Production of Biodiesel from Algae

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Several varieties of freshwater and saltwater algae were procured from three different commercial sources. All algae cultures received were contaminated with microorganisms (i.e., bacteria, fungi, protists) and macroorganisms (i.e., worms). The algal strains were purified using both solid and liquid media. The purified algal strains were then successfully grown in ~ 100 L batches with densities of 1.4 to 1.9 x 108 cell/mL. Several harvesting and drying techniques (i.e., filtration, centrifugation, flocculation, and freeze-drying) were evaluated to effectively dewater the algae cultures. On average, for every 1 L of high-density algae grown, ~ 1 g of dry algae was harvested. Algal oil was extracted from the dry algae using soxhlet extraction with hexane. Typically, 0.3 g of algal oil was recovered from 1 g of dry algae (30%). The algal oil was converted to biodiesel by transesterification with methanol using sodium hydroxide as a catalyst. Three commercially available stabilizers from Albemarle® (Ethanox® 4740, Ethanox® 4760E, and Ethanox® 4702) were evaluated for their ability to stabilize the algal oil based biodiesel. Preliminary testing of biodiesel without stabilizers failed a Rancimat test and showed an oxidative stability of only 2.42 hrs (min. acceptable stability is 6 hrs according to ASTM D6517-07a). Consequently, stabilizers must be added to meet ASTM standards. Ethanox® 4760E gave the best results and performed well even at elevated temperatures for long durations. Ethanox® 4740 and 4702 both experienced significant reductions in performance when subjected to elevated temperatures. Lastly, field demonstrations were performed in which farm equipment was successfully operated when fueled with biodiesel derived from algae.