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Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

New Strategies for Green Butanol Production

Tiago Pinto*,[1], Helena Junicke[1], Xavier Flores-Alsina[1] and Krist V. Gernaey[1]

* Corresponding author. Email address: *tiapi@kt.dtu.dk*

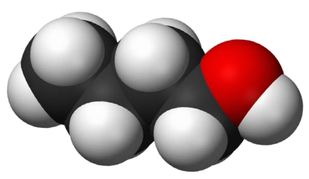
[1] Process and Systems Engineering Center (PROSYS), Department of Chemical and Biochemical Engineering, Technical University of Denmark, Søltofts Plads, 2800 Kgs. Lyngby, Denmark

Motivation

New national and international policies are pushing for a more sustainable production landscape. Once seen as waste, many resources are now the focus of valorization and recovery. Mixed culture biotechnology is held as a promising solution for producing valuable biofuels and chemicals from such low-value substrates and waste streams. In this context, butanol is a biofuel of particular interest.

Why biobutanol?

50% higher energy density than ethanol



Properties similar to gasoline

Drop-in replacement for fossil transport fuels

Why microbial mixed cultures?

Microbial mixed culture	Sterile pure culture
Cheap waste streams (non-sterile)	Expensive high-grade substrates (sterile)
Continuous	(Fed) batch
Ecological selection	Genetic engineering
Resource and energy recovery	Single product, maximized yield

Enrichment strategy

Starting from non-defined methanogenic communities **fed on butyrate and H_2**, butanol-producing microorganisms are enriched through directed ecological selection in a continuously-stirred tank reactor. Operating at **high H_2 partial pressure of 1.0 to 1.5 bar**, (1) anaerobic butyrate conversion becomes thermodynamically unfavorable, and thus also (2) acetoclastic and (3) hydrogenotrophic methanogenesis, reducing the amount of CH_4 and CO_2 produced as by-products.

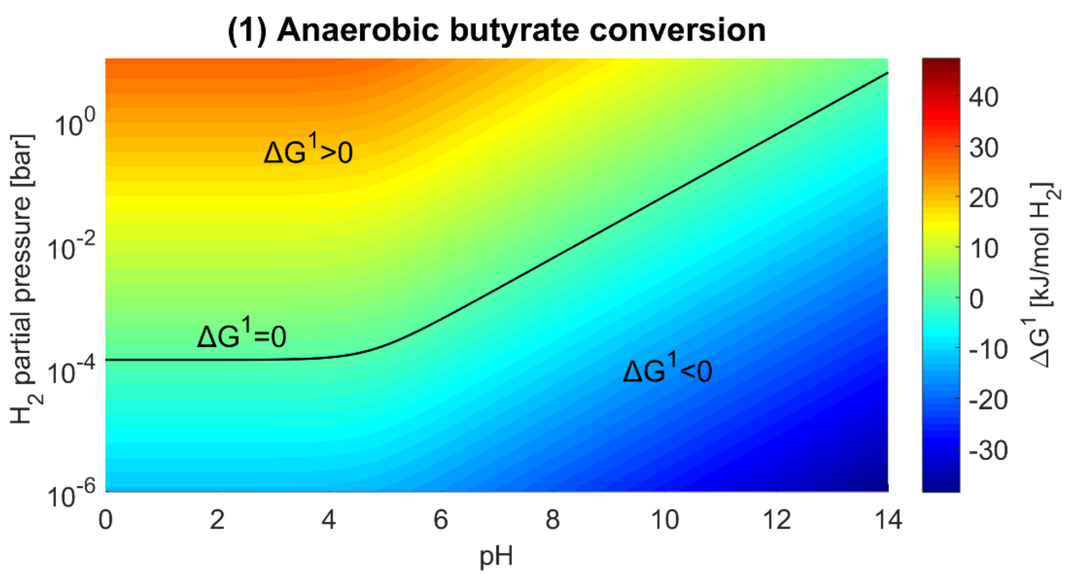
⬇ (1) Butyrate + $2H_2O$ → 2 Acetate + H^+ + $2H_2$

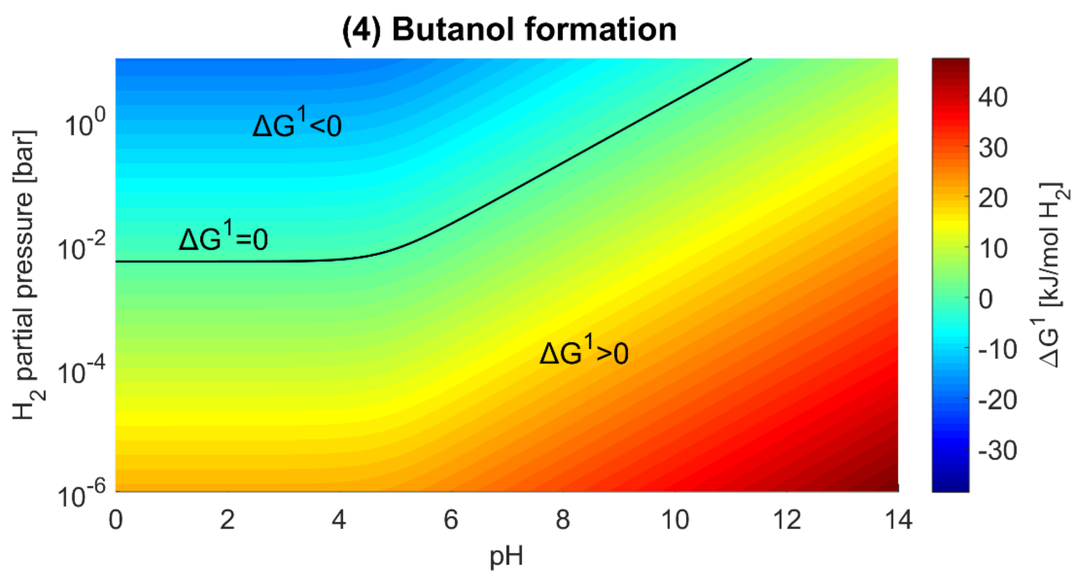
⬇ (2) Acetate + H^+ → CO_2 + CH_4

⬇ (3) CO_2 + $4H_2$ → CH_4 + $2H_2O$

⬆ (4) Butyrate$^-$ + H^+ + $2H_2$ → Butanol + H_2O

ΔG^1 = -6.8 kJ/mol-H_2, at p_0 = 1 atm and pH 7





Only high H_2 partial pressure is not sufficient to promote butyrate reduction to butanol. As such, by controlling the **fermentation at pH 5** we will further inhibit (1) anaerobic butyrate conversion while favoring (4) butanol formation.

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Acknowledgements

This work is a part of the DFF FTP research project GREENLOGIC, funded by the Danish Council for Independent Research, and a collaboration between DTU Chemical Engineering (PROSYS), TU Delft, TU Berlin, Lund University, University of Queensland, and industrial partner Novozymes. The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement no. 713683 (COFUNDfellowsDTU).