CHEMICAL TECHNOLOGY

FEBRUARY 2015

FEATURES

- Waste management
- Separation and filtration
- Plant maintenance, health, safety and quality
- Renewables

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Overtaken by time:
The time for change was yesterday

I have, for many years, harboured some inexplicable faith in time. I have always known that it is an ingredient in almost every change, be it positive or negative. However, in this 'Comment', I want to share something rather more remote from the obvious. To some extent I have lamented about the issue I seek to raise, albeit in a softer tone. I have decided to adopt a harder tone this time round. Who knows, it might just strike the right chord.

This world has changed drastically in the last 20 years. Issues on scarcity of resources have never been more pronounced. Water, energy and even food have taken the centre stage as threatened resources. As it is, South Africa is going through what I would appropriately call the dark phase, due to lack of reliable electricity supply. A plethora of possible solutions to this situation have been proposed, ranging from independent power suppliers or producers, to embracing nuclear energy as a sizeable part of our energy mix.

There have also been suggestions of possible shale gas explorations, so called hydraulic fracturing, even at government level. If my memory serves me well, it was only about six years ago when we experienced the same frequency of blackouts. Whatever the reasons provided, the reality is that the supply is outstripping demand. But why would any living nation suffer the same consequences from the same fate, particularly where every other serious nation has found sustainable solutions? Isn't this characteristic of a nation blind to change? Water has clearly proven that its abundance is nothing less than an illusion. Many places in this country are suffering droughts such as have never been experienced in recent times. Extreme levels of poverty are also disconcerting.

What all this means is that the world is a dynamic place and South Africa is no exception. The difference, though, is that elsewhere around the world this dynamism is understood and people adjust and adapt accordingly. In South Africa, on the other hand, it is the direct opposite.

Having said so, it would be utterly naïve to expect that every person in this country should have solutions to our current problems. However, our engineers, regardless of discipline, should. The progress or regress of any nation is characteristic of the calibre of its engineers. Is this not the time we should be asking ourselves if our engineers still have the capacity to provide solutions? The answer to this question is very obvious, but so unpalatable that I choose not to mention it.

We could go a bit further and ask another question: are the institutions that are meant to be producing these engineers still relevant to the world we find ourselves in? Again, I would rather not answer this question. As I write this 'Comment', I am visiting a few universities in the USA, which have recently completed a government-funded project to review engineering curricula across all disciplines in order to render them relevant to the needs of today. The results have been remarkable, with almost all disciplines undergoing serious revamp.

This exercise should be natural in any environment where people understand that the world is changing. We should also remember that any university is only relevant insofar as it continues to produce graduates that serve to advance the lives of the communities they are meant to serve. This is even more so in engineering. Any deviation from this fundamental fact, suggests otherwise about the university. I have a feeling that, before we know it, we will be producing engineers who are fit for extinction. Our university programmes should be relevant to the real problems of today and tomorrow. The time for change was yesterday!

The superior

filtration offering

The Bearing Man Group (BMG) has a reputation for the supply of reliable, cost-effective and 'state-of-the-art' technologies, engineered solutions and products across a broad spectrum of industries. With their recent and previously announced acquisition of the OMSA Group and their strategic partnership with the motion and control specialists, Parker Hannifin, BMG can offer superior filtration and lubrication solutions and systems that have the full BMG technical and after sales support via their mobile field services support technicians.

Managing Director for BMG Engineering, Gavin Pelser said: "The addition of these two well-known brands to our stable fitted perfectly with our seamless technical offerings, which service a wide range of industrial sectors, but have a particular role to play in filtration activities associated with the mining, petrochemical and fluid technology industries.

"A positive element of the BMG/Parker Hannifin agreement is that BMG's bulk fuel filtration systems can offer an extended range of products and turnkey solutions, meeting customers' individual requirements. This dual understanding of filtration processes ensures plant efficiencies are attained and plant reliability is enhanced making the BMG offering unique in this field," continued Pelser.

"The need for solutions that prevent dirt ingress during the transportation and storage of bulk fluids is critical. Our filtration offerings are designed to improve uptime and reduce the maintenance costs which are associated with filtered oil and fuel as well as the delivery of bulk fluids to site.

