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Biodiesel from Waste Cooking Oil for Heating, Lighting, or Running Diesel Engines

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Abstract: Biodiesel and its byproducts and blends can be used as alternative fuel in diesel engines and for heating, cooking, and lighting. A simple process of biodiesel production can utilize waste cooking oil as the main feedstock to the transesterification and cruzesterification processes. I currently make my own biodiesel for applications related to my nursery and greenhouse operations, which helps me reduce costs under the current circumstances of high fuel costs.

Keywords: fossil fuel, diesel, renewable fuels, biofuel, esters, triglycerides, glycerin

Introduction

In my opinion, the dynamics of environmental degradation and the increasing demand for energy require humans to find alternative sources of energy. I see our world beset with four major energy-related problems: (1) fossil fuel is running out; (2) a reduction in fossil fuel would harm the world economy; (3) fossil fuel is one of the central aspects to wars and rebellions; and (4) the earth is getting warmer due, in part, to the increase of carbon dioxide in our atmosphere. Not using renewable energy is expensive. For example, the United States gives the fossil fuel industry US$ 5 billion in tax money annually (Tickell and Tickell 1999), spends US$ 50 billion to maintain its military presence in the Middle East (Ramsey 1998), and has spent, as of 11 June 2008, US$ 528 billion on the war in Iraq (National Priorities Project 2008). Environmental costs are high too. It seems to me that everyone is talking about climate change, and for good reason. Carbon dioxide levels in the atmosphere, mostly from burning fossil fuels, increased from 280 ppb in 1750 to 360 ppb in 2000 (Consumer Reports 1996). While CO_2 does not directly affect health, synergistic effects are obvious, and lowering CO_2 emissions from fossil fuels would reduce air pollutants, such as smog-producing ozone and particulate matter.

Solutions

One solution to environmental degradation and the energy crisis is development of renewable and clean sustainable forms of fuels or energy sources. The supply of renewable energy (for example, ethanol, biogas/biomass, biodiesel, photovoltaics, wind, geothermal, and hydropower) is almost infinite. Compared with the limited availability of fossil fuels, biofuels are constantly grown and replenished. Fossil fuels took at least 40 million years to form, while biofuels can be produced in 3 months (fig. 1). Renewable fuels are carbon neutral, strengthen the economy by creating jobs and infrastructure, and reduce the petroleum deficit. For example, the United States could decrease its annual trade deficit by more than US$ 53 billion and create 1.43 million jobs in biofuels and supporting services by producing 100% of its fuel domestically (Campbell 1997). The U.S. ethanol industry alone adds US$ 51 billion to the economy; allows farm income to increase by US$ 2.2 billion; creates 5,800 direct jobs and 50,000 indirect service jobs; generates US$ 555 million federal taxes; and reduces the trade deficit by US$ 1.3 billion (Urbanchuk 1996).

Using renewable energy makes sense to me. In my opinion, our energy vision should seek harmony with culture and ancestral teachings. Our ancestors have taught respect for Mother Earth, that is, to live in harmony and respect what she has provided, to not take without giving, to not use and abuse without consideration of the holistic impact of our actions to future generations of our people. Our ancestors have taught us to conduct our life in a respectful, sustainable manner, walking lightly on the earth.

