Application Towards Green House Gas Mitigation and Carbon Fixation.

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linking biotechnology, chemistry + agriculture to create new value chains
Our Achievements

Development of the mass cultivation of micro algae and power generation.

- Based on today’s best achievements
- Continuous process from algae cultivation to Methane production and power generation.
- Simple in design
- Robust in construction
- Complete closed looped system.
- Membrane use for dissolved carbon
Technologies

Algae Production unit combines:

- Algae biomass cultivation and harvesting in:
  - Tubular photobioreactor and a Closed Looped pond The Phyta-System
  - Captured and Dissolved CO$_2$ in aqueous form for growing media with Nannomembrane
- Methane Production in simple Digesters
- Methane purification with Nannomembrane
- Combined Cycle Gas Turbine Generator
Photobioreactors vs. Raceway Ponds

Photobioreactors advantages over traditional raceway pond cultivation:

- Contamination of other algae species is minimized or prevented, allowing for the axenic algal cultivation of cultivating monocultures.
- Easy and better control over biocultural conditions (light, nutrients, CO2, pH and temperature).
- Evaporation of water is prevented.
- Better absorption of input CO2.
- Permit higher cell concentrations than raceway ponds.
- Reduce space need and increase production exponentially more than a raceway pond.
Photobioreactor
General Limiting Factors

- Fouling caused by algae collecting on the surface will inhibit photon absorption and reduce production.
- Pumping is a major concern:
  - Intensive pumping will damage more delicate algae species.
  - Low flow rates will bleach algae from too much light and dissolved oxygen will build up, both of which greatly inhibit cell reproduction.
- Light transmission into the growing media only reaches to a certain depth before photosynthesis ceases. In dark areas more complex synthesis occurs.
- When the algae do not have the proper amount of time in each phase of plantation the growth rates are greatly depreciated.
- Control over the growing parameters needs to be closely maintained to specifications.

*The Phyta-Platform has solved all of these limiting factors.*
Continuous Algae Production

Our Phyta-Platform:

- offers superior control over the inputs of photosynthetic reactions in microalgae
- uses tubular Photobioreactor
- uses photo tubes made from food grade Poly carbonate, PVC that has a UV inhibitors (for outdoor applications) and Glass
  - tube diameter is optimized for the optical path of photons
  - tube pattern is optimized for absorption of every photon from the flux upon a surface
- has a continuous self cleaning process
- completed with automated Control Panel, Harvesting, Self Cleaning Mechanism, Tank, Pump, 5 sensors (Temp., pH, ORP, DO, Conductivity), Platform, and full version software.
Monitoring and Controlling Panel

- Easy to use: intuitive three button navigation user interface
- Easy navigation through the menus and modification of the standard setup
- No external computer is required
- Easy to perform the initial setup: unit comes pre-programmed with a default setup easily modified to work with most aquaculture setups
- Monitor and control pH, ORP, Temperature, Conductivity and Dissolved Oxygen, expandable to handle up to 10 inputs
- Monitored data is continuously displayed on the large LCD display and logged into the internal RAM for later retrieval
- Remote access via modem or TCP/IP connection
- Integrated database
- Alarm system (alert message sent by e-mail, cell phone, etc.)
The Phyta-Pond combines all of the monitoring and controlling benefits from the Phyta-Platform into a Closed Looped Raceway. This combination reduces Capital Expense to build a commercial facility while still having all of the photosynthetic inputs optimized.

PATENT PENDING
Phyta-Pond vs. Raceways

- Covered, Closed Looped, and sanitized air intake
- Geothermal Exchange to maintain optimum Pond Temperature
- Monitor and Control Temperature, pH, EC, ORP, expandable to handle up to 10 inputs
- Durable cover with built in UV inhibitors to help maintain a healthy culture
- Proprietary pumping system that is designed to maximize the algae’s exposure to photosynthetic radiation. The Fluid Dynamics do not allow algae to rest on bottom of the pond.
- Proprietary cleaning system keeps the Pond from Biofouling.
- Theoretically achieve algae concentrations of 4-6 grams per liter at an efficiency of 20% in optimum summer daylight
Our Dissolved Aqueous Carbon Dioxide Transfer System is the leader in transferring and maintaining high levels of dissolved $CO_2$ in ponds, bioreactors and raceway or continuous flow algae growing systems. Simultaneously, it will condition the water atmosphere and remove harmful oxygen from the water. This results in the correctly balanced growing medium for various algae species and gives the intensely cultivated algae the concentrations of carbon dioxide they require.
Dissolved CO\textsuperscript{2} module configuration
The 1\textsuperscript{st} ‘key’ is gas solubility differences in water

![Graph showing solubility of CO2 in water vs. temperature](image)
The 2\textsuperscript{nd} ‘key’ is efficient CO\textsubscript{2} gas transfer in water

- US and worldwide patents
- Achieves ultra-efficient mass transfer with hydrophobic microporous hollow fiber
- Enormous surface area in small volume - >7000 m\textsuperscript{2} per m\textsuperscript{3}
- No bubble, low energy, low decay, ultra-high dissolved gas concentrations
- Simple, small, low O&M, model predictable, easily retrofitted
- Equal efficiency in fresh, brackish & salt water

Gas infusion &

Controlled Atmosphere Technologies
The 3rd ‘key’ is Algae Consuming Water with dissolved CO\textsuperscript{2} (the left uses hollow fiber dissolved CO\textsuperscript{2}, the right fine bubble diffuser)
Solubility rates for selected gases (ppm)
Advantages

- CO₂ gases are currently separated by expensive plasma arc gasification, chilled ammonia or amine solution technologies.
- Captured CO₂ is then pressurized and pipelined to EOR oil fields or buried underground (i.e. 8000 feet at AEP West Virginia Mountaineer Project).
- Dissolved aqueous CO₂ has proven to produce 300%-500% superior algae yields by dissolving 100% of CO₂ into water.
Bioreactor CO2 Nutrient Diffusion Technology Concepts – Gas Transfer Unit
Algae To Power Generation Flow Chart

- Dark Water
- Algal Cultivation
- Anerobic Digestion
  - Methane Purification
  - Power Generation
Combined Cycle Turbine Generator
RefRACTANCE WINDOW DRYING
Algae Fuels Process Diagram

1. Raw Sewage → Solids separation → Solids Digestion For Biogas → BioGas/Electricity Production → Power Facility


3. CO₂
Thank you for your attention

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