Isobutanol from Renewable Feedstock

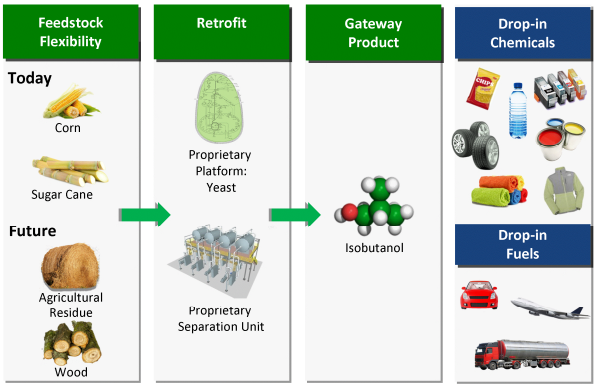
Process Optimization by Integration of Mass Spectrometry

Application Isobutanol Production

The Challenge

Isobutanol has broad market applications as a solvent and a gasoline blendstock that can help refiners meet their renewable fuel and clean air obligations. It can also be further processed using well-known chemical processes into jet fuel and feedstocks for the production of synthetic rubber, plastics, and polyesters.

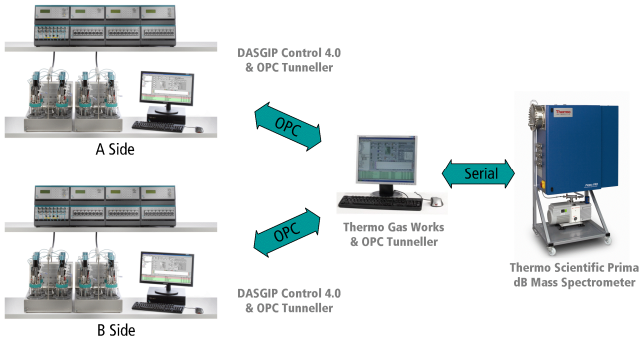
Isobutanol is an ideal platform molecule that can be made inexpensively using fermentation. The ability to automate the data analysis would increase production and reduce costs.



Isobutanol – A versatile Platform Chemical.

This application note describes the integration of a Thermo Scientific Prima dB Mass Spectrometer (MS) with DASGIP Parallel Bioreactor Control Systems implemented at GEVO Inc. in Englewood, Colorado. The availability of real-time MS data will aid in maximizing cell growth and isobutanol production.

GEVO (www.gevo.com) is a leading renewable chemicals and advanced biofuels company. They are developing biobased alternatives to petroleum-based products using a combination of synthetic biology and chemistry. Gevo plans to produce isobutanol, a versatile platform chemical for the liquid fuels and petrochemical market.



Setup of MS integration. Implementing OPC communication between the Thermo Scientific Prima dB Mass Spectrometer and the DASGIP Control System provided continuous off-gas results that were synchronized with fermentation data and viewed in real time. The isobutanol production rates could be calculated online and were then available for data driven control decisions.

Objective

The main objective of implementing OPC communication between the Thermo Scientific Mass Spectrometer and the DASGIP Parallel Bioreactor Control System during a fermentation run was to optimize growth and isobutanol production through automation. The system previously in place at Gevo required that manual data calculations had to be performed by merging the bioreactor runtime data with the MS data to assess the fermentation performance.

Setup & Procedures

Corn mash was used as a substrate for the production of isobutanol by fermentation. The fermentation process was carried out using two DASGIP Parallel Bioreactor Systems with eight vessels each. The working volume in all 16 bioreactors was 1L, respectively.

OPC communication was implemented between the Thermo Scientific Prima dB Mass Spectrometer and the DASGIP Control Software to provide real-time off-gas

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results. Script calculations were used to take the MS data as inputs and generate meaningful metrics to automatically analyze key fermentation operating values and quickly make process control changes.

Results

By integrating the Thermo Scientific Prima dB Mass Spectrometer with the DASGIP Parallel Bioreactor Control System the calculation of key fermentation operating values was successfully automated. This automation streamlined the workflow and allowed for data driven control decisions using the-real time off-gas-based analytical results.

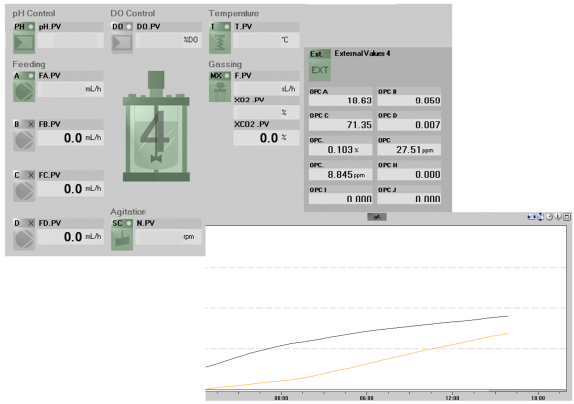
Before Automation

Without integration of the MS and the DASGIP Parallel Bioreactor Control System using OPC, calculation of key fermentation operating values was time-consuming and labor-intensive.

Optimized by MS Integration

Using OPC communication the real-time MS results were sent to the two DASGIP Control Systems. Within the control system, the fermentation runtime data and the MS results were charted and transferred to the data historian with synchronized time stamps.

Key fermentation operating values were calculated online from combined fermentation and MS runtime data, charted and sent to the data historian and were then available for data-driven control decisions. Set-up and script calculations were stored in a user-editable recipe.



MS Integration: Data Display and Charts. The DASGIP Bioreactor view shows online bioreactor runtime data including real time MS results. Editable scripting allows for online calculation of production rate and graphic display in defined charts.

Benefits of a DASGIP

With its comprehensive data management functions the DASGIP Parallel Bioreactor System allowed the seamless integration of the Thermo Prima dB Mass Spectrometer.

The most important success criterion was the ability to calculate isobutanol production rates in real-time giving instant feedback on the quality of run. The availability of the off-gas-based analytical results made data-driven control decisions possible. A secondary success criterion was the fermentation runtime data and MS data was logged with synchronized time stamps to allow for post-run analysis if needed.

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Structural Data

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