

Gas Fermentation—An Emerging Technology for CO₂ Based Fuels and Chemicals

Gas fermentation is an emerging technology in the field of industrial biotechnology, with the potential to play a key role in the growth of CO₂ based fuels and chemicals. While much of the work in the field of gas fermentation to date has been focused on the conversion of methane or carbon monoxide, we are seeing growing developments in the field of direct CO₂ conversion via fermentation to useful products. These products include a diverse array of fuels and chemicals such as ethanol, ethylene, triglycerides for fuel or chemical applications, proteins, and polyesters for polymer applications.

Gas fermentation provides inherent benefits as compared to thermochemical pathways for CO₂ conversion, including lower cost operating conditions, robustness to fluctuations in feed rate and composition, and tolerance to contaminants in the gaseous feeds.

In addition, interesting hybrid applications are emerging in which thermochemical and electrochemical conversion pathways are coupled with gas fermentation to convert CO₂ to a feedstock for gas fermentation, as well as thermochemical conversion of products from gas fermentation.

A key challenge of gas fermentation is the need to design an economic reactor system with high mass transfer coefficients for the gaseous feedstocks into an aqueous media. While CO₂ is generally quite soluble in the fermentation media, the most common co-reactants, including hydrogen and possibly oxygen, are much less soluble. Various reactor types have been developed to address this challenge, ranging from relatively simple bubble columns (a lower mass transfer option) and more complex designs such as air lift reactors and external loop designs. Typically, higher mass transfer is possible with the tradeoff of a more complex design.

Additional challenges include a limited (but growing) knowledge base in the design of appropriate reaction systems, as well as kinetic data to support reactor design.

This presentation will review the industrial applications of gas fermentation for CO₂ conversion and provide a detailed assessment of the benefits and challenges of gas fermentation. This presentation will also provide an overview of the gas fermentation reactor options and design considerations that can enhance mass transfer of the reactants. Finally, the presentation will propose a call to action for areas of research and development that can support the emerging field of gas fermentation technology for CO₂ conversion to fuel and chemical products.