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Full Length Article

Production of biodiesel from dairy wastewater sludge: A laboratory and pilot scale study

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ABSTRACT

This study investigates the production of biodiesel from activated sludge of milk processing plant as a low cost feedstock. The method involves lipid extraction, refining and optimization of biodiesel from activated sludge under laboratory conditions. These results were scaled up to a pilot plant was analyzed. In the laboratory study, the sludge yielded 18.81 wt% of crude lipid. It is degummed and dewaxed to get refined oil that is used for the production of biodiesel. The optimal reaction parameters were 0.8 wt% catalyst; a temperature of 55 °C; 6:1 methanol to oil molar ratio for 40 min. The process is scaled up to a prototype demonstration plant with a batch size of 10 kg. The dried sludge yielded 16.2 ± 1.3 wt% and 13.64 ± 0.8 wt% of crude lipid and biodiesel respectively. Biodiesel made in pilot plant is compared with ASTM standards.

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1. Introduction

Biodiesel has grown in popularity due to its environmental benefits and the need of an exact substitute for conventional diesel. At present, biodiesel is more expensive than petrodiesel because it is mostly made from expensive virgin vegetable oils [1]. Cost of biodiesel is the major obstacle for its commercialization [2]. Currently, researchers are interested in finding a low cost as well as an efficient source for the continuous expansion of biodiesel [3]. The resultant biodiesel will reduce the dependency on petroleum based fuels. Biodiesel produced from activated sludge provides an opportunity to improve low cost biofuel [4].

The conventional activated sludge process uses a consortium of microbes suspended in an aeration tank to absorb, adsorb and biodegrade the organic pollutants [5]. Most of the organic pollutants present in the wastewater are completely oxidized into harmless end products. These pollutants provide energy to sustain microbial growth. The assortment flows from an aeration tank to a settling tank where the activated sludge forms larger flocs that settle as sludge. A part of the sludge is returned to the aeration tank and the rest is processed and disposed in an environmentally acceptable manner.

In milk processing industry, though the biological treatment plant is extremely efficient, it results in large quantities of activated sludge. The sludge separated from the primary and the secondary settling tanks is de-watered and disposed off. In general, the sludge is disposed in solid waste disposal sites or by incineration [6]. These techniques are economically not efficient and they generate secondary waste. The sludge consists of 3–4 wt% solids (microbial biomass) which serve as a source of metabolic lipids, adsorbed and absorbed milk fat.

The present work studies the production of biodiesel from activated composite sludge (a mixture of primary and secondary sludge). The crude lipid was extracted from dried sludge containing triglycerides, phospholipids and free fatty acids. It was then subjected to appropriate pretreatment methods like degumming and dewaxing. This refined lipid was used to produce biodiesel in a laboratory setup which was then scaled up to a pilot plant. The product biodiesel was analyzed and compared with ASTM D6751 standard.

2. Materials and methods

2.1. Materials

The sludge was collected from the effluent treatment plant in Aavin III dairy, Chennai, India. It processes 8 Million Liters per Day (MLD) of cow and buffalo milk. Chemicals and reagents for laboratory studies were of analytical grade. Chemicals were

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