In a time when banks have run out of money, people are using less fuel and the rush to get into the biofuels market has led to over capacity, what happens to the plant constructors?

Fighting for survival

By Phil Thane

There is no denying that high profile bankruptcies such as that of VeraSun in April have left their mark. Based in Sioux Falls, South Dakota, the company had 16 plants in eight US states and was building another.

One of the big losers in a situation like this is the specialists that design and construct these plants and the related technology.

As a result of the downturn in the economy many companies investing in plants have had to plan for reduced returns on their investment and some highly leveraged projects have been put on indefinite hold or even cancelled.

Mario Bernardini, MD of Italy's C.M. Bernardini, reports that the company had a contract cancelled in Malaysia earlier this year but that projects in Romania and Lithuania are going ahead on schedule.

And Moritz Gaede of AT Agrar-Technik (AT), Schlaitdorf near Stuttgart, Germany adds that the company has not lost contracts though they have agreed to slow down some projects delaying stage payments and completion dates.

These are the lucky ones. Earlier this year US-based biodiesel technology provider Greenline Industries filed for Chapter 7 bankruptcy following what it called a catastrophic slowdown in business and several setbacks due to litigation.

Source: C.M. Bernardini

The economy is stalling many projects across the globe

Quality and efficiency

After a very difficult first half of 2009 optimism does seem to be returning. In North and South America, as well as Europe, demand for fuel is picking up again and investors are looking at restarting closed or delayed plants, but are not rushing to repeat previous mistakes.

'Customers want a certain quality of plant and if there are no good ones available they will look to build,' says Derek Masterson from US-based plant specialist Crown Iron. 'Operators would rather build a new plant than pick up something that's not going to work.'

To increase profitability many technology providers are offering a more comprehensive service than they once would have done, including aspects such as design work.

Austrian engineering company Vogelbusch adoped this approach for its recently completed 120mgy corn-based ethanol plant for Tharaldson Ethanol in Casselton, North Dakota.

Vogelbusch has not had any of its contacts cancelled so far and the company remains optimistic.

This project is the biggest ethanol plant in the state and was designed to be as efficient as possible. The facility is located in an area with limited surface and ground water resources. In an effort to lessen the impact on these resources, the plant will use approximately one million gallons of treated wastewater from Fargo each day when operating at full capacity. About 400,000 gallons of partially treated water is then returned to the Fargo wastewater treatment plant each day, where it will be treated for discharge or return to the ethanol facility.

There are no easy contracts just waiting to be picked up, but companies that can provide a full package to deal with tricky issues like making ethanol in an area with a water shortage can win business.

Widening the net

Over-capacity in western Europe and the US has led technology providers to look

Source: Crown Iron

A close-up of the Crown Iron-built Petrobras biodiesel plant

Source: Vogelbusch

Fermentation vessels at the Tharaldson Ethanol plant built by Vogelbusch

elsewhere for new business.

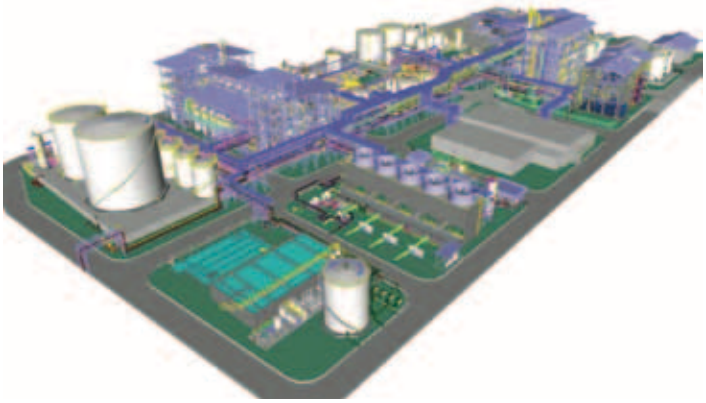
C.M. Bernardini is building a 25,000 tonne/year biodiesel plant in Lithuania and a 50,000 tonne plant in Romania. The Romanian plant is expected to be completed by mid-2010 and will process locally grown rapeseed. The Lithuanian plant is designed to process both rapeseed and animal fat and should be completed early next year. The company is also looking at contracts to build in Tunisia and Ghana.

