Can a new technology be an alternative to biodiesel distillation when meeting more stringent quality standards?

Keeping it cool

One of the challenges of the widespread use of biodiesel blends is producing a fuel with characteristics suitable for use in modern vehicles and engines. Regulations governing engine exhaust emissions are becoming increasingly stringent.

Achieving the required level of compliance, and maintaining compliance in the longer term, requires that fuel specifications must also evolve. As fuel specifications change, biodiesel producers must update processes to meet the more stringent fuel quality standards while at the same time reduce costs, improve yields and increase margins.

The differences in chemical composition and structure between petroleum diesel and biodiesel result in several notable variations in the physical properties of the two fuels. Biodiesel is made from plant-derived oils and animal fats and particular attention is required to limit minor constituents because they have lower solubility in diesel. These components are partly determined by the feedstock used and partly by the quality of processing.

These constituents include saturated monoglycerides (partially converted fats and oils found within biodiesel) and naturally occurring polar compounds such as sterol glucosides. As the proportion of biodiesel in diesel fuel increases, so does the concentration of these compounds and they can crystalise and cause fuel filter plugging issues in cold weather.

Biodiesel blends made with ultra-low sulfur diesel with low aromatics have been shown to be more susceptible to this problem.

Fuel quality standards

Standards organisations set the minimum fuel quality requirements. The American Society for Testing and Materials (ASTM), in 2012, released a new specification under ASTM D6751 that created a new biodiesel grade named Biodiesel No.1 which is suitable for cold weather applications[1].

The new specification sets limits on the amount of monoglycerides allowable (<0.4 %) and sets stricter limits for the cold soak filter test. The new specifications are intended to limit the likelihood of fuel filter plugging issues.

Biodiesel produced from animal fats, used cooking oils and even soya, using traditional transesterification process technologies, can have difficulty meeting the new lower monoglyceride levels and may require costly distillation of the final product.

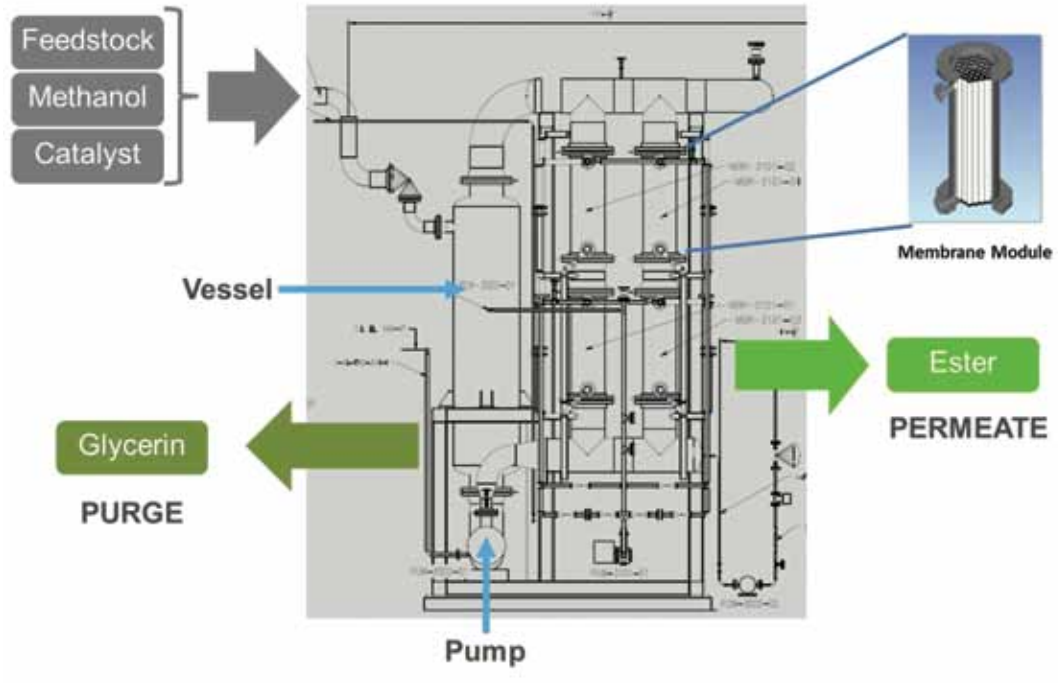
European and Canadian standards organisations have yet to set new lower MG level requirements for biodiesel. The Canadian General Standards Board is however expected to soon publish a new, more stringent, functional test method that evaluates the Cold Soak Filter Blocking Tendency (CSFBT) of B100 – aka potential for cold weather filter plugging in biodiesel diesel blends.

The CSFBT test quantifies the propensity of minor constituents to separate from a blend of biodiesel and an apolar isoparaffinic solvent after a cold soak cycle. It is particularly sensitive to levels of saturated monoglycerides and other polar compounds.

The test is currently being evaluated by other standards bodies and is starting to be used in commercial procurement specifications within North America. These commercial procurement specifications, some of which are stricter than the various established or contemplated standards, are a powerful market defining metric that most biodiesel producers should be aware of.

Biodiesel made from animal fats and soya may have difficulty meeting commercial procurement specifications, even though they meet the lower monoglyceride levels specified for Biodiesel No.1.

BDR membrane reactor schematic



Blueprint: a schematic of the BDR membrane reactor

High vacuum distillation of the final product is one solution to lowering monoglycerides and being CFSBT compliant. It is capital intensive, energy intensive and can significantly reduce overall yields, however. Canadian-based process technology company BDR Technologies believes it has a technology which represents an alternative to distillation.

Membrane technology

BDR's membrane reactor system uses a simultaneous reaction and membrane-based separation process. The reactor is compatible with conventional plant technologies and can be used as an add-on to retrofit existing plants. The technology can also leverage existing plant infrastructure to expand capacity and improve overall operations of the plant.

The reactor incorporates microporous ceramic membranes. These are arranged in modules in a reactor loop that contains a processing vessel and a pump. Oil feedstock, catalyst and methanol are continually fed into the reactor loop. The pump circulates the reaction mixture through the lumen of the membrane tubes.

The system maintains a stable emulsion – oil droplets in a polar mobile phase containing the methanol and fatty acid methyl ester (FAME). As the reaction mixture passes through the lumen of the membrane tubes, the mobile phase permeates through the membrane wall. The larger, more non-polar oil droplets remain in the membrane reactor available for further reaction. Glycerin is removed from the reactor via the purge.

The technology is unique in that the selective removal of FAME from the reactor shifts the equilibrium of the reaction towards the products, greatly improving conversion rates while at the same time lowering the amount of catalyst required. The higher conversion rate ensures lower mono-glycerides levels. The reactor can also selectively remove polar compounds such as sterol glucosides[2] during transesterification via the reactor's glycerin purge. In addition, the unit can also be configured to utilise lower cost free fatty acid (FFA) containing feedstocks (<5% FFA) without requiring pretreatment of FFAs.

The technology is currently in development and BDR is working on commercial deployment. Pilot testing has confirmed that biodiesel produced using multiple feedstocks can meet both the Biodiesel No.1 and CFSBT requirements without distillation. Tests have also shown it to be able to remove sterol glucosides efficiently with no impact on overall yields, so the final product is ultrafiltered and free of particulates. ●

References:

1 Biodiesel produced under the previous standard is now known as Biodiesel No. 2.

2 Sterol glucosides are often removed using a cold filtration step after wash washing. BDR's technology eliminates the need for this step.

For more information:

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