Efficient biofuel generation using genetically modified bacteria and copper

Genetically engineered bacteria are promising tools for generating biofuels and commodity chemicals from carbon dioxide and iron(II). However, the product of this reaction, iron(III), is poorly soluble and has prevented bacterial biofuel generation from achieving its full potential. This technology couples bacterial iron oxidation to copper reduction-oxidation (redox) reactions to allow iron(III) to be reduced back to iron(II) in situ, increasing bioreactor energy density and improving the efficiency of the overall process. Moreover, the solid copper needed for this process can be economically extracted from low grade mineral ores using genetically modified acid-producing bacteria. This technology has the potential to reduce the cost of bioreactors and increase the rate of biofuel production.

Compatibility with existing infrastructure and mature biomining technologies minimizes development costs

This technology is able to achieve more efficient biofuel production by using copper to reduce iron(III) to iron(II). However, a significant fraction of the earth’s copper supply is locked in the mineral chalcopryite, from which it is not economically feasible to use traditional pyrometallurgical processes to extract copper. Here, genetically modified biomining organisms are used to produce organic acids and other compounds that can increase the dissolution of chalcopryite and enhance the efficiency of copper extraction. Additionally, the use of copper in this approach enables this technology to seamlessly integrate with existing biomining processes that use bacteria to convert copper to cupric ions while also reducing iron(III) to iron(II). The regeneration of iron(II) during copper solubilization allows iron-oxidizing bacteria to continuously oxidize iron, fix carbon dioxide, and produce petrochemicals. This technology is fully compatible with existing bioreactor designs and can be easily incorporated into existing biomining operations. As such, the technology can help to minimize development costs while increasing bioreactor production rates.

Lead Inventor:

Alan West, Ph.D.
Applications:

- Integrated copper extraction from copper ores and biofuel generation to offset carbon dioxide emissions and fuel consumption in mining operations
- Carbon dioxide capture and storage directly from copper mining operations
- Copper extraction from low grade mineral ores, metal alloys, and/or scrap metals for recycling
- Low cost, continuous chemical production through recycling of copper feed
- Carbon neutral fuel production if combined with green electricity generation (wind or solar)

Advantages:

- Increased fuel production rate and energy density compared to iron-only bioreactors
- Utilizes existing large-scale reactors with minimal development costs
- Compatible with previously unrelated industrial processes such as copper mining
- Iron oxidizing bacteria have evolved a high tolerance for copper, making them robust and healthy in high-copper media

Patent Information:
Patent Pending (WO/2015/200287)
Tech Ventures Reference: IR CU14270, IR CU15288

Related Publications:

Inventors

Alan West