Bioconversion of Wastes (Wastewater Sludge, Glycerol) to Biodiesel

ENTRANT: Institut National de la Recherche Scientifique, Centre Eau, Terre & Environnement (INRS-ETE), Université du Québec
ENGINEERS-IN-CHARGE: R.D. Tyagi, Ph.D. and Rao Y. Surampalli, Ph.D., P.E., BCEE
LOCATION: Quebec, Canada

Growing environmental concerns coupled with diminishing crude oil reserves have increased the emphasis on renewable energy. Biodesiel is gaining significant attention as an alternative renewable energy source because it is biodegradable and evironmentally friendly; but production costs of biodiesel, which is traditionally produced from oleaginous microorganisms (vegetable oils and animal fats) has grown increasingly expensive. This has left biodesiel producers looking for cheaper raw materials such as wastewater sludge and/or crude glycerol.

In this project, highly active yeast and filamentous fungal strains were isolated from soil/wastewater sludge, then used to develop a process for lipids production using crude glycerol and/or wastewater sludge as raw material.

Municipal wastewater sludge and pulp and paper industrial secondary wastewater sludge were utilized for oleaginous microorganism cultivation to develop a process for lipids production. Lipids separated from the microorganisms were converted to biodiesel by transesterification. Its composition is similar to the biodiesel converted from animal fats. The results showed that 1 tonne of dry sludge produced around 210 kg of biodiesel (≈61 gal). The cost estimation showed that biodiesel produced from sludge was around US$3.5/gal, which is comparable with plant-oil based biodiesel (US$4.3/gal) and petro-diesel (US$3.2/gal).

During biodiesel production, glycerol is generated. Glycerol is a simple carbon source that is readily used by microorganisms. It is normally mixed with methanol, un-transesterified oil, water, and a catalyst, and thus called crude glycerol; but purification is becoming unfavorable due to the rapid decrease of refined glycerol prices. Usage of crude glycerol as a carbon source for oleaginous microorganism will create a clean cycle of biodiesel production.

The addition of crude glycerol to sludge was investigated as a medium for oleaginous microorganism cultivation. The biodiesel contained 40% - 45% of C16 w/w and 50% - 60% of C18, which is similar to palm oil based biodiesel. One tonne of dry sludge and one tonne of glycerol produced around 380 kg of biodiesel (112 gal). Assuming that there was 210 kg of biodiesel from sludge, 180 kg of biodiesel was due to the one tonne of glycerol addition - indicating that the biodiesel yield from glycerol is 0.18 g/g glycerol. It is comparable with the yield of using glycerol synthetic medium (0.19 g/g glycerol) in which chemicals were utilized as nitrogen, phosphorous, and mineral source. It reveals that sludge is an efficient medium for oleaginous microorganism production.

Thus, this study provides an efficient way of managing the wastewater sludge and simultaneously generating bio-energy. It reduces waste quantity and decreases the waste handling cost. In this study, isolated oleaginous microorganisms were successfully employed for biodiesel production from sludge.

The combination of sludge and crude glycerol in biodiesel production seems to provide more economic advantages than solo sludge utilization.