Alternative Energy Source for Self-Reliant in Ethiopia

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*Ethiopian s*elf-reliance in energy sources will result in the de-escalation of transport charges of food commodities and mitigate the difficulty arises out of escalation of import charges of petroleum due to devaluation of the Ethiopian Birr. Not achieving self-reliance in energy sources directly affects the common man's living. Similarly, many more examples which directly affect industries, public administration, states and the nation as a whole would be enumerated within moments. The task of achieving self-reliance in energy sources could be initiated by identifying waste land for non-edible oil grain cultivation like Jatropha Curcas resulting in non-edible vegetable oil production. A scheme would be planned and executed to identify and allot waste land to the farmers according to their edible item production in a hypothetical ratio called over all self-reliance ratio defined as the ratio of self-reliant food production to projected self-reliant energy source production in ton for a district or state or nation. Arithmetic behind this over all self-reliance ratio ensuring concurrent production of food and energy sources would ultimately lead a particular area towards achieving and utilizing full benefit of self-reliance as far as common man concerned. The energy source identified in this paper to achieve self-reliance in energy sources is one of the bio-fuel commonly known as Biodiesel because it is used in transport vehicle engines as well as electricity producing generator set engines.

Keywords: Energy, Bio-Diesel, Transesterification and Hydrogenation.

Introduction

Most of the places in Ethiopia do not have proper transportation facility. Achieving over all self-reliance that is self-reliance in energy sources along with food commodities will definitely bring food and transportation to all places of Ethiopia. Biodiesel is identified as one of the alternate energy source substitute for fossil diesel. Biodiesel can be used as fuel in diesel engines in blends as well as full substitute. Similarly, Biodiesel can be used in diesel power plants and diesel generators instead of fossil diesel.

First generation Biodiesel called as Bio-Transe sterified Diesel (BTD) is produced by Transesterification process whereas second generation Biodiesel called as Bio-Hydro fined Diesel (BHD) is produced by Hydrogenation process from non-edible vegetable oils. The transesterification process needs catalysts potassium hydroxide or sodium hydroxide as well as

ethanol or methanol in small quantities. BTD and BHD produced in this way have properties almost equivalent to fossil diesel and substituted in full or in part as blend with fossil diesel in diesel engines used in transport vehicle and electricity generating sets as well as in fossil diesel power plants. The cold flow property and oxidation stability of Biodiesel are improved better in the hydrogenation process than that in the transesterification process of vegetable oils.

The wonderful outcome of self-reliance in energy sources by the Biodiesel is the million dollars' worth healthiness of citizens of Ethiopia as a result of pollution free atmosphere. Carbon monoxide, Hydrocarbon and Particulate Matter emissions from transport vehicles and fossil diesel power plants are reduced to 60% to 80% by Biodiesel depending upon the operating conditions. The chief advantage of this energy source is the carbon di-oxide neutrality with atmosphere in principle. The neutrality is derived from the cyclic nature of absorption and emission of carbon di-oxide by the plants and engines respectively. Usage area under the self-reliant energy source Biodiesel will have carbon di-oxide free atmosphere because carbon di-oxide is cycled between plants and environment and thereby atmosphere is free from carbon di-oxide multiplication. Therefore, regions under the cloud of this type of self-reliance in energy source by Biodiesel are directly contributing to the task of reducing global warming effects of the world also.

Action Plan Need for Self-Reliance

Action plan required for implementing the scheme of self-reliance in energy sources would be listed as techno, commercial and social activities.

Techno Activities

The technical aspects of producing this energy source in small as well as large scale were carried out by technocrats around the world. Almost all the requirements for the successful production of this energy source from non-edible vegetable oils were completed by the researchers. A suitable production methodology could be evolved for using any vegetable oil based on its local availability without much difficulty by a set of scientists and engineers appointed for this purpose.

Commercial Activities

This commercial activity depends on the local availability of non-edible vegetable oils. Appreciating market could be developed for non-edible vegetable oils in any locality ensuring selling and buying of the commodity in whole sale and in retail. Similarly, the commercial outlets for the finished product Biodiesel could also be developed alongside with raw non-edible vegetable oils. The commercial activity may include the buy-back guarantee between farmers and industrialists for the finished product Biodiesel.

Social Activities

This activity includes the prime awareness campaign by local groups among themselves. The periodic interaction at regular intervals among locals, administrators and industrialists is also coming under the social activities so as to distribute the benefit of this scheme evenly to all the contributors. This final social activity among the contributors in a smooth and healthy way could only lead the scheme towards success that is empowers farmers with energy source that is oil.

Case Study - Bio-Transesterification Diesel (BTD) and Bio-Hydrogenation Diesel (BHD)

The Kyoto protocol [1] held in Kyoto, Japan in December 1997, iterates 6% reduction of greenhouse gases with respect to 1990 within the period 2008-2012 for Japan. In addition, transportation sector is to reduce CO_2 emission up to emission level in 1995 in order to achieve the purpose written in the Kyoto protocol.

