Photosynthetic fixation of fermentation off-gases
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Introduction:
• Controlling the release of carbon dioxide (CO₂) into the atmosphere is a major challenge.
• Fermentation off gases consist of mostly CO₂.
• These can be better controlled and mitigated using complementary heterotrophic and photosynthetic microorganisms.
• This novel bioprocessing strategy would result in an efficient biofuel production with virtually zero CO₂ emissions.

Methods:
• An efficient CO₂ collection and delivery system is designed to create an effective bioprocessing technique with greatly reduced carbon emissions¹.
• A membrane carbonation system is used to deliver effluent CO₂ to microalgal cultures to produce recyclable sugars.

Fermentation:
• The fermenter consists of a closed vessel operating at an elevated pressure.
• A glucose specialist strain with LY180 background is used².
• The head space in the bioreactor vessel is filled with argon.
• The fermentation is carried out in an incubator at 37°C.
• The pressure built up in the vessel is monitored through a pressure sensor.

Carbon collection and delivery:
• The CO₂ built up is collected in a sample cylinder.
• A 3-way ball valve is used for efficient collection.
• The collected CO₂ transferred to the photobioreactor system through a membrane carbonation system.

Photobioreactor systems:
• The CO₂ is delivered through mixed matrix membranes⁴.
• This is used to support the rapid growth of UTEX 2973 biomass.
• The biomass can then be hydrolyzed to obtain recyclable sugars.

Future research:
• Adding an inlet stream to facilitate fed-batch operations and in-situ product recovery⁵.
• Recycling the sugars produced in the photobioreactor.
• Automated collection and delivery through control valves.

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References:

Figure 1. Pressure (psi) vs time graph for the fermentation of LYglc1 in an argon atmosphere.

Figure 2. A bioprocess with enhanced carbon yields and reduced CO₂ emissions. Released CO₂ is collected then delivered to a photobioreactor via a membrane carbonation system, where it supports the growth of algae.

Figure 3. Closed bioreactor designs developed and used by the team for batch E. coli ethanol fermentations with CO₂ retention.

Figure 4. Recently developed PBR using MC for CO₂ delivery.

Figure 5. OD₇₃₀ vs time for various microbial strains⁴. Source: https://www.nature.com/articles/srep08132#Fig1