"Contaminated fuel and lubricants can cause additional unforeseen costs to a company's maintenance budget, particularly when equipment failures have occurred outside of the scheduled maintenance periods," added Philip Craig of BMG's Fluid Technology Filtration Division.

Bulk fuel filtration

BMG's Fluid Technology Division offers bulk fuel filtration and associated engineered systems which include offloading/receiving, transfer, kidney looping and dispensing filtration pumping systems.

These filtration systems offer two main benefits: they result in a reduction of operational and maintenance costs, as well as an increase in production efficiency. This translates into an increase in the plant availability to maximise the return on investment. BMG's products and solutions for mining applications include, but are not limited to: particulate removal filters; water coalescing and separation filters; online and offline condition monitoring; and on site vendor-managed inventories.

BMG offers quality products for bulk fuel filtration from the design and commissioning of diesel/oil lubrication systems; in-line diesel and oil conditioning monitoring; as well as filtration training, all of which is backed up with installation, maintenance manuals and procedures for various system applications.

Industrial hydraulic filtration

BMG supports top filtration brands in Parker, Mahle, Eaton-Vickers and OMT in consolidating quality filtration products, by manufacturing process filtration, air and gas filtration and separation, hydraulic and lubrication filtration, fluid power products and fluid condition monitoring equipment, into one broad-based range that covers many markets and most applications.

BMG offers high, medium and low pressure filters as well as engine fuel, oil and air filtration solutions. Technologies cover areas of expertise such as electromechanical, hydraulic and pneumatic, fluid and gas handling, sealing, climate control and aerospace.

Automotive /heavy mobile machinery

BMG's alliance with Cummins Filtration enables the group to

offer the globally recognised Fleetguard® brand of filtration, coolant and chemical products. The Fleetguard® range is used extensively throughout a wide range of engine application sectors, which include: on-highway heavy/medium duty truck/bus; open pit and underground mining; power generation, oil and gas, to name a few.

Mining

Today's electronically controlled diesel engines utilise the latest high pressure common rail systems that require pressures up to 30 000 psi with injection nozzle sizes down to 6 microns. Given the mining environment, meeting downstream ISO 4406 cleanliness standards for bulk fuel storage, dispensing and during transfer, can be challenging. BMG offers the filtration and process fuel monitoring technology that extends equipment uptime and assures clean dry fuel.

BMG filtration solutions are also used on all oil lubrication systems, manufactured in-house, installed at Jaw. Cone crushers as well as Sag/Ball mills, large gearboxes, which require clean oil to increase bearing life and extend plant availability. BMG also offers mobile filter systems, also known as off-line or '+kidney systems' and can be connected to various items of equipment which do not have their own filtration system.

Power generation

Diesel-powered plants require large fuel storage reservoirs and tank farms that must be available on demand. Fuel monitoring products can help ensure that fuel is monitored for contaminants. Filtration and separation products are used to remove particulate and water and to ensure that fuel quality meets engine ISO cleanliness standards in order to assure reliability.

Technical support and field services

The BMG Group has over 120 branches country-wide, making it Africa's leading supplier of engineered solutions and products. Other product ranges such as bearings, seals, components, electric motors and gearboxes, amongst others, are also available. Through the group's Field Services on-site support it can offer the assembly of critical plant, preventative maintenance assistance and vibration analysis and oil sampling.

Commented Pelser: "We believe that our technical support services, no matter where you are located, are a key element to the overall success of our operations – this is a service which we are proud to offer."

For further information contact: filtration@bmgworld.net or call +27 11 793 5562.

Life Cycle Assessment (LCA) of biodiesel

by T Sebitso, M Kharidzha and KG Harding, all of the School of Chemical and Metallurgical Engineering, University of the Witwatersrand, Johannesburg, South Africa

Although biodiesel is seen as an eco-friendly alternative to fossil fuels, the processing methods can vary its environmental impact.