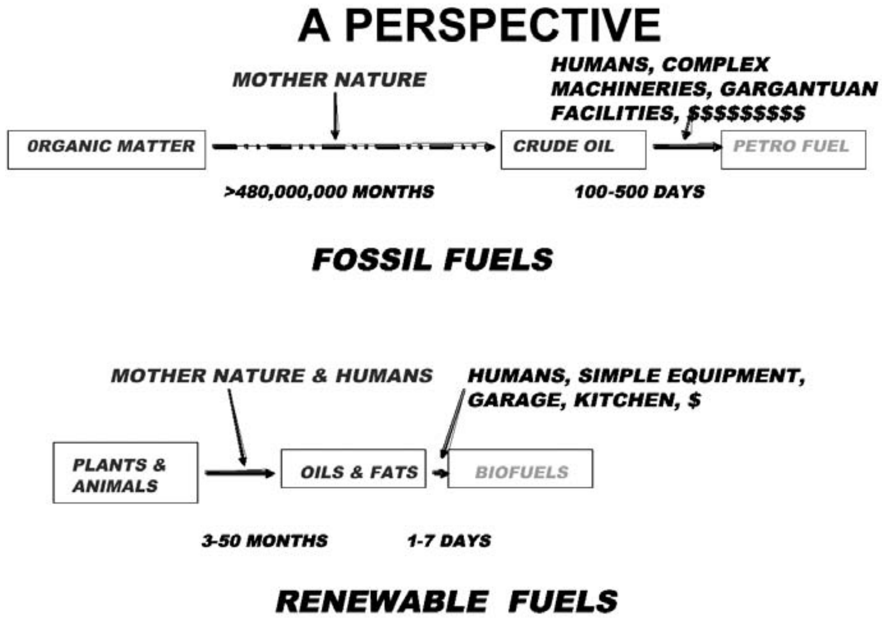

Figure 1. A perspective on fossil fuels and renewable fuels.

I feel that many businesses and energy technologies of today do not hold this as a primary guiding philosophy. I am using renewable biodiesel in my nursery and personal life in order to live more in harmony with Mother Earth.

Biodiesel

Dr. Rudolf Diesel developed the first diesel engine prototype in 1893, and demonstrated its use with renewable peanut oil (biodiesel) at the World Exhibition in Paris in 1900. Although it took another 80 years for interest in biodiesel to return, I see worldwide interest in biodiesel increasing. Biodiesel is physically and chemically similar to petroleum diesel fuel, and can, therefore, be used as substitute for fueling diesel engines without engine modifications. Biodiesel is environmentally and user-friendly for several reasons: (1) when burned or used as fuel in engines, significant reductions in emissions can be attained (fig. 2); (2) no sulfur or lead is produced; (3) emissions may not contribute to acid rain production; (4) it is safer to use because its flash point, or fire point, is about 200 °C (400 °F); (5) it is miscible and readily mixes with petroleum products and alcohol so it can be blended with petroleum products and alcohol at any percentage; and (6) it recycles carbon dioxide. Biodiesel has a zero net balance of CO_2 emissions because plants need CO_2 for growth and development. Studies indicate that for every liter of vegetable oil produced, the crop uses at least 2.7 kg (6 lb) of CO_2. Using biofuels is almost a win-win situation (fig. 3), depending on what feedstock is used. Although it takes at least 40 million years for nature to convert organic matter into crude oil that can then be processed into petroleum products (fig. 4), I am producing biodiesel in as little as 3 months. I have been promoting biodiesel as an alternative fuel since 1995 in the Phillipines, Uganda, Azerbaijan, Russia, Canada, Bulgaria, United States, and Paraguay.

EMMISSIONS REDUCTION
(DIESEL EMISSIONS BASE)

CO_2 = 78-100% (NET, PLANTS USE CO_2 FOR GROWTH)
SO_2 = 100% (NO SULFUR ADDED)
SOOT, PARTICULATES = 40-60%
CO, HC = 10-50%
PAHs: (phenanthren = 97%; benzofloroanthen = 56%; benzapyren = 71%; aldehydes and aromatic compounds = 13%)
NOx = PLUS/MINUS 5-10% (ENGINE'S AGE, DESIGN, TUNING)

Figure 2. Emissions reduction using diesel emissions as base.

Production

In the early 1990s I was involved with demonstrating and piloting biodiesel; this novel work was part of my post-doctoral investigation on biofuels (Cruz 1992; Peterson and others 1992). Biodiesel is produced through a process called transesterification, which is basically a chemical reaction of a triglyceride with an alcohol in the presence of a catalyst to produce fatty acid esters (commonly termed biodiesel) and glycerin (fig. 5). Our projects, however, embraced a simple, short fuel-making process, termed cruzesterification (fig. 6). This process uses simple equipment, no heat application, and no fuel washing (fig. 7), along with waste or used cooking oil from area restaurants, food service institutions, and households, to make small batches of biodiesel.

