Operations & Safety Bulletin (Retail) – North

Biodiesel: A Clean alternative fuel from renewable resources

History of Biodiesel:

Rudolph Diesel himself developed biodiesel in 1890, wherein pure vegetable oils were used in diesel engines for agriculture, where petroleum diesel was not available. Modern biodiesel fuel is an outcome of research conducted in 1930s in Belgium, which is made by converting vegetable oils into compounds called fatty acid methyl esters. Process of transesterification was used to convert vegetable oils into fatty acid alkyl esters and use as diesel fuel replacement with lower viscosity of vegetable oil. Biodiesel is the trade name of fatty acid methyl esters. Concerns over environment, energy security and use of agro products brought the use of vegetable oils to the forefront.

Biodiesel industry became house hold name in U.S. after terrorist attack of 9/11/2001, resulting in high oil prices. Biodiesel is being used Worldwide now, due to concerns over Global warming. The future of biodiesel lies in the world's ability to produce renewable feedstocks such as vegetable oils and fats to keep the cost of biodiesel competitive with petroleum.

Biodiesel- Need of the hour:

Biodiesel is a renewable alternative fuel created from vegetable oils, animal fats and greases through a chemical process. The chemical process involves reaction of natural oils with an alcohol in the presence of a catalyst (usually sodium hydroxide [NaOH] or potassium hydroxide [KOH] and then refining the mixture to create molecules which can be easily burned in a diesel engine. Blend of 20% to 80 % with petroleum diesel significantly reduces carcinogenic emissions and gases that contribute to global warming. Glycerin is the byproduct of the biodiesel production process which can be used for personal care products and variety of chemical applications.

Biodiesel is manufactured from plant oils, animal fats, recycled cooking oils and has following ***Salient advantages***:

- It is renewable & energy efficient.
- It can be used as a 20% blend in most diesel equipment with no or only minor modifications.
- It reduces tailpipe emissions, including air toxics.
- It reduces global warming gas emissions.
- It is nontoxic, biodegradable and suitable for sensitive environments.
- Biodiesel is most commonly used as a blend with petroleum diesel. At concentrations of up to 5 vol % (B5) in conventional diesel fuel.
- B20 is the most commonly used biodiesel blend in the United States because it provides a good balance between material compatibility, cold weather operability, performance, emission benefits and costs.

Introduction:

- Biodiesel blend is a mixer of methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oil, animal fat and recycled cooking oil. These esters are oxygenated organic compounds that can be used in compression ignition engines owing to their key properties

which are comparable with existing diesel fuel. Furthermore, it is eco-friendly, renewable and sustainable fuel which offer carbon neutral cycle. “Soy Methyl Ester” diesel (“SME” or “SOME”), derived from soybean oil, is the most common biodiesel available in the United States. “Rapeseed Methyl Ester” diesel (“RME”), derived from rapeseed oil, is the most common biodiesel blend stock available in Europe. On the other hand, Palm Methyl Ester (“PME”), derived from palm oil, is the most common biodiesel blend stock available in Asia as of today. Collectively, these fuels are sometimes referred to as “Fatty Acid Methyl Esters” (“FAME”) or “Fatty Acid Ethyl Esters” (“FAEE”).

Indian approach towards the development of biodiesel program is different than the other parts of world. It depends exclusively on non-edible feedstocks such as Jatropha, Karanja, Neem, Mahua, algae etc. It is targeted to raise these feed stocks on degraded/marginal or wastelands which are not suited for agriculture or diverted from stocks which are banned for human consumption such as waste cooking oil.

Biodiesel production:

Biodiesel is produced by a process called transesterification, in which various oils (triglycerides) are converted into methyl esters through a chemical reaction with methanol (FAME) or ethanol (FAEE) in the presence of a catalyst, such as sodium or potassium hydroxide (Fig.1). By-product of the transesterification process includes glycerol which needs to be removed from the finished product along with traces of the methanol or ethanol, un-reacted triglycerides, and the catalyst.

