Photobioreactors and algae, the alternative fuel

by Beau Sielken

With the world pushing the "Green" word, there has been a focus on alternative fuels and lowering green house emissions (CO_2). One way of achieving this is through the use of algae in a photobioreactor.

Photobioreactor is a bioreactor which incorporates a light source to provide photonic energy. The CO_2 from flue gas can be used in photobioreactors to grow algae. The algae uses the CO_2 and converts it into sugars with the help of light via photosynthesis. Later, these sugars are converted to oils and proteins. Through further processing, the oil can be converted to biodiesel, and the remaining biomass can be converted into simple sugars. These simple sugars can be converted to ethanol through the fermentation process.

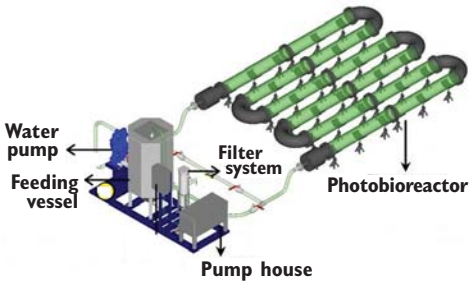
There are primarily two types of photobioreactors. One being an open system, similar to a lake or pond. The second being a closed system, consisting of clear round tubes.

In an open photobioreactor system, it is hard to control the process. Being open to the environment has its disadvantages in regard to contamination, evaporation and temperature.

In a closed photobioreactor system, there is better control of the process. The advantages are prevented or minimized contamination, better control over pH levels, light, and carbon dioxide (CO_2) losses due to out gassing.

Conceptual artist rendering of a large scale photobioreactor for a coal burning power plant.

At first glance growing algae is easy. It grows freely in ponds in your garden, but however the concentrations are very low (0.005g l-1) and productivity is almost zero, and that is because light and nutrients are limiting it. In these systems light is the most difficult parameter to provide, because light cannot be stored and the intensities need to be distributed in a way that covers the entire photobioreactor. Shading can prevent light from getting to all the areas of the photobioreactor.



The use of horizontal tubular photobioreactors consisting of long horizontal tubes eliminates the problem of shadowing.

In some cases flexible PVC tubing has been used, but because of the damaging UV rays the PVC tends to break down and get brittle. PVC when attacked by UV rays on conventional PVC will discolor the surface of the pipe preventing or limiting the light from getting to the medium. Acrylic tubes have also been used but installed costs make the system too costly.

There have been major strides in the manufacturing of UV resistant clear PVC piping designed specifically for outdoor applications, i.e. photobioreactors, biorefiners, aquaculture, sight glass applications and photohydrogen. The unique UV blocking technology prevents harmful ultraviolet light wavelengths from penetrating the PVC while allowing beneficial light wavelengths to pass through the PVC clear pipe.

The use of tubular photobioreactors consisting of long horizontal tubes eliminates the problem of shadowing.

Because the UV resistant pipe is made in IPS dimensions, conventional PVC fittings and valves can be used. The joining process is the same as solvent cement using regular PVC cement and primer. The clear pipe has the same benefits of standard PVC — corrosion resistance, nonconductivity and light weight construction.

Using specialty clear PVC piping is beneficial in the use of photobioreactors since clarity is key to allowing as much light into the process to allow the algae to grow and feed. ■

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Example of an open system photobioreactor.