Biodiesel may be defined as a monoalkyl ester of long chain fatty acids derived from a renewable lipid feedstock, such as vegetable oil or animal fat (Basheer *et al*, 2012). Biodiesel production has received considerable interest in the recent years as an alternative to the diesel produced from fossil fuels. This is because not only is biodiesel biodegradable and non-toxic, it also has a higher flash point (about 423 K) making it less volatile, safe to handle and to transport (Morais *et al*, 2010). It is compatible with currently existing technology of diesel production, eliminating the need to reconstruct and redesign equipment. Biodiesel has lower carbon monoxide, NO_x, SO_x and particulates emissions as compared to conventional diesel. Carbon dioxide emissions are not considered important because they can be absorbed by terrestrial plants through photosynthesis provided the highly productive ecosystems are not replaced by the less photosynthetically active biodiesel crop (Kiwjaroun *et al*, 2008).

Biodiesel, however, has its disadvantages: its production rate accounts for only 15 % of the transportation demands. The reason why the conventional diesel cannot be replaced completely by biodiesel is because its production competes with the food crop; the only solution is to use more land for biodiesel agriculture which leads to high costs. The costs of vegetable oil can be up to 75 % of the whole process and thus leading to the biodiesel process being 1,5 times more expensive than conventional diesel (Morais *et al*, 2010).

Biodiesel utilises various feed-stocks, including waste cooking oil, clean vegetable oil and animal fat. The advantage of using waste cooking oil is that it serves as a waste treatment process, thus solving waste disposal problems. Waste cooking oil also leads to the reduction in the production costs as compared to the vegetable oil.

The trans-esterification process is used in the production of biodiesel. It involves a catalysed chemical reaction with oil or fat (triglyceride) and alcohol as reactant. The reaction products are biodiesel and glycerol.

Life Cycle Assessment (LCA)

A Life Cycle Assessment is a tool that is used to determine or assess the impact of a product or a process on the environment. It evaluates the use of energy and raw material consumption, wastes and emissions of a product's life cycle (Navigant Consulting, Inc, 2012).

An LCA assesses a material or a product from 'cradle to grave', meaning that a material is assessed from the moment raw materials are extracted from the environment, its production, use, to the time the material is returned to earth as waste (SAIC, 2006). An LCA is used to evaluate the amount of energy, raw materials consumed, emissions to the atmosphere as well as the amount of waste generated during a product's entire life cycle (Navigant Consulting, Inc, 2012). Showing the environmental impacts of a product's life cycle using an LCA is helpful to decision makers when choosing the most feasible process or when making improvements. An LCA is carried out using a method that has four stages which

are: goal and scope, inventory analysis, impact assessment and interpretation.

Energy production from fossil fuels has higher greenhouse emissions that lead to global warming; the high demand of energy has led to renewable energy development. Biodiesel falls under renewable energy and has low environmental impacts as compared to the energy from the fossil fuels (Varanda *et al*, 2011).

The environmental impact of a product is considered important because it degrades to the earth and its species. Life Cycle Assessments (LCAs) are being used to determine the impact of biodiesel on the environment so that the impacts can be reduced by making improvements in their life cycle where necessary or by choosing a more environmentally friendly process.Making biodiesel from used cooking oil is considered as a way of reducing greenhouse emissions which benefits the environment and also shows sustainability through waste conversion to renewable energy (Basheer *et al*, 2012).

Problem statements and research questions

It is desired to perform a Life Cycle Assessment (LCA) on different biodiesel production processes in order to determine which one has fewer environmental impacts. Due to the escalating global warming issue, processes that have lower environmental impacts are getting attention from various industries. An LCA assists in deciding which process is feasible from an environmental perspective and which to rule out. The LCA will be performed by conducting lab scale experiments in order to find the required input and output for each biodiesel production process using SimaPro 7.3.3 as an analysis tool.

The following questions will be answered:

- What is the LCA score of a biodiesel production process using different catalysts, ie, KOH and NaOH and alcohols, methanol and ethanol?
- From the LCA scores which process is more favourable from an environmental point of view?

