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Integrated Filamentous Algal and Cyanobacterial Process for Manufacturing Biofuels and Co-Products via Fractionation of Flue Gas, Wastewater, and Solid Agricultural Waste

Background

The growing environmental concern surrounding fossil fuel consumption has driven tremendous research and development efforts into alternative energy sources. Microalgae are currently considered one of the most promising feedstocks for biofuel production. Compared with more common feedstock sources such as corn and sugarcane, microalgae have high photosynthetic efficiency, can be grown in a wide range of conditions, do not require arable land, and are not major food sources. However, commercial algal-based processes for biofuels and co-products face challenges associated with low productivity, contamination of invasive species, inefficient nutrient supplies, environmental disruptions, and scalability. In addition, these problems are often compounded by costly and inefficient harvesting, product extraction, thermochemical conversion, and hydrotreatment.

Overcoming these challenges to commercialization may require a broader reconsideration of the entire process instead of piecemeal improvements. A new comprehensive solution that integates algae selection, cultivation, harvesting, conversion, and refinement can provide the change needed to propel algal biofuels into major energy markets.

Invention Description

Researchers at Arizona State University have developed an innovative process for biofuel manufacturing through algal/cyanobacterial cultivation. Microalgae and cyanobacteria are cultivated in novel, elongated Runway Algal Cassette Reactor-Photobioreactor (RACR-PBR) growth vessels, designed specifically for filamentous, haloalkaliphilic strains. The filamentous morphology resists contamination by undesirable organisms while eliminating the costs associated with membrane filtration, centrifugation, flocculation, and other conventional harvesting methods. This system is capable of comprehensive and cost-effective fractionation of (1) flue gas from coal-fired boilers, (2) wastewater from anaerobic digesters, and (3) solid agricultural lignocellulosic waste. Systematic fractionation not only removes pollutants, color, and debris, but channels heat, organic carbon, and a host of nutrients towards the cyanobacterial and algal processes. The highly controlled, closed-loop system provides a scalable testing ground for bioprospecting and growth optimization.

Potential Applications

- Waste management
- Biofuel production
- Algae bioprospecting, genetic modification, and cultivation

Benefits and Advantages

- Innovative – Provides a comprehensive solution to a process fraught with inefficiencies
- Economical – Integrative process conserves resources and minimizes waste
- Versatile – Controlled environment allows in-depth study and optimization of algae cultivation conditions