First generation Biodiesel called Bio-Transesterification Diesel (BTD) is composed of long-chain fatty acids with an alcohol attached. It is produced by transesterification process in which vegetable oil react with methyl alcohol or ethyl alcohol in the presence of potassium hydroxide (KOH) or sodium hydroxide (NaOH) catalyst. The products of the reaction are biodiesel and glycerin, approximately in the ratio 3:1. Biodiesel significantly reduce emissions of Hydrocarbon (HC), Carbon Monoxide (CO), and particulate matter (PM) when used in automotive diesel engines because of its oxygen content and higher cetane number than fossil diesel [2]. U.S. Environmental Protection Agency (EPA) also found HC, CO and PM benefits from the use of biodiesel in engines [3]. Energy diversification and CO_2 reduction requirements emphasis the use of Biodiesel in automotive engines as well as in stationary engines meant for electricity production.

Second generation Biodiesel called Bio-Hydrofined Diesel (BHD) is a straight- chain hydrocarbon derived from the alkyl chains of the vegetable oil. It is produced by Hydrogenation of vegetable oil at reaction temperature of 260°C+. Study of reactivity and the pattern of product yields conducted of palm oil hydrogenation using pilot plants delivered hydrocarbon oil equivalent to the conventional fossil diesel under mild hydrogenation condition [4]. Moreover, as a result of various evaluations for the hydrogenated palm oil (oxidation stability, low temperature flow property, life cycle assessment (LCA); it was found that the hydrogenated palm oil (Bio-Hydrofined Diesel) has performances almost equivalent to fossil diesel fuel.

Evaluation of exhaust gases of vehicles running on conventional fossil diesel mixed with 20% Bio-Hydrofined Diesel (BHD) showed lower THC, CO, and PM than with fossil diesel alone. Biodiesel (BTD) and its blend help reduce enormous emissions of total hydrocarbon, carbon monoxide and smoke. However, both BHD and BTD cause slightly increasing emission of Nitrogen Oxide. LCA evaluation between fossil diesel and palm oil produced BHD and BTD showed that, although WTT-CO_2 of BHD and BTD is higher than that of fossil diesel, WTW-CO_2 is lower due to the application of the biomass zero count rule and WTT energy efficiency

was highest for fossil diesel, followed by BHD and then BTD. Hydrogenation of vegetable oil appears to be a better option than Transesterification in producing diesel substitute because of BHD's high oxidation stability, low viscosity, high cetane number (101) and disappearance of double bond in structure.

Sustainable development can be made by the use of Biodiesel in the bus depots by reducing the cost of operation and also reducing the exhaust emissions by saving environment and our earth. Total of about 54.29% of cost can be reduced by the use of Biodiesel in the bus depots of India [5].

Conclusion

Sustainable automotive and stationary engine fuels are fuels that satisfy the conditions of "3E", namely, they are "economical", "environmentally-friendly", and promote "energy security". The focus has shifted to issues of supply stability (diversification of resources) and environmental compatibility (CO_2 reduction), against higher import costs of crude oil prices due to Birr devaluation and the global warming problem. The renewable fuels, such as Biodiesel, probably would be the most viable option by utilizing domestic surpluses and non-edible vegetable oils while enhancing energy security. Many experts also see the introduction of biomass fuels as a promising solution to fossil diesel costs. Biodiesel contains no sulfur or aromatics and its use in diesel engines results in substantial reduction of Hydrocarbons, Carbon monoxide and Particulate matter. In addition to being renewable alternate fuel for diesel engines, Biodiesel have positive performance attributes such as increased cetane number, high fuel lubricant and high oxygen content, which make it a preferred blending stock also with future ultra clean fossil diesel. The byproduct glycerin from transesterification is used in cosmetics and soaps thereby providing the necessary value addition to the Biodiesel.

Abbreviation

BTD - Bio-Transesterification Diesel BHD - Bio-Hydrofined Diesel
NaOH - Sodium Hydroxide KOH- Potassium Hydroxide
HC - Hydrocarbon
CO - Carbon Monoxide
PM - Particulate Matter
EPA - U.S. Environmental Protection Agency LCA -Life Cycle Assessment
WTT - Well To Tank WTW - Well To Wheel

Reference

The 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, *"Kyoto Protocol to the United Nations Framework Convention on Climate Change",* (1997).

Schumacher.L. G., W. G. Hires, and S. C. Borgelt, *"Fueling a diesel engine with methyl-ester soybean oil . Liquid Fuels From Renewable Resources"* -Proceedings of an Alternative Energy Conference, Nashville, Tennessee State, U.S.A (1992).

United States Environment Protection Agency (EPA), *"A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions Draft Technical Report".* EPA 420-P-02-001, (2002).

Akira Koyama, HideshiIki, Yasutoshi Iguchi, Kazushi Tsurutani, Hitoshi Hayashi, Seitaro Misawa, *"Vegetable Oil Hydrogenating Process for Automotive Fuel",* Proceedings of the SAE International Fuels and Lubricants Meeting, Kyoto, Japan, 1871-76, July 2007.

S. Bhandarkar, R. Nijagunappa, *"Use of Bio-Diesel as an alternative fuel for sustainable development of transport in Gulburga bus depots"* IMECH-International Conference Proceedings - Innovations in Fuel Economy and Sustainable Road Transport, Pune, India, 149-160, 2011.