This article aims to produce different biodiesel samples and to compare the LCA of the different processes. Various biodiesel experiments using different alcohols and catalyst were performed. The input and output data from the lab scale experiment will be used as input to the LCA software, SimaPro 7.3.3 to quantify the environmental impact of each process. The LCA scores will then be used to determine which biodiesel production process has the lowest environmental impact.

Experimental procedure

Biodiesel production method

Oil filtration

Waste cooking oil that was used for frying food was collected from the dining hall (Matrix, University of the Witwatersrand).

- Food chunks in the oil were allowed to settle for a day.
- A sieve was used to filter out the small particles remaining

Experiment	Temperature	Catalyst	Alcohol	Alcohol volume (ml)	Pressure (atm)
1	65	KOH	Ethanol	160	1
2	55	KOH	Methanol	80	1
3	65	KOH	Methanol	200	1
4	60	KOH	Ethanol	200	1
5	60	NaOH	Methanol	200	1
6	60	KOH	Methanol	160	1

Table 1: Conditions used to carry out the experiments.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5	Experiment 6
Products						
Biodiesel (ml)	250	280	310	340	320	300
Glycerol (ml)	200	180	152	195	150	160
Feed						
Waste cooking oil (ml)	400	400	400	400	400	400
Methanol (ml)		80	200		200	160
Ethanol (ml)	160			200		
NaOH (g)					3.4	
KOH (g)	9.26	9.26	9.196	9.26		9.26
Water (ml)	2000	1580	3000	1200	640	1090
Electricity (kWh)	0.5	0.5	0.417	0.458	0.417	0.708
Waste						
Wash water (ml)	2000	1580	3000	1200	640	790
Catalyst (g)	9.26	9.26	9.196	9.26	3.4	9.26

Table 2: Summary of the inputs and outputs obtained from the biodiesel experiments

in the oil and the oil was transferred into a beaker in order to titrate the oil.
- The food chunks were disposed of in a safe manner.

Indicator solution preparation

- 0,5 g of phenolphthalein was weighed.
- A 50 % ethanol solution was prepared by adding 50 ml of water into 50 ml of ethanol.
- The phenolphthalein was then dissolved into the solution.

Oil titration

- A titration solution was prepared by dissolving 1 gram of catalyst, ie, potassium hydroxide or sodium hydroxide in a litre of water.
- 10 ml of isopropyl alcohol was then poured in a 100 ml beaker, a syringe was used to transfer 1 ml of oil into the same beaker and the contents in the beaker were mixed for 5 minutes.
- 2-3 drops of the pH indicator were added to the mixture.
- A burette was then used to add the titration solution to the mixture until the solution turned pink, the amount or volume of the titration solution added to the mixture was recorded.
- The titration was repeated three times and the average volume was calculated.
- The average volume was used to calculate the amount of catalyst required.
- In order to calculate the required amount of the catalyst, the average volume was added to the base amount of the catalyst and the total was multiplied by the volume of the oil.

Biodiesel production

- 400 ml of oil was used for all the experiments. The volume of alcohol used varied from experiment to experiment.
- The required amount of alcohol was poured into a measuring cylinder.
- The required amount of catalyst was weighed and added to the alcohol until the catalyst dissolved completely.
- The oil was heated to the required temperature of 60°C using a magnetic stirrer.
- The alcohol solution was added to the heated oil mixture while it was allowed to react for 30 minutes or so whilst it was constantly stirred and heated.
- The reacted mixture was poured into a separatory funnel and allowed to settle for approximately 12 hours.
- The glycerin layer was then drained out.
- Water was added to the biodiesel to remove excess methanol and glycerin, the washing was repeated multiple times until the water at the bottom was clear.
- The water was drained from the diesel and poured into a washwater collection container.
- The biodiesel was then poured into a beaker and heated for 15 min to allow the remaining water to evaporate.

Table 1 summarises the actual parameters or volumes that were used for all six experiments. Each experiment was done using 400 ml of oil.

