MSc thesis project proposal

Modelling CO fermentation in chemostats

Background

Syngas is a mixture of CO, H_2 and CO_2 that traditionally is produced from fossil resources. Novel methods are biomass or waste gasification, and by CO_2 and water electroreduction. Hence, conversion of syngas to useful products should fit in a circular economy.

Syngas fermentation to ethanol has become industrial reality in the past years. Continuous, large fermenters are used. Gas-liquid mass transfer is usually limiting the rate, such that microbial kinetics is easily obscured. Recently, however, useful chemostat data for *Clostridium authoethanogenum* fermentation of CO at various conditions have been obtained at TU Delft and other labs, and some batch data are also available. Consequently, it has become clear which operational settings determine the outcome of CO fermentation, for example liquid dilution rate, kLa, and pH.

However, a quantitative overall description is missing, such that optimization of the fermentation is currently rather empirical. A quantitative model would allow a more systematic optimization, leading to a more sustainable process.

Research questions

Using unstructured microbial kinetics (the "Black Box kinetic model") plus the current insight in the ATP-production of the CO pathways to ethanol and acetic acid, what is the simplest quantitative model that can be made that can explain the available chemostat data?

Can the model be extended with H_2 and CO_2 conversion? If so, can the model predict a window of operation that is interesting for industrial syngas conversion? Are advanced operation modes (multistage fermentation, recycling) attractive?

Approach

The approach will be fully theoretical. In short:

- Fixing the dataset from literature
- Determining the model structure
- Coding the fermentation model, and fitting the model to experimental data.
- Validation of the model, and sensitivity analysis
- Studying implications of the model predictions.

Required

LST-MSc student, good at FTEB and at programming. Early availability is preferred.

Support

Dr. Adrie Straathof on model structure and experimental literature data.

Lars Puiman on coding and literature models.

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