Processing systems for biodiesel production

Turnkey processing lines for multi-feedstock applications

Two 24000 LPD processing lines installation

Application

Alfa Laval Ageratec biodiesel processing lines are complete turnkey systems for producing ASTM6751 or EN14214-compliant biodiesel on the basis of a wide range of oils, of either vegetable or animal origin.

These systems are in widespread use in the production of biodiesel to replace fossil-based diesel as fuel. This can be as blends i.e. B5, B20, etc. or fully as B100 for vehicles, machinery or generator sets. Operators of these systems span from seed farmers to companies that collect used cooking oil and from the owners of vehicle fleets to mainstream fuel manufacturers.

For a typical manufacturer of biodiesel, the costs of feedstock can easily represent as much as 80% of the overall production costs. Alfa Laval Ageratec systems, with their built-in front-end esterification process, guarantees freedom of choice tapping into alternative oils for maintaining a cost-effective approach that provides room for future market changes.

This means an Alfa Laval Ageratec system enables any biodiesel manufacturer to tap into a wide-ranging selection of oils and fats supply sources. These include soybean, rape seed/canola, sunflower, palm, jatropha, camelina, cotton, copra (coconut), algae, used cooking oil, yellow grease, beef tallow, poultry fat, pork fat, leather fat and fish, along with many other feedstocks of vegetable or animal origin, virgin or used.

Next after feedstock, the second-biggest item of expenditure in biodiesel production lies in the main chemical involved – methanol. Methanol normally accounts for as much as 50% of biodiesel plant operating costs (apart from the feedstock). Using Alfa Laval Ageratec systems, however, these costs are dramatically reduced by built-in equipment for methanol evaporation and recovery after each process step.

The big picture

Alfa Laval Ageratec systems are optimized to provide maximum return on investment (ROI) and the shortest possible payback time, in acknowledgement of the financial drivers behind every biodiesel production project. These drivers can include international. national and local factors such as legislation, the wholesale prices of fossil fuels and electricity, and the availability of suitable raw materials. Alfa Laval can provide ROI calculations based on each individual project situation.

The systems are easily scalable to ensure a close match to the specific needs of each particular business entity. Equipment configurations can be chosen so that a plant can start off on a small scale, and then expand as and when growing sales and feedstock availability generate sufficient cash flow.

Design

Alfa Laval Ageratec systems are intended for industrial-scale production of biodiesel with a throughput corresponding to 330 days of full-rate operation per year. All the component systems are pre-assembled on skids for prompt delivery and easy installation, followed by rapid, problem-free commissioning.

The core of these systems lies in three unique and highly innovative design features. The first is a front-end acid esterification for direct conversion of any free fatty acids (FFA) into methyl esters. This is a standard feature, rather than just an optional extra.

The second is the utilization of high-efficiency plate heat exchangers to recover heat from processed to unprocessed oil and for condensating evaporated recovery methanol, resulting in exceptional levels of energy efficiency and cost-effectiveness.

Thirdly, the production process includes a revolutionary, patented water-free washing of crude biodiesel in high-speed separators, ensuring plant logistics free from water and effluent. This avoids the conventional water wash and its associated consumption and effluent treatment requirements, and does away with conventional ion exchange dry-bed resin management, with its related problems of regeneration and replacement logistics.

Control and certification

To help ensure the required safety levels and quality requirements associated with fuel production, Alfa Laval Ageratec systems are ATEX certified and bear CE and PED marking. Other certifications are available on request.

Precise control of operating parameters provides reliable, consistent product treatment. The process is monitored and adjusted by sensors and actuators from a central automation cabinet equipped with a touch screen PLC (programmable logic controller). This control set-up provides 24/7 traceability as well as remote monitoring and supervision via Ethernet and the Internet, and SMS alarm messaging.

The systems are designed for stand-alone use as soon as they are connected to the necessary power and heat sources. The appropriate storage facilities for raw oil, chemicals and produced biodiesel are to be chosen to comply with local regulations and customer requirements.

The front-end process features a batch-type sequence that makes it easy to undertake changes in the feedstock being used. Most importantly, however, it permits effective management of the water removal involved in the esterification of degraded fats and oils with high FFA content. This set-up overcomes the downside of continuous processing technologies that only perform best when processing of virgin oils FFA <0.8%.

Effective purification

The patented ACA90 fluid is a consumable that is dosed in-line upstream of the high-speed centrifugal separator in the Alfa Laval Ageratec biodiesel washing circuit. ACA90 is slightly acidic in order to first neutralize the biodiesel. The liquid solution also contains an inorganic chelating agent that combines with impurities (such as traces of phospholipids) in the biodiesel to produce large, dense gum-like complexes that can be removed by a separator.

