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TECHNO-ECONOMIC ANALYSIS OF NEW FERMENTATION PROCESSES FOR SUSTAINABLE PRODUCTION OF COMMODITY CHEMICALS AND BIOFUELS

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Thomas Grotkjær holds a position as Business Development Manager in the BioBusiness Division of Novozymes A/S, Denmark. The BioBusiness Division develops all new business activities outside the industrial enzymes area. Thomas is responsible for techno-economical analyses and all aspects of business development of technologies for producing renewable products within the strategic growth platform "Biochemicals".
The business unit is building up a pipeline of technologies for producing renewable chemicals. Currently Thomas drives the commercial development of two projects: fermentation technology for producing 3-hydroxypropionic (3HP) and for acrylic acid as well as enzyme/chemical
technology for producing the key building block propylene and 5-hydroxymethyl furfural (HMF), a new and renewable biochemical intermediate for the chemical industry.
Thomas has an MSc in chemical engineering and a PhD in metabolic engineering from the Technical University of Denmark as well as BCom's in marketing economics and finance from Copenhagen Business School.

Abstract

Over the last century, fossil raw materials such as crude oil and natural gas have been instrumental for the production of transportation fuels and commodity chemicals. The success of the industry has been the cheap access to fossil raw materials but also intensive production optimisation and economy of scale has driven down costs while markets expanded. Growing concerns about the environment and depletion of fossil raw materials have urged scientists and engineers to look for alternative feedstock and processes that are both renewable and cheap.

Introduction of new production processes in the chemical industry requires both technical and commercial success. A key evaluation criterion for new technology is the competitiveness of the production process and is typically measured as the "cash cost"; i.e. what are the required costs of raw materials, energy, chemicals, utilities and labour to produce the desired chemical. For the typical techno-economic analysis in the chemical industry, the raw materials are identical but introduction of new technology based on renewable feedstock makes the analysis much more complicated: competitiveness dependents technical specifications but also on the cost of different raw materials that may show large fluctuations.

It is a difficult and R&D intensive task to develop new production technologies and one of the challenges in microbial strain development is to develop microorganisms that efficiently convert the raw materials into chemicals. Here it will be discussed how fermentation performance (carbon yield, titre and productivity) will influence the production cost and what parameters that has the largest impact on operating costs (OpEx) and capital investment (CapEx).

Finally, I show how Novozymes is evaluating new technology for production of chemicals and how the feedstock price has a paramount influence of the commodity chemical production economics. The concept of “cost indifference curve” will be introduced and as an example it is shown how the cash cost for production of the chemical 1-butanol is changing dependent on whether it is produced by the classical oxo-process from propylene or by fermentation from glucose. The concept is equally applicable when the renewable feedstock is biomass hydrolysate (C5/C6 sugars), sugar cane juice, vegetable oil etc.