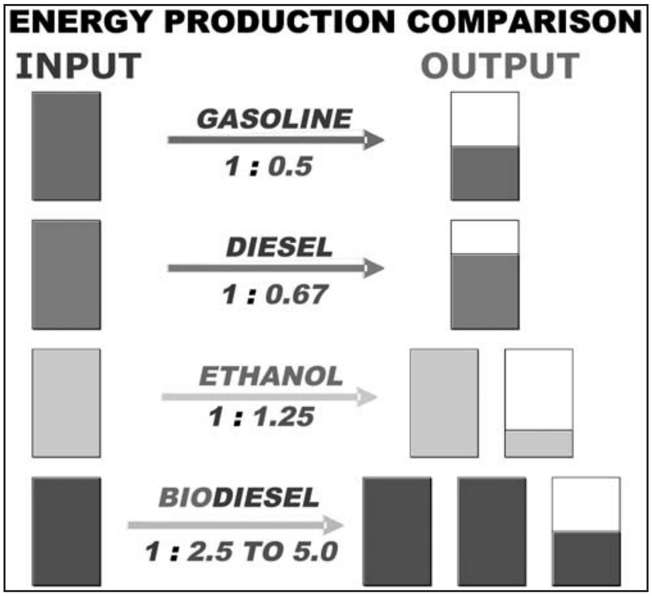

Figure 3. A comparison of energy input/output of biofuels and petroleum fuels.

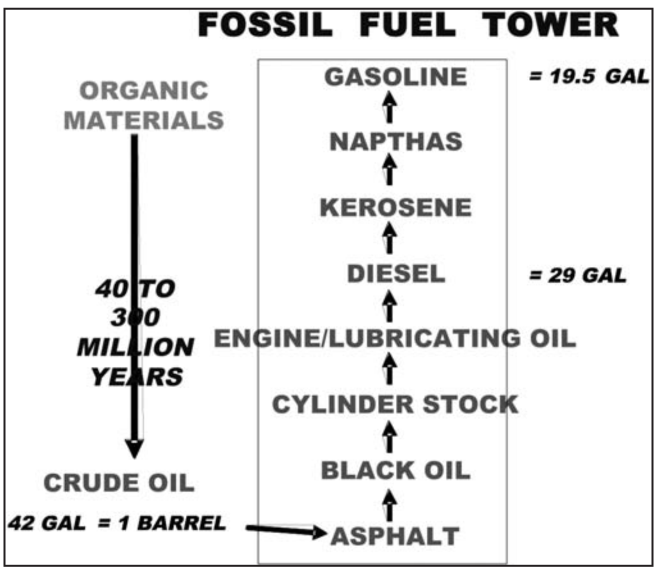

Figure 4. Process flow of petroleum products.

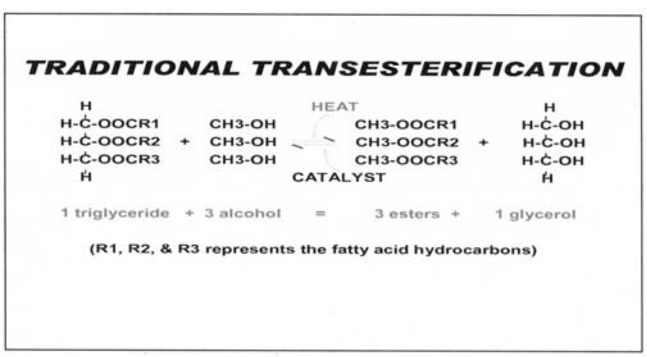

Figure 5. Traditional transesterification process.

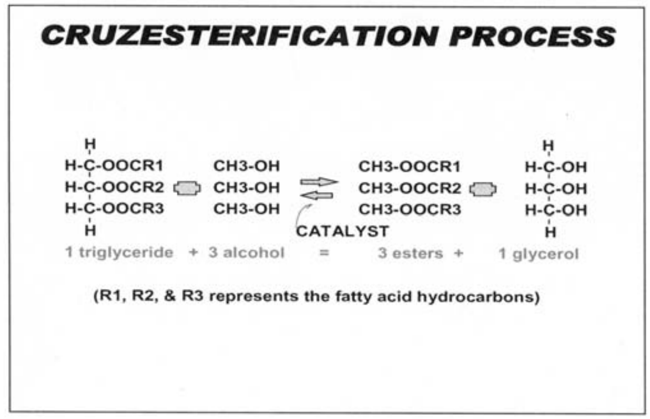

Figure 6. The cruzesterification process.

