

## **Technology Brief**

### **Membrane Filtration-based Algae “harvest to paste” Dewatering System**

Several algae derived products are being developed for a variety of applications, in nutraceutical, vitamins, food supplements, and animal/fish feed industries. Algae is also being considered as a promising renewable bioenergy source because of high oil content of certain algae strains. Algae grown in open ponds or in closed PBRs are very dilute with < 1 gm/liter solids concentration. The whole cell algae concentration must be increased substantially for optimal downstream processing and conversion to produce algal products. Because of very dilute algae concentrations and consequently very large volumes of water that must be processed, harvesting and concentrating algae contributes a significant cost to algal products. Reduction of capital and operating costs of algae harvesting and concentration step is essential to make algal products economical.

A two-step, “harvest to paste” algae dewatering process is developed for economical dewatering of algae: 1) a pre-concentration first step with porous hollow fiber membrane filtration to produce ~ 5% w/w algae pre-concentrate and 2) second step with SmartFlow Technologies’ “open channel” membrane module filtration, that allows free flow of fluid streams even with high solids concentration, enabling production of algae paste of desired concentration. An optimal intra-step cross-over point is determined by testing with actual algae harvest for the lowest overall cost. This second step was demonstrated by Techverse in a DOE Phase II SBIR project in a pilot scale continuous-flow system (Figure 1) consisting of three membrane stages designed for dewatering ~1% w/w algae feed, at a rate of ~100 L/hr, to produce  $\geq 20\%$  w/w algae paste discharge. Smaller, single stage, lab scale, 0.1 m<sup>2</sup> membrane area (Figure 2) and field scale, 0.8 m<sup>2</sup> membrane area (figure 3) systems are used for initial feasibility studies as demonstrated during Phase I.

During the first year of Phase II, the pilot system testing was conducted using several algae strains of industrial interest demonstrating continuous, steady state, algae paste production in short 4 to 7-hour tests at Arizona Center of Algae Technology and Innovation (AzCATI) facilities. Hollow fiber membrane filtration was used by AzCATI to pre-concentrate harvested algae to up to 2 % w/w concentration for feeding in to the pilot skid and generation of algae paste of >20% w/w concentration was demonstrated for all algae strains tested with appropriate test parameters. During the second year of Phase II, several long term (24-hr) dewatering tests were conducted to demonstrate, run-on-run, reproducible algae dewatering performance producing algae paste with development of a membrane cleaning protocol in between runs.

Our membrane filtration-based two-step algae dewatering systems are modular and can be designed for any scale - from a small lab demonstration scale to an intermediate pilot scale to a full production scale - system to process harvested algae of any strain at any specified feed rate and feed concentration to produce desired product algae concentration with no loss of algae in the permeate. An overall low-cost system is designed by conducting tests with actual algae harvest.

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**Figure 1.** Photo of the Phase II continuous flow pilot scale algae dewatering skid



**Figure 2.** Photo of Phase I lab scale batch system



**Figure 3.** Phase I field scale batch system