Evaluation of a Pilot-Scale Oil Extraction from Microalgae for Biodiesel Production

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Abstract— **Biodiesel derived from microalgae is one of a suite of potential solutions to meet the increasing demand for a renewable, carbon-neutral energy source. However, there are numerous challenges that must be addressed before algae biodiesel can become commercially viable. These challenges include the economic feasibility of harvesting and dewatering the biomass and the extraction of lipids and their conversion into biodiesel. Therefore, it is essential to find a suitable extraction process given these processes presently contribute significantly to the total production costs which, at this stage, inhibit the ability of biodiesel to compete financially with petroleum diesel. This study focuses on pilot-scale (100 kg dried microalgae) solvent extraction of lipids from microalgae and subsequent transesterification to biodiesel. Three different solvents (hexane, isopropanol (IPA) and hexane + IPA (1:1)) were used with two different extraction methods (static and Soxhlet) at bench-scale to find the most suitable solvent extraction process for the pilot-scale. The Soxhlet method extracted only 4.2% more lipid compared to the static method. However, the fatty acid profiles of different extraction methods with different solvents are similar, suggesting that none of the solvents or extraction processes were biased for extraction of particular fatty acids. Considering the cost and availability of the solvents, hexane was chosen for pilot-scale extraction using static extraction. At pilot-scale the lipid yield was found to be 20.3% of total biomass which is 2.5% less than from bench scale. Extracted fatty acids were dominated by polyunsaturated fatty acids (PUFAs) (68.94±0.17%) including 47.7±0.43 and 17.86±0.42% being docosahexaenoic acid (DHA) (C22:6) and docosapentaenoic acid (DPA) (C22:5, ω-3), respectively. These high amounts of long chain poly unsaturated fatty acids are unique to some marine microalgae and protists and vary with environmental conditions, culture age and nutrient status, as well as with cultivation process. Calculated physical and chemical properties of density, viscosity of transesterified fatty acid methyl esters (FAMEs) were within the limits of the biodiesel standard specifications as per ASTM D6751-2012 and EN 14214. The calculated cetane number was, however, significantly lower (17.8~18.6) compared to ASTM D6751-2012 or EN 14214-specified minimal requirements. We conclude that the obtained microalgal biodiesel would likely only be suitable for blending with petroleum diesel to a maximum of 5 to 20%.**

Keywords— microalgae, lipid/fatty acid extraction, biodiesel, fuel properties