

Increasingly stringent fuel specifications, such as a new cold soak test, demand high levels of filtration as new and widely varying sources of biofuels enter distribution channels, reports Brian Davis

# Effective biofuel filtration

In 1998, vehicle engine manufacturers embarked on an introduction of a Worldwide Fuel Charter in an attempt to set international fuel standards. As advanced and ultra-clean vehicle technologies are introduced, fuel quality will have to rise accordingly.

Philip Johnson, director of liquid filtration at worldwide provider Donaldson states: 'Cleanliness recommendations by some manufacturers of high pressure fuel injection systems have already indicated they need significantly cleaner fuels.'

Last updated in 2006, the typical level of ISO cleanliness required under the Worldwide Fuel Charter is 22/21/18 particle count, though many companies try to clean biodiesel to 14/13/11 in a single pass in accordance with ISO 4406.

However some engine manufacturers, like Bosch, are now calling for cleanliness in the range of 12/9/6 or better. This will be a highly demanding standard, requiring one thousand times reduction in particulate contamination. 'To get to these cleanliness levels will require high efficiency filtration and multiple filtration cycles,' says Johnson.

## Advantages of spin-on filters

Biofuel contamination can take many forms depending on the feedstock and



Source: Donaldson

Donaldson recommends using spin filters for bulk biofuel filtration

sources, from cold pressed seed and vegetable oils to waste oil and grease.

Contamination is created by clay, carbon and silica absorbents from refined oil, haze and sterols from methyl ester in biodiesel; filtration is also required of glycerine to remove solids or activated carbon; as well as filtration of waste oil, water extraction and dirt, rust or bacteria sludge removal.

Filtration is commonly set up for single or more commonly, multiple pass filtration. Reliance on single pass filtration is difficult to achieve, costly and often ineffective.

Donaldson has developed a wide range of custom filtration products.

However, Johnson recommends using spin-on filters for bulk filtration of biofuels. 'They are capable of handling large flow rates, exceeding 1000 gal/minute,

and are relatively inexpensive.' Cost per gallon of filtration is around \$0.01 (€0.007).

Typically a pressure vessel can be equipped with multiple spin-on cartridges mounted in parallel, offering a pressure advantage up to 300psi. Johnson claims maintenance is swift: 'Spin-on filters can be serviced in 10-15 minutes whereas large conventional filter pots can take two to three hours to service.'

Donaldson recently introduced a high efficiency single pass filter, and is also developing a new solution to prevent water contamination in diesel.

The first stage of most biofuel feedstock filtration is simply separation and settlement. The bulky contaminants are then skimmed off the top or removed from the bottom of the vessel. Donaldson also produces strainers to remove

bulky contaminants. But Johnson reckons: 'Strainers are a waste of time because they don't filter to the level required for fuel. You can't see below 40 microns with the human eye, but the type of fuel for diesel vehicles today requires sub-micron filtration.'

## Finishing and polishing

David Henry, product manager for biofuels and process at Schroeder Biofuels, makes the point that having a good and complete reaction for biodiesel production is not enough. The production residues and impurities left in the crude biodiesel after the reaction must be removed, whether using a wet wash or dry process for biodiesel purification.

Schroeder Biofuels is focused on finishing and polishing products for the post-reaction stage of biodiesel production. The company has introduced a dry wash system (replacing traditional use of resins like Magnesol for filtration) to pull out soaps, water, glycerine and other contaminants.

The system uses a series of filter towers containing a special media called Eco-2 Pure, which looks natural like woodchips and can be burnt. The filter media will handle most biodiesel feedstock, including poultry fat, beef tallow, yellow grease, white grease, waste vegetable oil and palm oil. Each kg of

Eco-2 Pure can handle 130-180 gal of crude biodiesel to ASTM and EN quality.

