Ultrasonic Transesterification of Oil to Biodiesel

Ultrasonics is a very desirable tool for producing biodiesel from vegetable oil and animal fats, because it lowers the cost of processing, speeds up transesterification, does not require elevated temperatures, and produces a higher grade of biodiesel.

The longitudinal vibrations of the ultrasonic probe are transmitted into the liquid as ultrasonic waves consisting of alternate expansions and compressions. The pressure fluctuations give birth to microscopic bubbles (cavities) which expand during the negative pressure excursions, and implode violently during the positive excursions. As the bubbles collapse, millions of shock waves, eddies, and extremes in pressure and temperature are generated at the implosion sites. Although this phenomenon, known as cavitation, lasts but a few microseconds, and the amount of energy released by each bubble is minimal, the cumulative amount of energy generated is extremely high.

- With ultrasonics, the amount of catalyst required for the transesterification of oil to biodiesel is substantially reduced.

- Ultrasonic processing is fast, usually minutes, compared to one hour or more using conventional batch reactor systems.

- Time required for glycerin phase separation is greatly reduced - typically 1 to 2 hours.

- Biodiesel yield is typically around 95%.

- Ultrasonic processors generate non-inertial cavitation and have only one moving part.

TYPICAL PILOT APPLICATION

The catalyst usually consists of sodium hydroxide, potassium hydroxide, or methoxide and methanol alcohol. The base is added slowly to the alcohol, using a dosage pump and is stirred until it dissolves.

The vegetable oil is heated to 65C as it passes through a heat exchanger (a hot water boiler can be used to heat the oil) and fed to a mixing vessel via a centrifuge pump. To start the transesterification the catalyst is injected with a dosage pump into the mixing vessel. A diaphragm pump can be used for that purpose.

The temperature of the material going into the mixing vessel (usually a pipe or flow cell) is monitored and controlled at around 65C using a heating jacket. The pressure in the vessel is maintained at 25psi (150 KPa).

Compressed cooling air is fed to the ultrasonic converter, the Sonics & Materials Model VC 750/VCX 750 ultrasonic power supply is energized, the amplitude is set at 70%, and the material is circulated under the probe at the rate of 200 liters/hour. A pressure gauge monitors the pressure inside the processing chamber. A back-pressure valve located on the processing chamber discharge pipe regulates the pressure within the chamber.

The material coming out of the processing chamber is fed to a pressureless evaporation settling tank and allowed to rest for 1 ½ hours. Although not yet separated, the methyl ester and glycerol liquid have been transesterified. Any methanol vapors are fed back to the methanol tank. After the resting period, the lower layer, composed primarily of glycerin and other waste products is drained out of the bottom of the tank. The top layer consists of a mixture of biodiesel and alcohol. The excess alcohol can be distilled off, or extracted with water. The biodiesel at the top of the tank is drawn out or sent to another vessel for additional processing such as purification, washing or drying. If it is determined that additional processing is required, the biodiesel can be recirculated through the processing chamber.

Variables which might require adjustment include catalyst /oil ratio, temperature, pressure, flow rate and ultrasonic amplitude. A typical application consists of 100 liters of vegetable oil, 14 liters of methanol, and 700 grams of sodium, potassium hydroxide, or methoxide.

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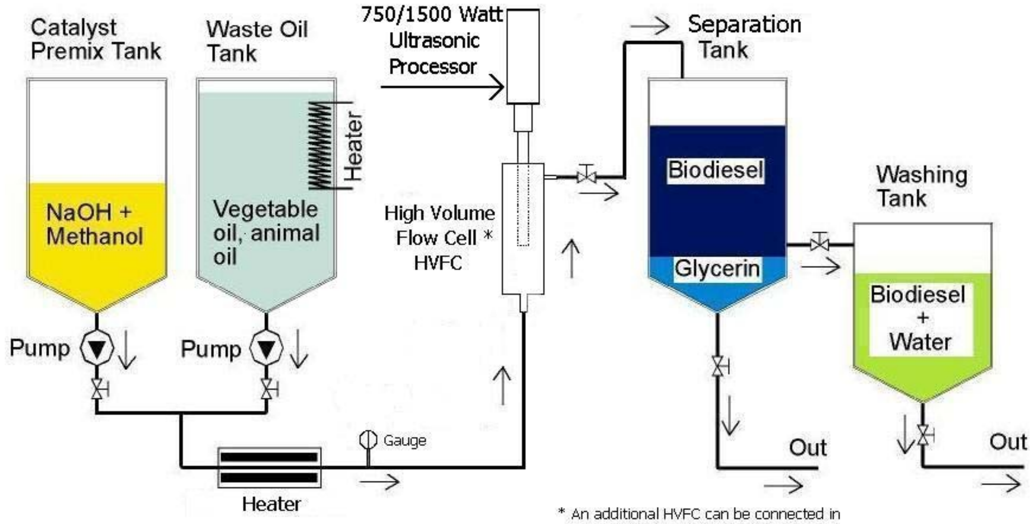
(In-line Processing Reactor)



Sonics & Materials schematic for BIODIESEL PROCESSING

* An additional HVFC can be connected in series for shorter processing time

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