Docket #: S21-276

Delivery and Enzymatic Conversion of Hydrogen Gas to Reducing Equivalents for Carbon-Negative Biosynthesis

Stanford inventors have developed a cell-free method for carbon-negative biosynthetic production of commodity biochemicals by using hydrogen gas as a source of reducing equivalents.

The incorporation of the carbon from carbon dioxide into biofuels and other biochemicals would help counteract global warming while also producing useful commodities. However, since carbon dioxide is highly oxidized, it requires a large quantity of reducing equivalents to be converted into the necessary precursors for production of biochemicals. These reducing equivalents could in theory be supplied by hydrogen gas, but hydrogen gas is difficult to transfer into aqueous solution and to convert into a form that biosynthetic enzymes can use in redox reactions.

In this invention, scientists in the Swartz lab have developed a process that converts hydrogen gas into NAD(P)H reducing equivalents for biosynthetic reactions. First, a stream of bioreactor fluid is removed, pressurized, and then injected with pressurized hydrogen gas. When returned to the reactor, the supersaturated gas will come out of solution to form very small bubbles of pure hydrogen for good mass transfer. This hydrogen can then be used by a simple secondary enzymatic pathway in a cell-free reaction that generates the NAD(P)H required to reduce carbon dioxide into useful forms that capture carbon.

Related Technologies
Swartz lab inventions S21-281 and S21-271 can be combined with this technology in a carbon-negative process for synthesizing biochemical commodities.

Applications

- Carbon-negative, cell-free production of biochemicals including biofuels, biopharmaceuticals, and agricultural commodity chemicals

Advantages

- Carbon-negative biosynthesis method helps mitigate global warming
- Does not require expensive and electricity-intensive agitators to make use of hydrogen gas
- Hydrogen injection process can be used in any reaction where hydrogen is a substrate to produce both organic and inorganic chemicals

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