Henry suggests that the cost of filtration with this approach is about \$0.03 per gallon or lower with volume purchases. What is more, the resulting filtration media can be used as a fuel or mulched as a source of phosphate in the reaction process. Henry reckons the closest comparison to Eco-2 Pure is diatomaceous earth, which is used filtration in the food and wine sectors. Schroeder plans to introduce an upgraded cartridge version of the Eco-2 Pure product early in 2010.

The longest established method for biodiesel purification is wet washing. As water passes through the fuel, it attaches to impurities. Once settled, the contaminated

## Filtration in practice

**A Belgian** food producer was experiencing serious screen blockage problems when filtering rapeseed oil. The company decided to purchase a self-cleaning filter from UK-based separation specialists Russell Finex, and consequently increased productivity and improved product quality.

Biodiesel production is a multi-stage process. During the first stage of one method of fuel production, seeds or other raw materials are passed through a mill to release oil. The product is then transferred to a centrifuge, which removes seeds from the oil. Then a filter is used to remove fine particles. The oil at this stage is ready for transesterification, a process where it reacts with methanol to produce methyl ester (biodiesel). A small amount of glycerine is also produced, and during the final processing glycerine is separated from the biodiesel by gravity separation or centrifugal force.

The company originally used piston-cleaning systems and wedgewire screens

to remove small particles from the oil at stage 3 of the process. But there were severe problems with screen blockage, which meant regularly stopping production to manually clean the filters and replace parts. The old filters simply let too much foreign material pass through, such as stocks, debris and other large particles.

The new self-cleaning Russell eco filter ensures that the flow of material goes from the inside to the outside of the filter element.

The screen is then automatically cleaned using a rotating wiper inside the element, working on a continuous basis and ensuring consistent throughput rates, while preventing build up of differential pressure. Using the 600 micron Russell microscreen and high temperature resistant, polymer spiral wipers, particles are removed with density between 0.85 and 0.90 kg/l at 90°C, allowing the company to filter their rapeseed oil without continuous interruption of production for cleaning and parts replacement.

*‘Very few biodiesel products can pass the new standard with their current filtration products’*

**David Henry, product manager for biofuels and process, Schroeder Biofuels**

water is drained off. Once all the water is removed, the biodiesel is dried using a demosturising unit, such as Schroeder’s BD6000. Though this purification method works well, tightening environmental legislation makes it increasingly difficult to dispose of the highly contaminated water.

Crude biodiesel can also be purified by dry washing, using ion-exchange resins like Amberlite or Purolite, and silicates like magnesol or TriSyl. Specialty ion exchange resins can be used to remove trace impurities like ionic salts, trace catalysts, soaps and glycerine.

The efficiency of the resin to remove contamination depends on the efficiency

of bulk separation of the biodiesel and glycerine. The resin treatment is a polishing process which removes trace materials in the 275-750ppm range, but is not a replacement for efficient bulk separation. There are also concerns about the resin becoming blinded or disabled, so a bad batch of fuel passes through. Fine particles of contaminant can also pass downstream, which have to be removed by final polishing with a system like Schroeder’s BD6000 unit. Polishing will filter to a 3 micron level.

Schroeder Biofuels has also introduced ColdClear as the final process in filtration to meet the new ASTM D6751 standard for cold flow properties. During the

cold soak test, the fuel is chilled after filtration for 24 hours, then allowed to come up to room temperature, and tested for cold soak i.e. the time for 300ml of fuel to pass through a filter.

Under the new standard, which came into force on 1 October 2009, biodiesel which does not pass the cold soak test cannot be sold to market. ‘Very few biodiesel products can pass the new standard



Marksman filter elements combine the performance of cartridge filters with the ease-of-use bag filter systems

Source: Pall Corporation



Pressure leaf filters are expensive and US biodiesel companies are reluctant to invest in today's economic climate

with their current filtration products, but all biodiesel producers are now responsible for meeting the new ASTM standard,' Henry explains.