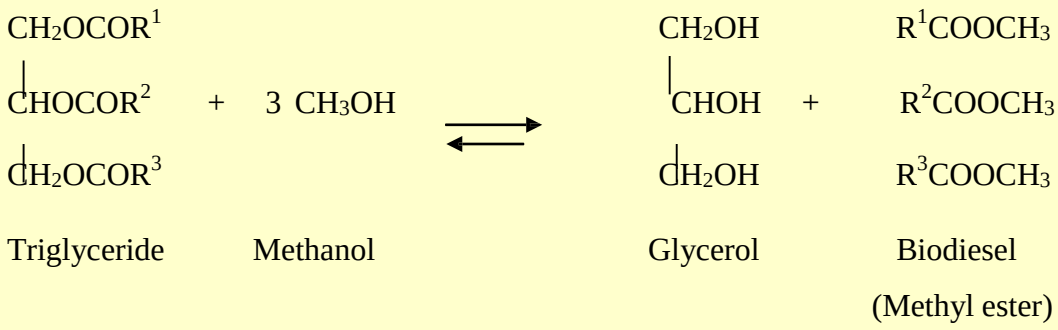

Figure 1: Transesterification reactions for biodiesel synthesis

R^1, R^2 & R^3 Fatty acid chain of triglyceride.

The simplified process schematic of the biodiesel production process is depicted in Figure 2 below –

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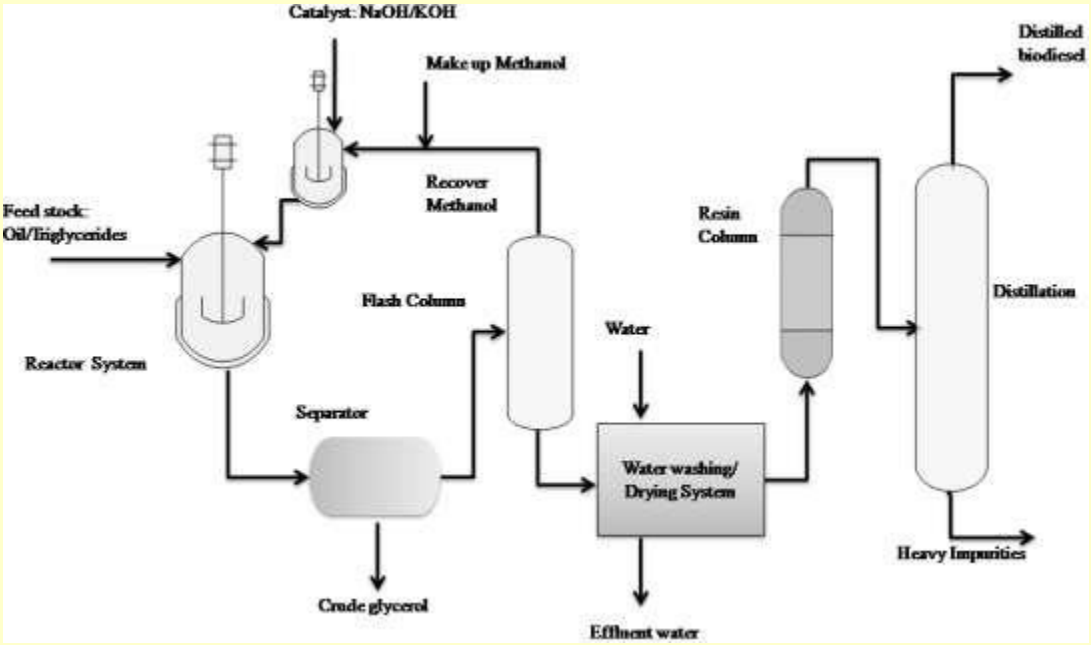

Figure 2: Simplified process flow diagram for conventional homogeneous catalytic biodiesel process

Specifications:

Biodiesel is produced in a pure form (referred to as “B100”or “neat biodiesel”) and is typically blended with petroleum-based diesel fuel. Such biodiesel blends are designated as BXX, where XX represents the percentage by volume of pure biodiesel contained in the blend (e.g., “B5,” “B20”).