AT-AgrarTechnik is also succeeding further afield with a recently completed plant for Thai Oleochemicals, built as a turnkey project by UHDE company (a subsidiary of ThyssenKrupp) now in operation. The plant is on target to produce 200,000 tonnes/year of biodiesel and 31,000 tonnes/year of refined glycerol making it the biggest biodiesel and glycerol plant in Asia.

AT is now working on new projects in Indonesia for PT IndoEnergy, Jakarta, in Canada for BFuel Canada Corp, Lethbridge, Alberta and in Kisangani, in the Republic of Congo.

AT has designed and engineered more than 30 plants worldwide since beginning of 1990s using modular designs that can be scaled from 30,000 to 500,000 tonnes a year. AT plants are designed to handle multiple feedstocks and achieve 99% conversion.

Like many other companies it offers the complete package from feedstock pre-treatment to finished biodiesel and use dry-wash techniques that minimise water use and minimise environmental impact. What gives the company the edge in many markets though is its patented process used for producing biodiesel and pharmaceutical grade glycerine.



Computer generated image of the AT Agrar-Technik design plant for Thai Oleochemicals

Diversification

Having a spread of product lines is enormously important when times are tough. CM Bernadini was originally a producer of machinery for edible oils which diversified very successfully into oleo chemicals and construction, then into biodiesel plant and glycerol refining.

Bernadini believes that as a medium sized company with other product lines his company is not suffering too much and thinks the situation is much worse for larger companies focused entirely on biofuels plants.

Vogelbusch has taken a slightly different route, offering its customers horizontal diversification into such products as starch, sweeteners and organic acids.

And although Crown Iron is best known for biodiesel plants, the company also makes extraction equipment that is used in ethanol production and other industries not related to biofuels.

This certainly helps plant constructors in difficult times but there is no one foolproof to surviving this downturn.

For one thing the global recession is patchy. It tends to be the most developed nations with the most sophisticated financial sectors that got themselves into most trouble. Less developed countries may not be rich but their unsophisticated bankers have done a better job of holding on to what they had.

Such countries were also left behind in the rush to build new plants, so often there is still money available to build efficient plants adaptable to foreign conditions and feedstocks.

There is no denying it is a tough world at present, but suppliers with compelling products offering a long-term technology partnership rather than seeking a quick buck are hanging on and look likely to make it through. ●

Useful contacts

AT Agrar-Technik	http://at-agrartechnik.de
C.M. Bernardini	www.cmbernardini.it
Crown Iron	www.crowniron.com
Vogelbusch	www.bioethanol.vogelbusch.com

Efficient separation of products resulting from any chemical or biological process is the key to maximising output and reducing waste. Methods such as settling and distilling are being replaced by newer techniques but are they worth the investment cost?

Advanced separation solutions

By Phil Thane

Biodiesel is made from a variety of feedstocks needing different treatment before transesterification can take place. Some oils, especially recycled oils from catering or grease from meat processing, may contain water or debris and both these are detrimental to the process. Simple settling will remove many impurities but it takes time and in a large plant the volume of oil and the time it takes represents a huge investment in stock and storage capacity, so many companies are opting to use centrifuges to pre-treat their feedstocks.

Spanish Bionor in Berantevilla produces 30,000 tonnes of biodiesel a year using used oil from Spain's catering trade. The main challenge at the plant has been to achieve acceptable biodiesel quality from the used cooking oil – a raw material that changes characteristics from day to day.

Sweden-based Alfa Laval has been a preferred supplier to Bionor since 2003, originally supplying heat exchangers but more recently supplying centrifuges for feedstock pre-treatment, glycerol separation and waste water treatment.

