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TURNING EMISSIONS INTO ENERGY: OUR JOURNEY WITH MICROALGAE AND CO₂

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Preparation of microalgae cultivation medium



Microalgae growth measurement using gravimetric dry biomass weight

Our project started with a search for the right microalgae species. We screened *Chlorella vulgaris*, *Chlorella sorokiniana*, and *Coelastrella*, exposing them to various CO₂ concentrations, from the natural ambient level to 30 % pure CO₂. The goal was to find strains that not only survive but thrive in high-CO₂ environments. Once we identified our most promising candidates, we focused on fine-tuning the cultivation conditions. We looked at how different CO₂ levels affected their growth rates, lipid production, and carbon capture efficiency, aiming to strike the perfect balance between biomass yield and biofuel quality.



CO₂ gas mixing system setup for microalgae cultivation

At the heart of our research lies a bold question: What if the CO₂ emitted by the oil and gas industry isn't just waste, but a resource waiting to be used? This idea inspired us to explore an unexpected ally in the fight against carbon emissions—microalgae.

The oil and gas sector, a key driver of economic development, also produces massive amounts of CO₂, particularly from flue gases during combustion. In most cases, these emissions are treated as pollutants. But in our lab, we're taking a different approach; one that views these emissions as a valuable input for bio-based innovation. Microalgae, tiny photosynthetic organisms, are capable of fixing carbon dioxide from the air while producing lipids that can be turned into biodiesel. By combining the principles of environmental engineering and biotechnology, we're working to develop a system where waste becomes fuel.

To understand how microalgae respond on a biochemical level, we are also analysing their metabolic changes using techniques like Fatty Acid Methyl Ester (FAME) profiling and FTIR spectroscopy. These methods help us determine which conditions produce the most desirable fatty acid profiles, a key indicator of biofuel quality. This part of the study offers valuable insight into the mechanisms behind lipid accumulation under CO₂-rich environments.

Looking ahead, we plan to test the system under more realistic conditions by introducing typical flue gas pollutants such as sulphur oxides (SO_x) and nitrogen oxides (NO_x). These compounds are common in actual industrial emissions and may affect microalgae performance. By simulating such scenarios, we hope to evaluate how robust our selected strains are in the face of these additional stressors and to assess the system's feasibility for large-scale applications.

What we've observed so far is promising. With the right species and controlled conditions, microalgae can effectively convert industrial CO₂ into renewable biomass. This work moves us closer to a future where emissions are not only captured, but productively reused. As we continue our investigations, we remain committed to engineering solutions that support a low-carbon, sustainable future powered by science, and inspired by nature.



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