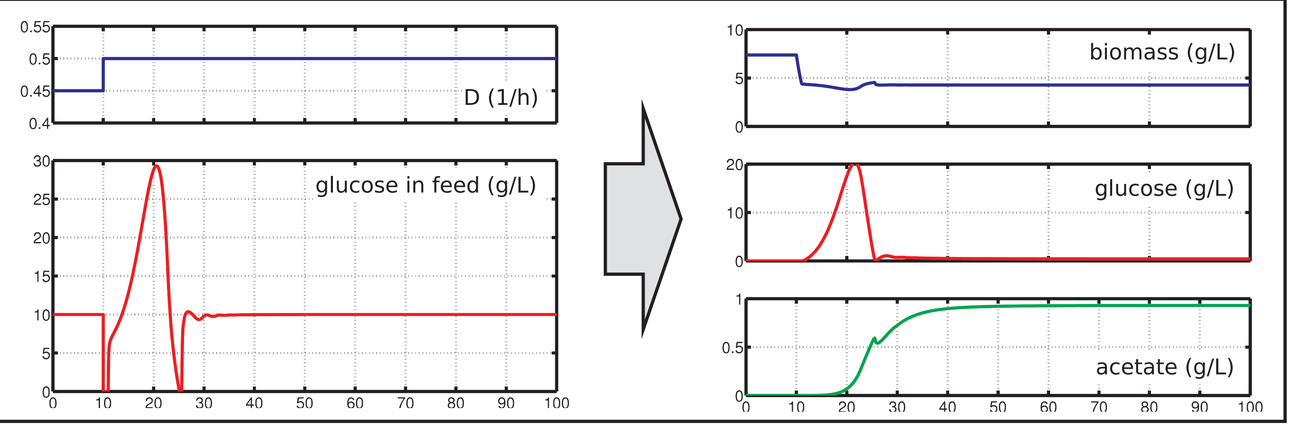
Shift in dilution rate without control

- Shift from D = 0.45 1/h to D = 0.50 1/h at t = 10 h
- Glucose concentration in influent was kept constant at 10 g/L
- Transient period lasts approximatly 70 h ≈ 3 d



Shift in dilution rate with control

- Shift from D = 0.45 1/h to D = 0.50 1/h at t = 10 h
- Glucose concentration in influent was dictated by the controller
- Transient period lasts approximatly 35 h ≈ 1.5 d



Conclusions

- A significant decrease in the transition period was achieved with a simple control
- Given the fact that only one degree of freedom was used to steer the process, improvement is to be expected when the other degrees of freedom are exploited as well

Acknowledgements

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For further information, visit www.memore.ugent.be or contact karl.rumbold@ugent.be.

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