Germany-based separation technology provider GEA Westfalia is also very active in this area and has developed systems that de-gum and winterise oils containing waxes by alcohol neutralisation. In this refining method, a glycerol/methanol/alkaline mixture from the post transesterification separation is fed back to assist with de-waxing.

A small Westfalia disc centrifuge for biodiesel, supplied by Kyte Centrifuge

Transesterification proceeds best when there is an excess of methanol compared to glycerol in the reactor, so many plants use two reactors with a separation stage between them to remove some of the glycerol generated in the first reactor so speeding the reaction in the second. This separation may be done by settling or by centrifuging. Following the second reactor another separation stage is required.

Many plants that were initially built using settling are moving to centrifuge systems as they seek to increase production. There are plenty of centrifuge manufacturers to choose from; Pall Corporation and US Centrifuge in addition to Alfa-Laval and Westfalia are well known. And Kyte Centrifuge, which has supplied 200 reconditioned centrifuges into the biodiesel market in recent years, is the largest supplier to the US biodiesel market.

Following glycerol separation, biodiesel is either washed with water, or treated with products such as Magnesol to reach the desired purity. In either case another centrifuge is used to remove the water or Magnesol.

Many producers purify their glycerol output to obtain the best price for it a centrifuge is also traditionally used here but Pall's PhaseSep liquid/liquid coalescer can be used to provide an efficient separation of the organic phase, often producing water white crude glycerol and improving efficiency of the downstream purification steps.

Separation in ethanol production

Ethanol can be prepared by fermenting many different grains, fruits, syrups and so on, and the feedstock determines the processes used.

Where grain is mashed and fermented and distilled in a beer column the distillers' grains are separated from the stillage using a decanter designed to produce a clear liquid ready for the rectification column, and the driest possible grain.

Where sugar syrup and/

or molasses residue from sugar production is used, as in Brazil, the fermented broth has a considerable quantity of the microorganisms that are removed by centrifuging and sent back into the fermentation vessel before the liquid is distilled.

Following fermentation the broth or beer contains only a few percent of ethanol. It is usually raised to around 95% by distilling then further improved by passing through molecular sieve units (MSU) to remove most of the remaining water.

Distilling is usually carried out in two stages: primary distillation, carried out in a beer column; and rectification, and is an energy intensive process.

Explaining the technology

Settling: Many mixtures will separate quite quickly and cleanly under gravity, including biodiesel (FAME) and glycerol. The separation happens best when there are two phases with low levels of impurities, and with clean dry, feedstocks and well controlled reactors a couple of hours is sufficient.

A Westfalia RSE300 disk separator for biodiesel use

Centrifuges: Simple centrifuges are used in batch production to remove solids from liquids. They are loaded, spun, and then the liquid drained and the sold matter scraped off the sides of the vessel.

US Centrifuge manufactures a semi-batch self-cleaning centrifuge, in which a spinning bowl acts as a filter. Liquids pass through it but solids accumulate inside. The machine stops processing to periodically clean out accumulated solids.

For continuous production there are essentially two forms: decanters to remove solids from liquids and separators to separate liquids. To confuse matters some separators can remove solids and separate two liquids at the same time.

Decanters: Decanters are horizontal drums with a screw-like auger inside which rotates at a different speed to the drum. In operation the liquid/solid mix enters the decanter near the middle, the solids settle against the wall of the drum and are scraped towards one end by the action of the auger where they are ejected. Liquids are free to flow past the auger and are continuously drained from the other end. The relative speeds of the drum and auger are controlled to deal with differing amounts of solid in the oil.

Separators: Separators usually contain a stack of rotating conical discs sometimes with blades or guides fitted to each. Internal arrangements vary but in principle the mixed liquid is fed into the lower disc somewhere between the centre and the edge, the heavier component migrates outwards and the lighter inwards before being passed upwards to the next disc to improve the separation. Where the percentages of components in the mix vary it is useful if the feed-in point can be moved. The separated products are drawn off at the top of the machine.

