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A new source for biodiesel – caustic fish

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Abstract: Limited availability of edible oils prevents it from being used as viable source of Biodiesel. Low cost and abundantly found fish oil produced from soap stock could be a better option for biodiesel processing. Such type of fish oil contains a higher amount of moisture and FFA and requires a pre-treatment prior to biodiesel production. The use of animal fat to produce bio-diesel is not a new technology; however the adaptability of this technology to aquatic resources has only attracted public interest recently. The stress on land based products to produce biofuels is becoming quite significant and will be even more so in years to come. Therefore looking at aquatic resources for energy production makes not only ecological sense but economic sense too. The conversion process is simple after the fish oil has been produced from the left over waste of the fishing industry the oil is cleaned purified and with the addition of some caustic soda and methanol the bio-diesel is produced. 1kg of fish waste can produce up to 1.13lts of bio-diesel.

Keywords: Biodiesel, Caustic, fish

Development of biodiesel which is a renewable alternative energy source, could easily reduce global dependence on petroleum, and could also help to reduce air pollution. Worldwide production of biodiesel is mainly done by utilizing edible oils such as soybean, sunflower and canola oils. Since, India is not self-sufficient in edible oil production, hence, some non-edible oil seeds available in the country are required to be tapped for biodiesel production The bio-diesel produced from fish waste would be anon-toxic and fully biodegradable renewable fuel that can easily be adapted without any modification to current diesel engines (Raheman H*et al.*, 2007). Bio-diesel is particularly good for the environment as opposed to standard fuel or diesel because it reduces the air toxins, CO_2, particulates, black smoke and other hydrocarbons. The fish oil is similar to a vegetable oil or animal oil and it reacts with an alcohol (methanol), the catalyst used is generally caustic soda. This produces a pure bio-diesel or B100 (100% bio-diesel) with a valued by product glycerin. Glycerin is an important by-product, and is currently further being enhanced and could become a new source of income for bio-diesel producers. It is a colourless, odorless, slimy liquid which is used for pharmaceutical, food and cosmetic purposes. Up to now market conditions have impeded this valuable by product to be sold commercially, however, worldwide researchers and experts are looking at ways to enhance the product and find more ways to utilize it in order to make it economically and commercially viable. Some fish oils contain essential fatty acids like omega 3, which is a highly valued commodity especially in the pharmaceutical industry. Therefore care has to be taken on which types of fish are used when producing the fish oil. Below you will find a table of fish species and their content of Omega 3 fatty acids per 100 gr. One of the lowest in Omega 3 content but high in oil is catfish. One other note of care is the acid content of the oil extracted. or example, salmon oil is high in acid and this acid needs to be removed. Therefore an additional step in removing this acid is required. Sulfuric acid is added to reduce the acid value of the oil. Once this has been done the process of trans-esterification can begin.
Biodiesel is a fatty acid methyl ester (FAME). It is produced from a chemical reaction called trans esterification (Jose M*et al.*, 1999). When entering the biodiesel processor, the raw material is heated up to 40-50 degrees Celsius. During heating, methanol is mixed effectively with the catalyst for the trans-esterification operation.

Search for stable and continuous source/feedstock for biodiesel production is important to utilize the benefits of biodiesel as an alternative to diesel fuel. Many of the researchers have tried edible as well as non-edible oils for biodiesel processing, but due to their higher prices, it is not feasible to produce biodiesel from them. Low cost and abundantly available fish oil prepared from soap stock could be a viable option. Fish oil is produced in large quantity by fish-processing industry. The viscera, eyes, fins, tails, and other discarded parts of fish are used as soap stock in the manufacturing processes of various fish products. The weight proportion of soap stock is about 25% of the fishery production. The soap stock of marine fish including mackerel, salmon, tuna, and cod is frequently ground into fish meal for aquaculture, livestock, and pet food, and Costs little.

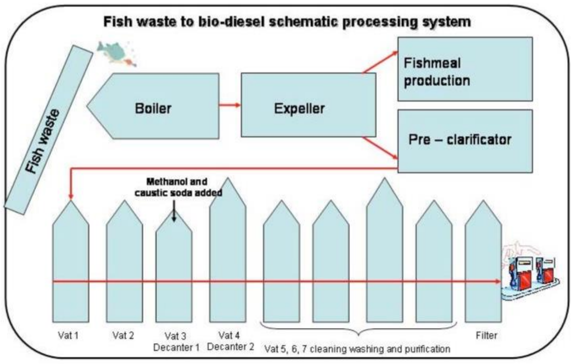
Table 1: Fish species and their Omega 3 fatty acid content

Fish species	Omega 3 (EPA+DHA) content (g) per 100 g of fish
Tuna (fresh)	0.28-1.51
Atlantic salmon	1.28-2.15
Mackerel	0.4-1.85
Atlantic herring	2.01
Rainbow trout	1.15
Sardines	1.15-2
Halibut	0.47-1.18
Tuna (canned)	0.31
Cod	0.28
Haddock	0.24
Catfish	0.18
Flounder or sole	0.4
Oyster	0.44
Shrimp	0.32
Scallop	0.2
Cod liver oil capsule	0.19
Omacor (Pronova)	0.85

Source: adapted from the guidelines of the American Heart Association.