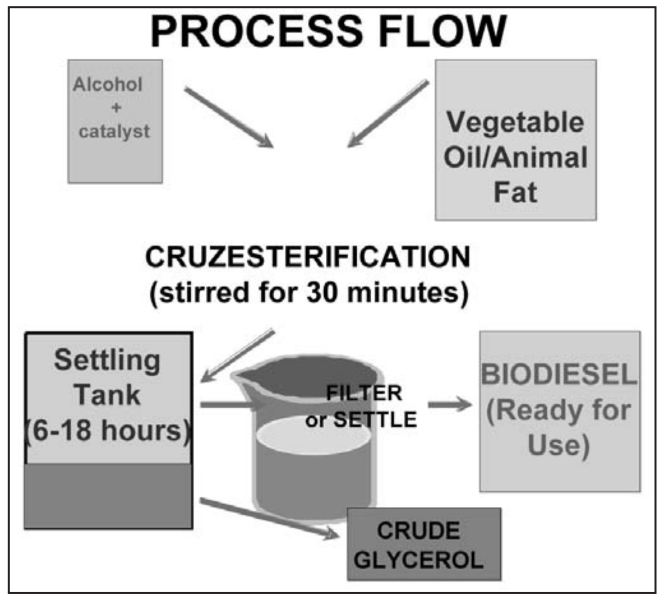

Figure 7. Simple biodiesel process flow.

Essentially, cruzesterification employs used (usually less than 3 months old in storage) cooking oil or yellow grease that has been filtered or screened to eliminate any water or food morsels. Any amount of water in the oil and alcohol will prevent and stop the reaction. I prefer young used oil or grease because the older the oil, the more free fatty acid (FFA) it contains, which competes with the potassium hydroxide catalyst. At too high a level, FFA stops the chemical reaction. The process of making biodiesel requires taking several precautions, including the use of non-rubber gloves, eye protection, and a breathing mask or respirator, and completing all mixing in a well-ventilated area, at an ambient temperature ≥13 °C (55 °F), and at least 18 m (20 yd) from sources of open flames or embers, including cigarettes. My recipe for making biodiesel is easy. Please contact me for complete details. I am happy to share my technique.

Figure 8. A demonstration vehicle used by the author.

Biodiesel Application in Engines

I use biodiesel for work and personal use. I have used biodiesel in an old Ford Bronco with a Toyota engine (100% biodiesel), a 2005 Volkswagen New Beetle (5% to 100% biodiesel), and, because some times I need to get away from the nursery, in the 10HP engine on my boat (100% biodiesel). I drive my Beetle up to 1,290 km (800 mi) per week (fig. 8).

Recommendations and Outlook

In my opinion, making your own fuel for use in nursery/greenhouse operations is a good strategy to minimize environmental degradation problems, minimize global warming/greenhouse gases, and improve cost effectiveness in day-to-day operations. As fuel for engines, biodiesel or blends can be used in tractors, backhoes, bulldozers, mowers, pumps, trucks, cars, back-up or main generator sets, any 2-stroke engines as additive, and other equipment that have diesel engines. Biodiesel can substitute as heating oil for heating a greenhouse during winter operations and lighting whenever needed. It can also be used for cooking or for sterilizing planting media and laboratory glasswares/gadgets.

For more information on biodiesel system plans, processors/kits, multi-fuel heater plan, supplies, gadgets, equipment, chemicals, test kits, accessories, How-To books/DVDs, one-on-one training/consulting work, and ASTM specifications, the following resources are available online:

www.utahbiodieselsupply.com
www.biodieselamerica.org
www.journeytoforever.org
www.ecoenergyinternational.com
www.biodiesel.org
www.homebiodieselkits.com

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