Where separators are used to remove solids there has to be provision for removing the solid from the walls of the vessel. In self-opening separators the bottom of the vessel is moved downwards periodically allowing sludge to emerge through slots in the vessel sides. Where the proportion of solids is more than 5-6% the vessel would fill rapidly and the separator spend more time opening and closing than functioning.

The nozzle-type centrifuge such as the Westfalia HDE 200 used to clarify Brazilian ethanol broth has tangential nozzles in the bowl wall allowing the sludge to be extracted continuously.

Source: Crown Iron

Note the horizontal cylindrical vessel in the right middle. This is Decanter #1. The end head of Decanter #2 is just visible behind it and a little to the right

Filtration technology

Filtration is used wherever particulate matter needs to be removed, either to meet final product specifications or to facilitate the following stage. Replaceable cartridge filters such as those supplied by

Pall Corporation are the norm and can be used to remove particles from 0.1 down to 150 microns. An alternative is the bag filter such as those produced by Eaton Filtration.

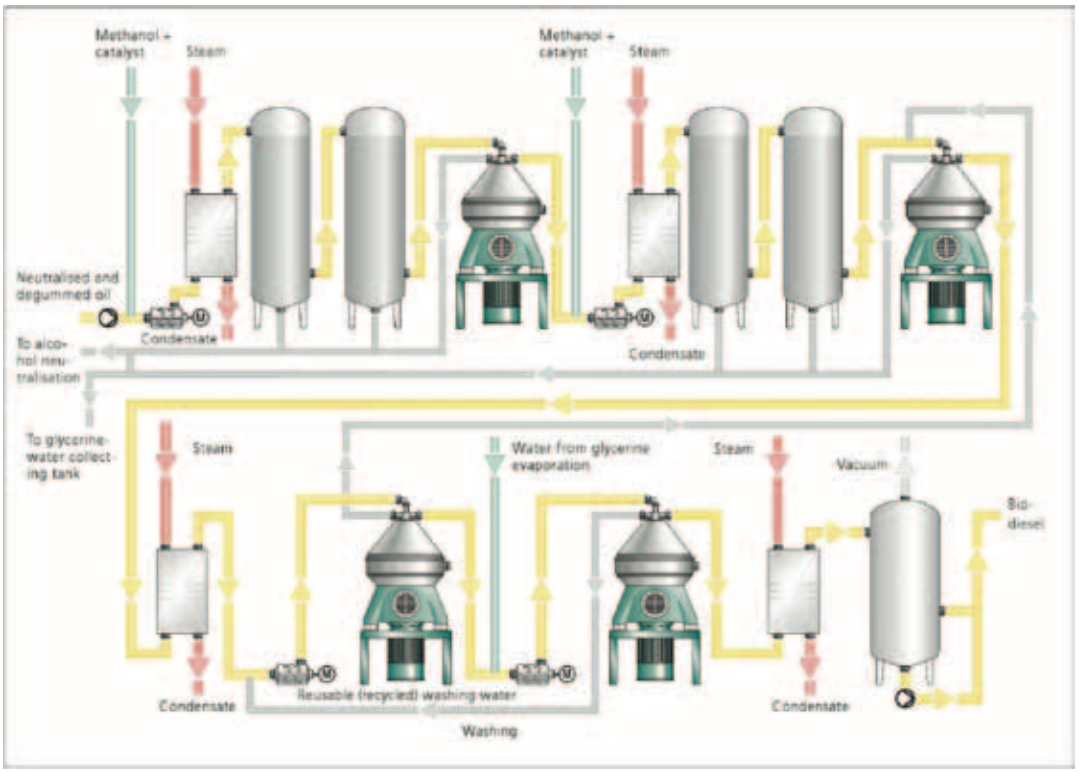
Coalescers: Separating liquids by settling takes place in two stages. The majority of the liquids separate quickly but there remains a small percentage of each product in the form of a mist of tiny droplets suspended in the other product. These droplets are so small that the force of gravity struggles to overcome the viscosity of the liquid and they remain suspended for a very long time. A coalescence device aggregates these droplets into larger drops that will separate more easily.

