While the initial cost of lower grade biodiesel feedstock is less expensive, purifying the end product to meet relevant standards can cause a bit of a headache

Refining feedstock in the blink of an eye

Crude vegetable oils and animal fats, which are comprised mostly of triacylglycerols (TAGs), contain numerous impurities which negatively affect the quality and shelf life of oil and oil-derived biodiesel and must be removed.

The utilisation of low-grade, low-cost feedstock usually escalates the cost of both the transesterification step and the post-transesterification purification as producers struggle to comply with the current EPA regulations and/or other applicable national standards.

The impurity phospholipids (PLs), for example, are known to prevent phase separation following transesterification due to their emulsifying properties. Additionally, the excessive concentration of PLs in feedstock increases the consumption of ion-exchange resins in the downstream purification step and lowers the yield and the quality of the final product.

The more purification the feedstock or biodiesel needs, the more expensive the production process will be. When considering a technology solution, the cost of feedstock and the cost of its purification along with the biodiesel production cost should be compared to the cost of the production of biodiesel from non-purified feedstock. The most cost-effective business models also minimise the accumulation of waste and is ameliorates its environmental impact.

To reduce the downstream purification cost and expenses associated with transesterification, many biodiesel producers rely on the preliminary refining of TAG feedstock aimed at lowering the level of unwanted impurities and, therefore, both phosphorus and phytosterol concentrations in the final product.

Choosing the right method

When selecting the best suited method there are numerous approaches oil refining approaches available, depending on the feedstock properties and final product requirements. Conventional chemical refining includes degumming, neutralisation, washing, drying, bleaching, filtration and deodorisation. Traditional batch-type degumming and neutralisation require long-duration, high-shear agitation to sustain the large oil/water surface area and the elevated mass transfer rates. However, to achieve as large of a profit margin as possible, it is necessary to decrease time, energy consumption and oil loss.

With the cost of energy and human health concerns rising rapidly, biodiesel manufacturers are especially interested in cost-effective, expeditious, high-throughput methods that lower the levels of phosphorus and phytosterols in feedstock and allow the full recovery of highly valuable lecithin and residual concentrates.

Hydrodynamic cavitation

In 2013, process engineering company Desmet Ballestra installed flow-through hydrodynamic (HD) cavitation technology at a vegetable oil refinery in Argentina, supplied by Caviation Technologies (CTi) – a relatively new company founded in 2007 which designs and manufactures HD cavitation systems and develops processing technologies for use in the refining of vegetable oils and animal fats, renewable fuel production via transesterification and algal oil extraction, among other applications.

The new system at Desmet's plant is able to process 300 tonnes a day of oil and has reduced the amount of caustic required for neutralisation to the theoretical value, and the level of phosphorus in the refined oil became less than 10 ppm. The consumption of catalysts in the transesterification process is significantly decreased due to its reduced deactivation by impurities, while the quality of biodiesel produced from feedstock purified using the CTi Nano Neutralisation process was found to be superior to the quality of that produced from conventional feedstock. The biodiesel also has a lower cloud point and improved pour point properties. Importantly, Desmet is able to use lower grade, less expensive crude oil while still producing biodiesel of a high quality.

The technology is able to obtain refined TAG oil suitable for the production of haze-free biodiesel of ASTM quality. HD cavitation involves the formation of cavitation bubbles of volatile compounds within the mixture's flow, accelerated to a proper velocity. The bubbles expand and collapse, reaching regions of higher pressure. These implosions cause a localised rise in the pressure and temperature and intense shearing forces, resulting in heating, thorough mixing and the acceleration of rates of reactions and processes.

The process

Although extreme conditions can be disadvantageous, the outcome of an optimised treatment is beneficial. The method comprises feeding a mixture of oil and water or an aqueous solution of a suitable chemical reagent (sodium hydroxide, citric acid, phosphoric acid, EDTA, a phospholipase or other reagent) into the flow-through HD cavitation Nano Reactor: a compact, stainless steel unit which contains no moving parts and uses a preset inlet pressure of 800-1,200 psi sustained by a high-pressure pump.

The repeated formations and implosions of numerous cavitation micro- and nano bubbles provide vigorous mixing and a large water/oil interface, requiring only a small amount of reagent, and can be easily scaled up to accommodate high throughput. During HD cavitation-assisted processing, the impurities are efficiently transferred from the oil phase to the aqueous phase. The purified oil and gums are then separated via gravitational settling, static decantation, centrifugation, filtration, distillation, absorption or another procedure. The oil is refined in a simplified manner without employing an elevated temperature and pressure associated with conventional methods. The process is attractive to both small- and large-scale biodiesel producers and oil refiners.

As an add-on to existing neutralisation systems, the Nano Reactor has been found to increase yield, improve oil quality, cut the use of chemicals and reduce processing costs by applying the most suitable pump pressure and cutting energy consumption. The reactor can be placed at the oil production site, storage facility or biodiesel plant.

Today Desmet Ballestra markets the patent-pending Nano Neautralisation process and patented Nano Reactor to large-scale facilities worldwide. The two companies first entered into a partnership in 2010 and in September 2011 this was amended to become the 'Technology, License, Marketing and Collaboration Agreement'. CTi also has a 'Technology and Licensing Agreement' with AG- Westfalia Separator, part of the GEA Group. Under the agreement GEA Westfalia assembles the commercial system comprising the Nano Reactor to carry out trials and accelerate the development of promising applications. ●

For more information:
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