**Strainers, bag filters and vacuum dehydration**

Engineered Filtration Inc (EFI) produces a wide range of strainers, filters and vacuum dehydration equipment. Its most popular bag filters are housed in vessels fabricated of carbon steel, stainless steel or aluminium. Typically, several filter housings are placed in parallel on the particulate side, filtering from 25 micron down to 1 micron. 'These are extremely cost-effective, as bag filters cost less than \$8 per filter, and can handle everything from restaurant grease to rapeseed oil and palm oil feedstocks,' says Stephen Cook, VP of sales at EFI.

EFI also produces a self-cleaning filter, but as yet none have been sold into the biodiesel sector. 'However, we can provide

an automatic self-cleaning straining like Metaledge, which is suitable for the biodiesel market,' explains Cook.

'Most people come to us for water removal or methanol recovery. For this purpose we use a vacuum dehydrator, which removes water from the oil by lowering the boiling point under vacuum conditions, achieving moisture

Source: Pall

levels of 20-50ppm.'

EFI's Lakos centrifugal separator can remove large solids without the use of filter media or cones. Solids are then purged out of the bottom of the separator.

The company also deploys a pleated microglass particulate filter for final polishing of the fuel down to 3 micron.

**Coalescers**

Pall Filtration produces a comprehensive range of separation and filtration technology for use in biodiesel production. Doug DiLillo, industrial biotechnology leader at Pall Filtration, believes coalescer technology is the key to success in filtration of biodiesel, 'as high efficiency phase separation will remove contaminants that need to be filtered out'. The PhaseSep liquid/liquid coalescers are used to coalesce the glycerol/glycerine from methyl ester or remove water from biodiesel after washing. Pall's Marksman large capacity filter can be retrofitted into a bag filter housing, and is available down to 1 micron.

Pall is working with a number of biodiesel producers in Europe on final product filtration for removal of sterogluosides, a contaminant which comes

from soya-based and palm-based biodiesel, and other sources of feedstock.

The final product filter uses a depth medium with high solids handling capability and built-in filter aids. The filters are available in sheets as well as modules to fit in an enclosed filter housing. Evaluation is currently underway in France, Spain and Italy.

Pall also offers a self-cleaning horizontal pressure leaf filter, which features a permanent cleanable septum, for use with a filter aid such as resin, diatomaceous earth or cellulose. But DiLillo admits: 'these are expensive systems and US biodiesel companies have been reluctant to invest in this technology during the current economic climate'.

DiLillo does not consider cold soak test a major challenge for biodiesel producers. 'Many biodiesel producers can meet this requirement by having their process under control. Those who have difficulty meeting the cold soak standard can use various resins and sheet filter systems to pass the test.'

**Belt filters for cellulosic biofuels**

Finnish filter manufacturer Larox is focused on filtration



Horizontal vacuum belt filters offer multi-step processing on a single unit

Source: Larox

## Stricter standards prompt new technology

**New legislation** in Europe has just been introduced imposing stricter limits on pollutant emissions from light road vehicles. The Euro 5 standard came into force on September 1 2009 and the Euro 6 standard will come into force on 1 September 2014.

In the US, the new Tier 2 emission standards are due to be phased out and replaced by the stricter Phase 3A standards between 2010 and 2016. The Corporate Average Fuel Economy (CAFÉ) standards in the US are also due to jump considerably in 2011, and again in 2020 to bring them more in line with standards in the rest of the world.

To meet these new standards vehicle manufacturers have been actively improving engine control and fuel delivery hardware. Diesel fuel injection systems are being run at higher pressures and are using smaller injector nozzles than ever before.

In order to combat the buildup of harmful deposits on this equipment fuel must also be cleaner than ever, which requires increasingly sophisticated filtration equipment.

Traditional filtration was done using medium efficiency filters and filter/coalescers



that filtered out solid contaminants from the free water.

Now tighter, highly efficient cartridges are used, which are more effective at removing the finer particles. Detergents are also increasingly being added to prevent and clean up harmful deposits.