Several international organizations have adopted and continue to revise biodiesel specifications and guidelines. Specifically, ASTM International recently approved revisions to its specification for B100 biodiesel blend stock referenced as D6751. Europe’s Committee for Standardization (“CEN”) has adopted a technical standard for biofuels referred to as EN 14214.

In India, Bureau of Indian Standard (BIS) also adopted a technical standard i.e. IS 15607:2005 for Biodiesel as blending stock. The B5 biodiesel blend specification is similar to existing diesel specification i.e. IS 1460:2005. However, specification of biodiesel for standalone application and B6-B 20 blends are under consideration and development stage by BIS.

IS 15607:2005 specification of biodiesel (B100) as blending stock –

Characteristics	IS 1567 2005:
Density, Kg / m^3	860 – 900
sEster Content, % min.	96.5
Flash point (closed cup), °C	120
Water and sediment, mg / Kg, max.	500
Kinematic viscosity at 40°C, mm^2/s	2.5-6.0
Oxidation Stability at 110°C, hours min.	6

Ramsbottom carbon residue, % mass, max.	0.05
Sulfated ash% mass, max.	0.02
Sulfur, mg / Kg max	50
Copper strip corrosion 3 hrs. 50°C	Class 1
Cetane Number, min.	51
Acid number, mg KOH/g, max.	0.50
Methanol or Ethanol, % m/m, max	0.2
Free glycerin, % mass	0.020
Total glycerine (free glycerine and unconverted glycerides combined), % by mass, max.	0.25
Group I Metal (Na+K), mg/Kg, max	5
Group II Metal (Ca+Mg), mg/Kg, max	5
Phosphorus content, mg/Kg, max	10

Storage and Handling of biodiesel:

Untreated biodiesel blend stocks generally exhibit poor oxidation stability, which can result in long-term storage problems. Thus, anti-oxidation additives are added to improve its storage stability. Biodiesel blend stock and higher biodiesel blends act as solvents, removing historical deposits accumulated from the use of petroleum diesel fuel. *The materials removed accumulate in fuel filters, resulting in more frequent than typical service intervals until the deposits have stabilized. Therefore, when converting from petroleum diesel fuel to a biodiesel blend, fuel storage and vehicle/equipment tanks should be cleaned and rid of any residual water.*

- Biodiesel is generally more susceptible than petroleum diesel to microbial degradation. In the case of spills in the environment, this is a positive attribute because it biodegrades more rapidly. However, microbial contamination of fuel storage tanks can plug dispensers and vehicle fuel filters and cause vehicles to stall. The

best way to deal with this issue is good housekeeping & monitoring quality, especially minimizing water in contact with the fuel. *Water bottoms must be removed from tanks and product tanks should be sampled and tested for microbial contamination.*

- B100 is not compatible with some metals and plastics. Biodiesel will degrade and form high sediment levels if contacted for long periods by copper or copper containing metals (brass, bronze) or with lead, tin, or zinc (galvanized surfaces). These high sediment levels may clog filters. B100 may also permeate some common plastics (polyethylene, polypropylene) over time, so these should not be used for storing B100.
- The D6751 specification also includes the following statement: *"The biodiesel fuel shall be visually free of undissolved water, sediment, and suspended matter".*
- B100 should be clear, although it may come in a variety of colors. The biodiesel's color does not indicate fuel quality.
- ASTM recently passed specifications for biodiesel blends. These include the allowance of up to 5% biodiesel.