A device such as Pall's PhaseSep system resembles a filter with many layers each with progressively larger pores. At each stage droplets attach to the medium until sufficient have accumulated to form a larger drop that drifts off onto the next layer. The product leaving the coalescer contains large drops that may be separated by settling.

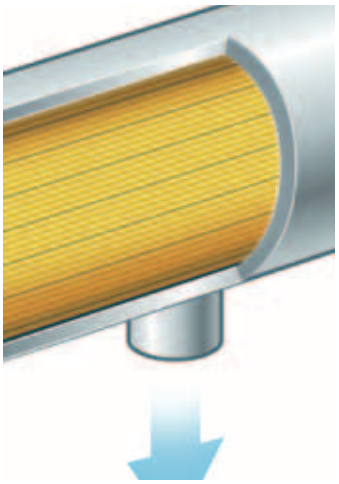
Molecular sieves: Ethanol forms an azeotropic mixture with water at 95% ethanol, 5% water. Even the best distillation columns cannot get rid of the last 5% of water unless a costly solvent such as cyclohexane is used to break the azeotrope.

To produce anhydrous ethanol as required by most fuels specifications molecular sieves are used. Invented by UOP in the 1950s MSU can be tailored to meet a wide range of chemical separation needs. The sieve consists of a column packed with beads designed to adsorb water onto their surface. Typically two columns are used alternately, one in use the other undergoing regeneration by washing with ethanol under a vacuum.

Membranes: Filtering works at the level of catching particles too big to pass through the filter, membrane technology operates at a molecular level.



Schematic of a Westfalia centrifuge equipped biodiesel production plant



Schematic drawing of a Vaperma Siftek module

Canada-based technology provider Vaperma is pioneering a new approach using hollow fibre membranes to replace rectification and MSUs. The Siftek system uses microscopic hollow fibres made of a hydrophilic polymer packed into a container. An ethanol/water vapour flows into the fibres, but only water can pass through the walls of fibres, the ethanol flows straight through. Some pressure is needed to draw the water through the membranes and this is provided by applying a vacuum to the water-rich permeate stream.

Membranes like this can only work on vapours not liquids but even so the energy savings compared with distillation are considerable.

After building two demonstration plants at home in Canada (Greenfield Ethanol plants in Tiverton, Ontario, 2006 and Chatham, Ontario in 2008) Vaperma's third demonstration unit was built in Brazil in partnership with Dedini. The plant has two membrane stages and has been designed to be flexible enough to process three types of feed: 45% (by weight) ethanol from a beer column, 93 wt% from a rectification column, and 85 wt% from the molecular sieve recycle

The industrial performance tests of these different options were carried out at Costa Pinto Sugar Mill in Piracicaba in 2008 and São Martinho Sugar Mill in Pradópolis during 2009 and results are encouraging.

Which to choose?

In many cases there is only one reasonable choice of technology for a given separation stage. The choice is simply between suppliers offering minor variations on well tried and tested themes.

As the industry matures and plants get bigger, settling is giving way to centrifuges in biodiesel production. Whether membrane technology will supplement or even replace rectification and MSUs in large scale ethanol production it is too early to say, but the energy savings make it a tempting prospect. ●

Links

Alfa-Laval	www.alfalaval.com
CrownIron	www.crowniron.com
Bionor	www.bionor.es
Dedini	www.codistil.com.br
Kyte Centrifuge	www.kcentrifuge.com
Pall Corporation	www.pall.com
UOP (Molecular Sieves)	www.uop.com
US Centrifuge	www.uscentrifuge.com
Vaperma	www.vaperma.com
Westfalia	www.westfalia-separator.com