In India, fishing industries could play a bigger role in giving rise to the new industrial sector of biodiesel production by supplying its by –product(soap stock) to the biodiesel processing industries (Dorado, M.P *et al*, 2002).Hence, biodiesel production from fish may leads to the control of solid waste generated from fish industries and helps in improving Indian economy. Although there is great potential for the use of fish-oil as biodiesel for transportation sector or as a power source, research in this field is limited.

The technology used in the production of bio-diesel from fish waste is adaptable and transferable in many other parts of the world including developing regions in Africa, Asia and Latin America as well as small fishing communities and small islands who rely heavily on oil imports. It can provide labor, and produce local energy free from greenhouse gases and emissions. With little investment in already existing fishing communities local energy can be produced at very little cost (Masjuki HH *et al.*, 2001).

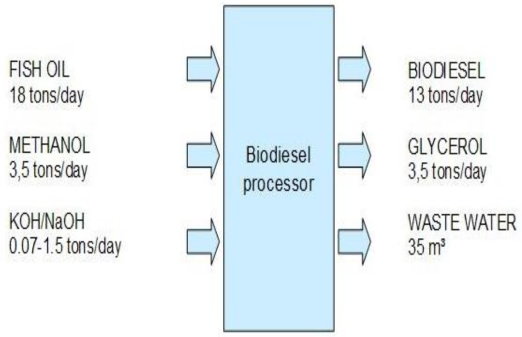


Pic : Fish waste as it arrives at the bio-diesel plant

The refined fish oil was first filtered by filter paper mainly to remove the remaining dirt and other inert materials and then placed in a conical flask equipped with magnetic stirrer and water condenser (Steigers JA, 2002).The base catalyzed trans esterification process for biodiesel production was optimized. Under agitation, the raw oil was heated closer to its boiling point to remove the water contaminants present in the oil. After that, the oil was allowed to cool down under room temperature. The treated oil was then taken for biodiesel production. The above treated oil was again agitated and heated up to a desired temperature on the hot plate. A fixed amount of freshly prepared sodium hydroxide–methanol olution was added to the oil, this moment was considered as the starting time of the reaction (Demirbas A, 2003). When the reaction reached the preset reaction time, heating and stirring were stopped. The products of reaction were allowed to settle for three hours. During settling, two distinct liquid phases were formed: crude ester phase at the top and glycerol phase at the bottom. The crude ester phase separated from the bottom glycerol phase was then washed by warm de-ionized water several times until the washed water became clear.

The fome was dried using anhydrous sodium sulphate and then there maining excess methanol and water in ester phase were removed by evaporation under atmospheric condition. In this way neem methyl ester was prepared. The final biodiesel was then filtered to remove remaining sediments with the help of filter paper. The reactions were investigated step by step. The optimal value of each parameter involved in the processes was determined keeping the rest of the parameters as constant. After optimal value of each parameter was attained, the value was adopted for the optimization of the next parameter (Ma, F, *et al.*, 1999).

Thus, crude fish oil from soap stock contains a higher amount of initial FFAs, which could not be directly employed for biodiesel processing. Caustic stripping is the cheapest and convenient way for the reduction of FFAs from fish oil while acid esterification darkens the fish oil (Reyes JF *et al.*, 2006). Base catalyzed trans esterification is a faster and an economical way of biodiesel processing with its optimized parameters which leads to the achievement of desired quality of biodiesel fuel (within the limits prescribed by ASTM,IS and EN standards).



The challenges are the heterogeneity of fish waste, remoteness of fish processing plants in NL, and fish oil is high in free fatty acids (FFA). The remoteness of the plants means that producing the biodiesel for export is likely not feasible. Further, the high FFA content and high rate of degradation of the fish oil exaggerates the export problem. High FFA content translates to an extra pre-treatment step. The most likely option for fish biodiesel is on-site production for blend in the diesel engine for energy.

Reports conclude though that there is potential to take the tonnes of waste from the salmon farming industry and turn it into a fuel to be used in diesel engines, the challenges notwithstanding. More study and research will no doubt continue and the salmon aquaculture industry will watch closely.

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