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Biodiesels – What are They?

By Ara Barsamian

Three distinct types of biodiesels form the bulk of what is available today:

- Fatty Acid Methyl Esters (FAME) or Fatty Acid Ethyl Esters (FAEE)
- Hydrogenated Biomass (Vegetable or Animal Fat) Oils Biodiesel
- Gasified Biomass Fischer-Tropsch Synthesized Biodiesel

Biodiesels are also categorized by “generations,” where FAME-type biodiesels are the 1st generation, while the hydrogenated biomass oil and Fischer-Tropsch diesels are part of the 2nd generation.

Fatty Acid Methyl Esters (FAME)

Today, FAME is defined as the only “official Biodiesel.” Its pure properties (B100) are specified in ASTM D6751 and EN14214. It is made by a trans-esterification process, similar to making soap: vegetable oil + sodium hydroxide + methanol = FAME + glycerin. In the USA, according to ASTM D975-09, FAME can be blended in petroleum-based diesel up to 5 vol%. The resulting B5 diesel does not need to be identified as containing biodiesel. In the EU, according to EN590-2009, FAME can be blended in petroleum-based diesel up to 7 vol%. The resulting B7 diesel needs to be identified as containing biodiesel. FAME generally has poor cold flow properties (i.e., Cloud, CFPP, Pour). So in general, the equipment (e.g., tanks, piping, pumps, and blender manifolds) must be heat traced. FAME has poor oxidation and stability properties. Therefore, it must generally be used within six months of when it was produced before possibly becoming rancid (i.e., “going bad”) and unusable! FAME in B5 or B7s has negligible GHG lifecycle emissions reduction, if any.

Hydrogenated Biomass (Vegetable or Animal Fat) Oils Biodiesel

This process hydrogenates biomass-origin (i.e., vegetable, wood byproducts, or animal fat) oil in a hydrotreater, possibly followed by isomerization of high paraffins to improve the cold flow properties. The resulting biodiesel is indistinguishable from the petroleum-based diesel. Thus, it can be blended in any amount (not limited to 5 or 7 vol%). Because it cannot be distinguished, there are no special specifications for it. Hydrogenated Biodiesel has very good GHG lifecycle emissions reduction. Several trade names for this type of biodiesel are NexBTL (Neste), Green Diesel (UOP, ENI, Topsoe), etc.

Upcoming Training Courses held in our NJ offices

- Course 1210, *Process Design for Process Plant Equipment* May 24-26, 2011
- Course 1302, *Relief System Design*, June 21-23, 2011

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Work Highlights

Materials Engineering

Performed a materials engineering audit of the atmospheric and vacuum pipestill units at a major refinery to determine actions required to permit the processing of increased amounts of High Acid Crude (HAC). The audit concluded that processing a higher TAN feed was practical and could best be accomplished by raising the feed TAN in small increments accompanied by selective use of corrosion inhibitor. Guidelines on feed TAN and inhibitor injection locations were provided.

Process, Operations & Safety

As part of an atmospheric relief mitigation effort, our client was considering the removal of some of the existing reactor pressure relief valves that currently provide over-pressure protection for the reactor vessel. Conducted a FCCU process engineering “cold-eyes” review of the design contingency cases that are currently being used to establish the reactor/fractionator relief loads for the design of a new flare system.

Gasified Biomass Fischer-Tropsch Synthesized Biodiesel

This type of biodiesel is produced using a two-step process:

- Step 1: Gasification of the biomass to produce Syngas
- Step 2: Use the Fischer-Tropsch Synthesis process to convert the Syngas to Fischer-Tropsch Biodiesel

This process has been used successfully for over 50 years by Sasol in South Africa, albeit with coal instead of biomass for Step 1.

Fischer-Tropsch Biodiesel properties are excellent. Like the Green/NexBTL diesel, it is indistinguishable from petroleum diesel, and thus can be blended in any amount into the petroleum-based diesel. It also has the lowest GHG carbon intensity from all biodiesels.

Comparing Biodiesel Capital Investment

FAME requires the least capital investment; green diesel is the next higher expense (hydrotreater, H₂ plant, maybe isomerization plant), and Fischer-Tropsch diesel is the most expensive (O₂ plants, gasifiers, Fischer-Tropsch reactors, etc.). Nevertheless, the advantages of 2nd generation biodiesels in terms of properties, blending, handling, and low carbon/GHG footprint suggests that the future belongs to them.

New ASTM Biodiesel-Related Standards

ASTM approved a new B6 to B20 FAME-type biodiesel blend specification using between 6 to 20 vol% B100 FAME. It is the ASTM D7467-09 standard. Note, however, that B6 to B20 blends must be used with engines specifically approved to work with it, and the tank farm equipment and blenders must be properly segregated against contamination. The B100 FAME specification update is described in ASTM D6751-09.

ASTM D975-09 (automotive diesel) has been updated to explicitly say that it can include up to 5 vol% FAME. ASTM D396 (marine and heating fuel oils) has been updated to explicitly say that it can include up to 5 vol% FAME. Note that all specifications mention 5 vol% (or 7 vol%) biodiesel, not 5.0 or 7.0. This means that you can blend 5.99 vol% biodiesel and still be compliant with B5 specifications!

Useful References Available Free on the Internet

The following are several references related to biodiesels that are available free on the Internet:

- US DOE "Biodiesel Handling and Use Guide" - available at <http://www.nrel.gov/vehiclesandfuels/npcf/pdfs/43672.pdf>

- US EPA "Guidance for Biodiesel Producers and Biodiesel Blenders/Users" - available at <http://epa.gov/otaq/renewablefuels/420b07019.pdf>
- US EPA "Renewable Fuel Standard: Notice of 2008 Requirement" - available at <http://www.epa.gov/fedrgstr/EPA-AIR/2008/February/Day-14/a679.pdf>
- US Code of Federal Regulations 40CFR80, covers gasoline and diesel - available at http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr80_01.html

About the Author

Ara Barsamian has over 35 years experience, covering gasoline blending and in-line blend certification, diesel/ULSD blending and in-line blend certification, renewable ethanol use in gasoline blending, use of biodiesel to stretch existing diesel supply, atomic vapor laser isotope separation (AVLIS) for uranium enrichment, nuclear stimulation of old crude and gas fields, energy policy drafts for presidential candidates, and comprehensive test ban treaty position papers for presidential candidates.

Please contact Jerry Lacatena (jlacatena@carmagen.com) if you'd like more information on Carmagen's expertise in this area.

Details of our upcoming Course #1302, *Relief System Design*, June 21-23, 2011 in our New Jersey offices:

WHO SHOULD ATTEND?

Individuals seeking the requirements for analyzing and specifying relief systems, require a detailed discussion of the design of relief systems, or manage and perform relief system analysis and require a comprehensive system to achieve consistency of approach.

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- Design Pressure and Temperature and Maximum Allowable Working Pressure
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- Determination of Relief Loads
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- Pressure Relief Device Selection
- Pressure Relief Device Sizing
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- Pressure Loss Calculations
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