The amount of refining agent needed for the neutralizing effect is typically around 0.4–0.6% by weight. This is a mere fraction of what would be required with conventional wash technology.
The entire process is semi-automated. Operator involvement is normally limited to manual sampling and quality control procedures before and after transesterification and during the refining process, along with a final quality control carried out in the finished biodiesel storage tanks.

Working principle

Due to its esterification capabilities, the Alfa Laval Ageratec process can accept feedstocks with FFA levels of up to 10% m/m (19 mg KOH/g). Depending on the quality of the incoming raw material, the operator chooses to use either esterification with two-step transesterification or – if virgin oils or refined oil are being processed – only a two-step transesterification.

The operator can also choose to change the raw material to any available alternative that matches the Alfa Laval Ageratec raw material requirements, simply by changing the recipe.

Acid esterification

The feedstock is pumped from storage and pre-heated to a minimum of 70°C (158°F) by heat exchangers that use heat from an external source along with heat recovered from the previous batch to pre-heat the incoming raw material flow.

It then enters the acid esterification reactor tank, where vacuum evaporation is used to remove any residual water from the raw material. When the raw material has reached reaction temperature, methanol and a catalyst (sulphuric acid) are added. The contents are then mixed so that acid esterification can take place.

Once this reaction is complete, the contents are allowed to settle, resulting in a glycerol phase separating from the biodiesel. This phase consists of glycerol, catalyst, methanol, water and other impurities from the raw material. This phase is then pumped to a tank outside the system.

Alkaline transesterification

After the glycerol phase has been drained off, the still-unreacted raw material and the produced biodiesel phase are mixed together.

A representative sample is taken for the special analyses used to calculate the exact recipe for the two-step transesterification of each particular input.

When the appropriate values are entered into the PLC, the first step begins. Methanol is pumped into the reactor tank, along with an alkali catalyst consisting of a potassium or sodium methylate solution (depending on the feedstock). The subsequent two-step transesterification follows the same basic sequences as the previous esterification, until a deactivation agent is added to stop the reaction and to counter a reverse reaction when methanol is removed.

Washing process

After pumping the last glycerol phase out into a storage tank, the excess methanol is flash evaporated under vacuum. It is then condensed so that the methanol can be recovered and re-used. This results in big savings on methanol costs.

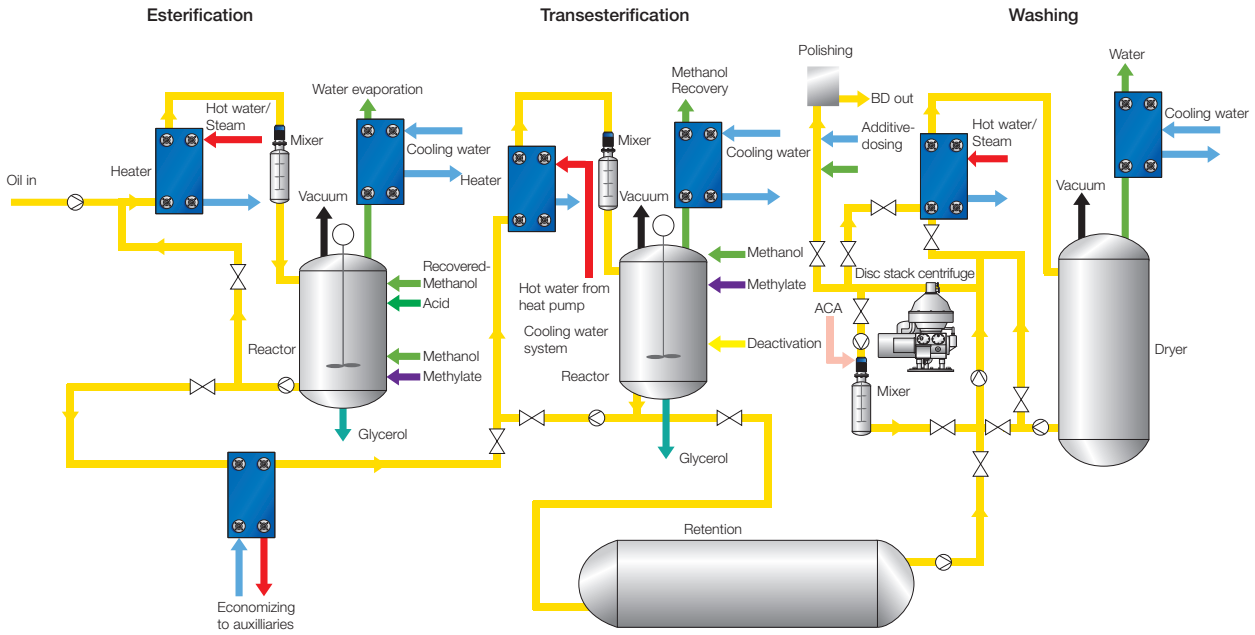
At this stage, there may be traces of ions such as potassium, sodium, magnesium, sulphur and calcium still present in the biodiesel. These originate from the oil seed or other impurities present, such as glycerol residue, sediments and other solids, or are a result of contamination during the process. All these impurities must be removed, along with any water that might still be present after the reaction. Prior to the washing, the crude biodiesel is therefore pumped to an external retention tank so that impurities settle out during the cooling period.