Unfortunately these detergents as well as biodiesel, when this is blended in, dramatically reduces the water removal efficiency of traditional filters/coalescers so they can no longer remove free water.

US-based Velcon Filters has created a new free water absorbing cartridge as an economical and effective way of removing dirt, silt, rust and water. The Aquacon cartridge is available in either 10 or 25 micron nominal filtration efficiency and incorporates a super-absorbent media that absorbs free water from the fuel.

The absorbed water is retained in the cartridge. As it reaches either its dirt or water holding capacity it provides a differential pressure signal and reduction of flow to alert the operator that it needs to be replaced.

The cartridge's pleated design helps provide an extended filtration and water absorbent area as well as life expectancy. ●

of second generation biofuels, which use lignocellulosic feedstock. The company offers a wide range of solid-liquid belt filter separation solutions for the isolation of lignin and other non-sugar convertible components from cellulose and hemi-cellulose components in the feedstock.

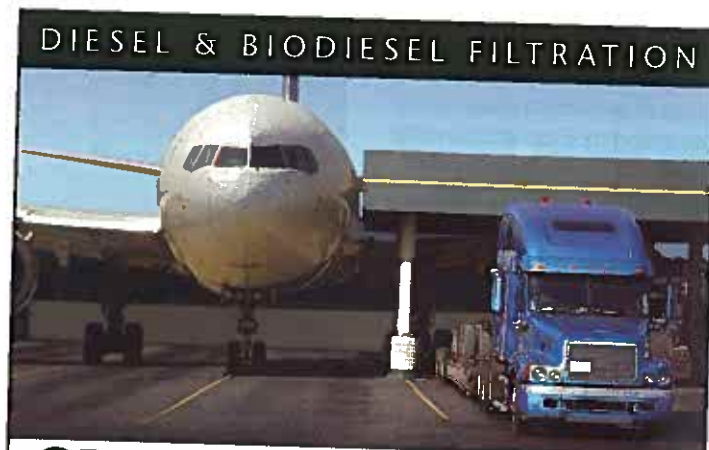
The Pannevis range is suitable for washing high flow rates, which are determined by the process and filter cake permeability. Pressure and vacuum filtration systems are available with open and fully enclosed options, and are mainly used in second generation biofuel plants in the US and Asia. 'The cost of our horizontal filters is competitive and new versions are continuously under development,' explains business manager Oskar Sieking.

Pannevis horizontal vacuum filters offer multi-step processing on a single unit. Steps include cake washing in either co-current

or counter-current modes, and advanced dewatering by cake compression, mechanical compression, hot air, infra-red or radiation. The Larox pressure filter (PF) units offer continuous operation on a 24/7 basis, with a wide choice of filter cloth and horizontal filtration areas from 2m<sup>2</sup> to 168m<sup>2</sup>.

Pannevis Gas Tight (GT) filters can process solvent-based product in a sealed housing while operating under a continuously re-circulated blanket of nitrogen or other inert gas. The latest C series filter is an automatic horizontal pressure filter, for dewatering and fine wash of difficult to dewater solids in high volume, producing high purity, dry filter cakes in a fully automatic mode.

Larox also offers Schiebeler polishing filters for removal and recovery of solids in low concentrations from process liquids, using adsorption filtration to cause micron and sub-micron particles to adhere to the filter media. ●



## Clean Enough to Fly!

You trust us for aviation, now Velcon also filters Diesel and Biodiesel to those same high standards. Get protection from engine damage caused by contaminated fuel.

For information visit our web site or contact your Velcon Representative.



VELCON FILTERS, LLC  
 COLORADO SPRINGS, CO, USA  
 (719) 531-5855 • FAX (719) 531-5690  
 WEB SITE: [www.velcon.com](http://www.velcon.com)

VELCON FILTERS - A NAME YOU CAN TRUST