Health & Safety aspects:

Biodiesel and their blend stocks are biodegradable, which may render them useful in applications where biodegradability is desired (e.g., marine or farm applicationEmissions from engines using biodiesel blends have undergone successful health effects testing in accordance with EPA Tier 2 requirements for fuel and fuel additive registration. Biodiesel blends with diesel are reported to reduce particulate, HC and CO emissions.

Biodiesel has a higher flash point than petroleum-based diesel fuel, which allows for transportation and storage without the restrictions associated with flammable materials.

Launching of Bio-Diesel:

In Northern Region Biodiesel has been launched on 10 th August 2015, the World Biodiesel Day **with HSD blended with 5 % biodiesel (B5) at one select RO (COCO) fed from Bijwasan installation. Bhatinda, Salawas, Rewari, Jobner, Mathura & Kanpur are earmarked for launching in near future.**

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Transportation of biodiesel:

- Biodiesel must be transported in a way that does not lead to contamination. Following precautions are recommended –
- Ensure that trucks are fabricated of aluminum, carbon steel, or stainless steel.
- Ensure proper inspection or washout (washout certificate) before loading.
- Check for previous load carried and residual. Generally only diesel fuel or biodiesel is acceptable as a residual.
- Ensure that there is no residual water in the tank.
- Check that hoses and seals are clean and made from materials that are compatible.
- Biodiesel is challenging to transport in cold weather. Ensure that while transporting the fuel does not freeze.

Safety, Health, and Environmental Issues:

Biodiesel contains no hazardous materials and is generally regarded as safe. A number of studies have found that biodiesel biodegrades much more rapidly than conventional diesel. Users in environmentally sensitive areas such as wetlands, marine environments, and national parks have taken advantage of this property by replacing toxic petroleum diesel with biodiesel. The flash point of biodiesel is higher than 100C°, so it is considerably less dangerous as compared to Kerosene (flash point-38 C° to 72°C) and diesel flash point-52 C° to 96°C). However, biodiesel blends will have flash points intermediate to the two liquids.

Signs, Labels, and Stickers:

No placards or warning signs are required for the transport of pure biodiesel. However, biodiesel blends with diesel are required to be transported in conventional TLs with UN code.

Fire Safety Considerations:

Pure biodiesel can be extinguished with dry chemical, foam, halon, CO2, or water spray, although the water stream may splash the burning liquid and spread fire.

First Aid Measures:

EYES: Wash eyes with a heavy stream of water for at least 15 to 20 minutes. SKIN: Wash exposed areas of the body with soap and water.
INHALATION: Remove from area of exposure, seek medical attention if symptoms persist.
INGESTION: Give one or two glasses of water to drink. If gastrointestinal symptoms develop, consult medical personnel.
Accidental Release Measures Spill Clean-Up Procedures: Remove sources of ignition, contain spill to smallest area possible. Stop leak if possible. Small spills can be controlled with “absorbent materials”, sand, or dirt. Recover large spills for salvage or disposal. Wash hard surfaces with safety solvent or detergent to remove remaining oil film. Greasy nature will result in a slippery surface.

Way forward:

Introduction of biodiesel as a fuel in India is envisaged to offer benefits w.r.t. reduction in crude oil import. It is nontoxic, biodegradable and can be used as an excellent feedstock for production of biodegradable lubricants. Keeping in view of these benefits, MoPNG has introduced B5 blend in few select cities mainly due to non-availability of feedstocks in India. The non-availability is primarily ascribed availability of non-edible oils. Therefore, to derive maximum benefits from environment and reduce dependency on crude oil import, it is utmost important to develop genetically modified non-edible oil plant such as Jatropha, Karanja for improved oil yields. Furthermore, alternate feedstocks for biodiesel production need to be explored for long term economic viability and sustainability.

Our sincere thanks to Mr. Vivek Rathore, Manager on deputation to Biofuel cell, MoP&NG & Mr. Bharat Newalkar, Ch. Manager, R&D for their contribution on the subject article.