ISGC 2022

N°273 / OC
TOPIC(s) : Biomass conversion / Energy

Evaluating the Material and Energy Efficiency of a Microbiological Process for Fermentative Hydrogen Production Using Interdisciplinary Performance Indicators

AUTHORS

Natascha EGGERS / FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF, SANDTORSTRASSE 22, MAGDEBURG
Lukas KERPEN / FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF, SANDTORSTRASSE 22, MAGDEBURG
Fabian GIEBNER / MICROPRO GMBH, MAGDEBURGER STRASSE 26 B, GOMMERN
Torsten BIRTH / FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF, SANDTORSTRASSE 22, MAGDEBURG

PURPOSE OF THE ABSTRACT

The currently observed climate change urges the energy transition, which essentially consists of two main elements: the implementation of energy efficiency measures and the expanded use of renewable energies. Hydrogen plays a key role in the latter. It serves as an energy storage medium with superior storage and transport properties, is an elementary component of sector coupling and is already an indispensable component of various industrial processes. However, to realize the energy transition, hydrogen must be generated in a variety of manners and used in a wide range of applications. It is therefore necessary that appropriate technologies are available for different use cases and quantities as well as requirements for the provided hydrogen. At the same time, due to the increasing complexity of the technologies used, conventional performance indicators are increasingly no longer sufficient to evaluate the energy and/or material efficiency of energy-providing processes comprehensively. An objective, meaningful and, above all, comprehensive evaluation of biochemical processes is usually not achievable with stablished process evaluation methods.

Considering the aforementioned aspects, the Fraunhofer Institute for Factory Operation and Automation IFF is developing and testing a microbiological process for fermentative hydrogen production with industrial partners. This fermentative hydrogen production is embedded in a biogas process to increase its overall efficiency. The process, which has been studied in several research projects, is being evaluated using interdisciplinary performance indicators.

The presentation introduces the technology developed in HyPerFerment, which generates fermentative hydrogen based on a microbiological process. To highlight the advantages resulting from integrating a dark fermentation process into an existing biogas plant, the technology is compared to the conventional process. For the evaluation of the energetic efficiency, limit value-oriented performance indicators are used, as defined in VDI Guideline 4663. They enable targeted process optimizations, and may therefore be applied in common energy monitoring systems, such as DIN EN 50001. Furthermore, they enable a process evaluation that defines limit values and thus identifies maximum process optimization potentials. Therefore, their application is particularly useful in energy audits according to DIN EN 16247. By additionally considering time as a parameter for the evaluation of chemical and biochemical processes, the indicator system developed here can distinguish itself from conventional limit values (e.g. energetic or exergetic) and generate additional information. To highlight advantages of this new evaluation method, it is compared with an exergetic evaluation model in the frame of this presentation. The material efficiency is evaluated by means of Green Chemistry Metrics and thus provides direct information on the sustainability of the process. In addition, a theoretical optimization potential becomes apparent. Using these

performance indicators shows that by integrating an appropriate dark fermentation system into an existing biogas plant, an efficiency increase of up to 38 % can be expected.

Thus, the presentation covers a variety of topics addressed at the ISGC symposium and provides listeners with insight into novel hydrogen production technologies and the application of novel, limit value oriented metrics for comprehensive process evaluation of chemical and biochemical processes.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
Biogas | Hydrogen | Dark Fermentation | Efficiency

BIBLIOGRAPHY