World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:10, No:04, 2016

Strategic Analysis of Energy and Impact Assessment of Microalgae Based Biodiesel and Biogas Production in Outdoor Raceway Pond: A Life Cycle Perspective

Authors : T. Sarat Chandra, M. Maneesh Kumar, S. N. Mudliar, V. S. Chauhan, S. Mukherji, R. Sarada

Abstract : The life cycle assessment (LCA) of biodiesel production from freshwater microalgae Scenedesmus dimorphus cultivated in open raceway pond is performed. Various scenarios for biodiesel production were simulated using primary and secondary data. The parameters varied in the modelled scenarios were related to biomass productivity, mode of culture mixing and type of energy source. The process steps included algae cultivation in open raceway ponds, harvesting by chemical flocculation, dewatering by mechanical drying option (MDO) followed by extraction, reaction and purification. Anaerobic digestion of defatted algal biomass (DAB) for biogas generation is considered as a co-product allocation and the energy derived from DAB was thereby used in the upstream of the process. The scenarios were analysed for energy demand, emissions and environmental impacts within the boundary conditions grounded on "cradle to gate" inventory. Across all the Scenarios, cultivation via raceway pond was observed to be energy intensive process. The mode of culture mixing and biomass productivity determined the energy requirements of the cultivation step. Emissions to Freshwater were found to be maximum contributing to 93-97% of total emissions in all the scenarios. Global warming potential (GWP) was the found to be major environmental impact accounting to about 99% of total environmental impacts in all the modelled scenarios. It was noticed that overall emissions and impacts were directly related to energy demand and an inverse relationship was observed with biomass productivity. The geographic location of an energy source affected the environmental impact of a given process. The integration of defatted algal remnants derived electricity with the cultivation system resulted in a 2% reduction in overall energy demand. Direct biogas generation from microalgae post harvesting is also analysed. Energy surplus was observed after using part of the energy in upstream for biomass production. Results suggest biogas production from microalgae post harvesting as an environmentally viable and sustainable option compared to biodiesel production.

Keywords : biomass productivity, energy demand, energy source, Lifecycle Assessment (LCA), microalgae, open raceway pond
Conference Title : ICEBWE 2016 : International Conference on Energy, Biomass and Waste Engineering
Conference Location : Boston, United States
Conference Dates : April 25-26, 2016