Results and discussions

Biodiesel experiment results

Table 2 shows the raw material quantities as well as the amount of the product, by product and waste generated from alternative biodiesel experiments. It can be seen from the table that experiment 3 used the most water to wash out the impurities from the biodiesel and experiment 5 used a smaller quantity of water in comparison to all the experiments. Experiment 4 which used ethanol and KOH as a catalyst gave the highest yield of biodiesel; experiment 1 gave the lowest biodiesel yield and the highest glycerol yield.

Life Cycle Analysis

Goal and scope

The life cycle assessment was carried out using the SimaPro 7.3.3. and ECO-Indicator 99 (E) V2.08 / Europe EI 99 E/E assessment methods, the analysis was done on the complete life cycle of the biodiesel produced from waste cooking oil using different alcohols, ie, methanol and ethanol and different catalysts, ie, KOH and NaOH. The SimaPro software program compared the environmental impact of the biodiesel alternative production routes on a basis of 1 kg of biodiesel produced (Functional unit).

Data used for the assessment was collected from the lab experiments (quantities of the raw materials, product, by-product, waste and electricity consumed), internet as well as the SimaPro 7.3.3 database. For each experiment

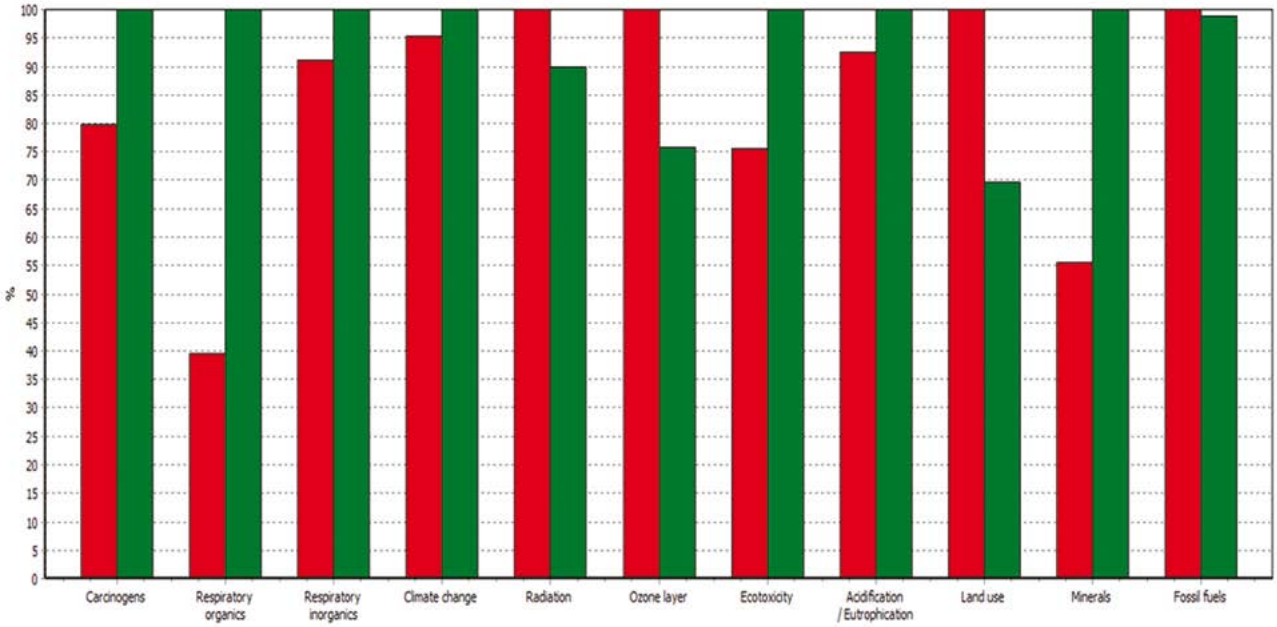


Figure 1: Impact assessment results using the Eco-indicator 99 (E) V2.08 method/ characterisation- comparing methanol to ethanol using KOH as a catalyst