After settling, the biodiesel is passed through a high-speed separator. A cleaning agent is added to bond with the ions, and the biodiesel is then making a second HSS pass taking out the impurities as a heavy sludge phase. Finally, the washed biodiesel is sent for removal of any excess water generated in the neutralization phase evaporated by vacuum evaporation.

An anti-oxidation agent is normally added to improve the properties of the biodiesel. Winterizing agents can also be added to the final product.

Finally, the dried biodiesel is pumped to the biodiesel storage tank through a polishing filter.

Process flow depicting 8000 LPD processing line



Scope of supply

- Skid-mounted turnkey processing line
- Control cabinet with PLC and MCC
- Control room computer station
- Oil heating and evaporation capability
- Methanol recovery
- Auxiliary pumps
- Heat pump cooling system
- Additive dosing system
- Factory Acceptance Test (FAT)
- Training
- Commissioning
- Start up
- Engineering documentation
- Performance guarantee (EN14214 or ASTM6751)

Optional

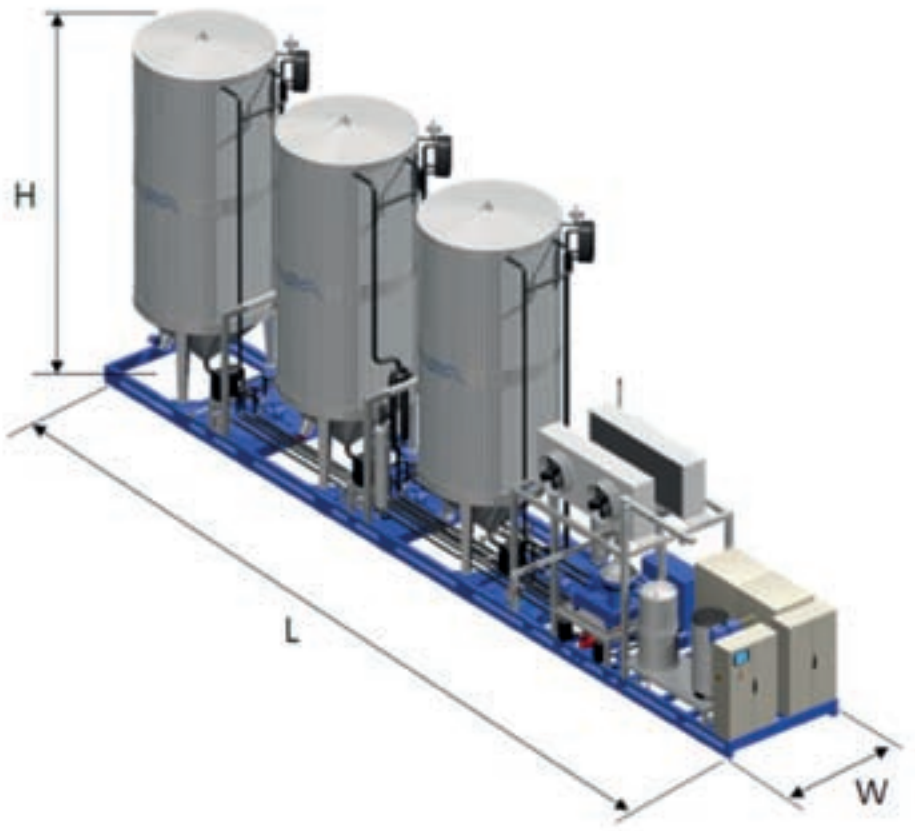
- Site engineering or civil works
- Installation
- Oil pretreatment
- Glycerol treatment
- Air compressor
- Boiler
- Settling tanks
- Storage tanks
- Laboratory

Technical Specifications

System unit model:		A1	A2	A3
Capacity*	LPD (US gallons)	3000 (792)	8000 (2113)	24000 (6340)
Thermal energy	kWh (HP)	8 (11)	22 (29.5)	64 (86)
Electrical	A (400V)	80	125	125+63
Dimension L	mm (inches)	9000 (354.3)	11500 (452.8)	15520 (611)
Dimension W	mm (inches)	2012 (79.2)	2232 (87.9)	2232 (87.9)
Dimension H	mm (inches)	4800 (188.9)	4800 (189)	6542 (257.6)

*Capacity based on raw material with maximum 500ppm water, feed temperature of 50°C (122°F) or minimum 5°C (41°F) above fat melting point, whichever greatest and within Alfa Laval Ageratec mandatory requirements (available on request).

Note: The dimensions mentioned are guidelines only.



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