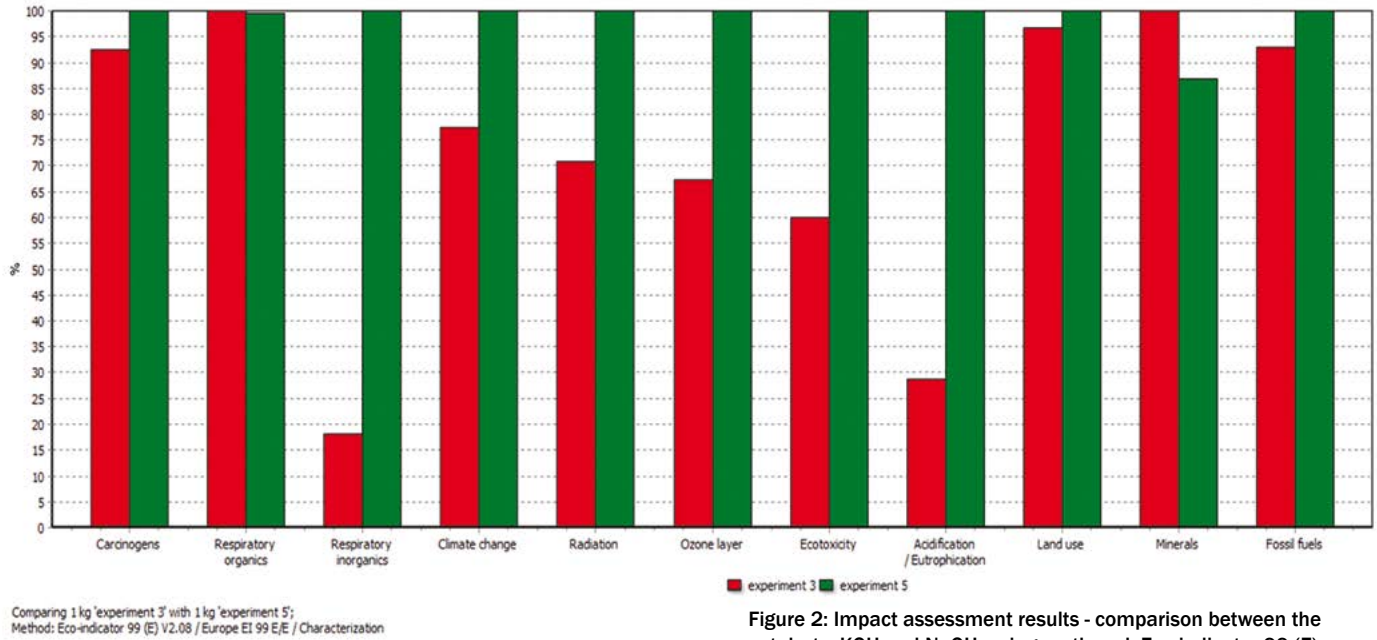


Figure 2: Impact assessment results - comparison between the catalysts, KOH and NaOH, using methanol, Eco-indicator 99 (E) V2.08/ Europe EI 99 E/E method/ characterisation

400 ml of waste cooking oil was used, however, the volume of alcohol used varied from experiment to experiment. The chosen system boundary included the production process (experiment), assembly, transportation to the selling point and burning of biodiesel in an engine, however, the initial process of growing and harvesting the oil crop was excluded because the use of waste cooking oil for the production of biodiesel is considered a waste treatment process. The system boundary remained when performing Life Cycle Assessments for different biodiesel production routes in order to obtain a good comparison.

The conducted lab scale experiments were not continuous (batch process) and the alcohol was not recovered from the process; it was assumed that 94% of the unreacted alcohol will evaporate and the remaining is washed out with other impurities during the washing process. The Life Cycle Assessment (LCA) was performed on a mass ratio allocation basis because of the useful by-product glycerol that is obtained during the experiments.

ECO-Indicator 99 gave back the contribution of the different biodiesel production routes in 11 impact categories namely eutrophication/acidification, climate change, carcinogens, respiratory organics, respiratory inorganics, ecotoxicity, radiation, land use, minerals, fossil fuels and depletion of the ozone layer. The transportation distance of 5 km was chosen on the basis that the production facility will be placed nearby selling points in order to reduce the environmental impact of the transportation of biodiesel.

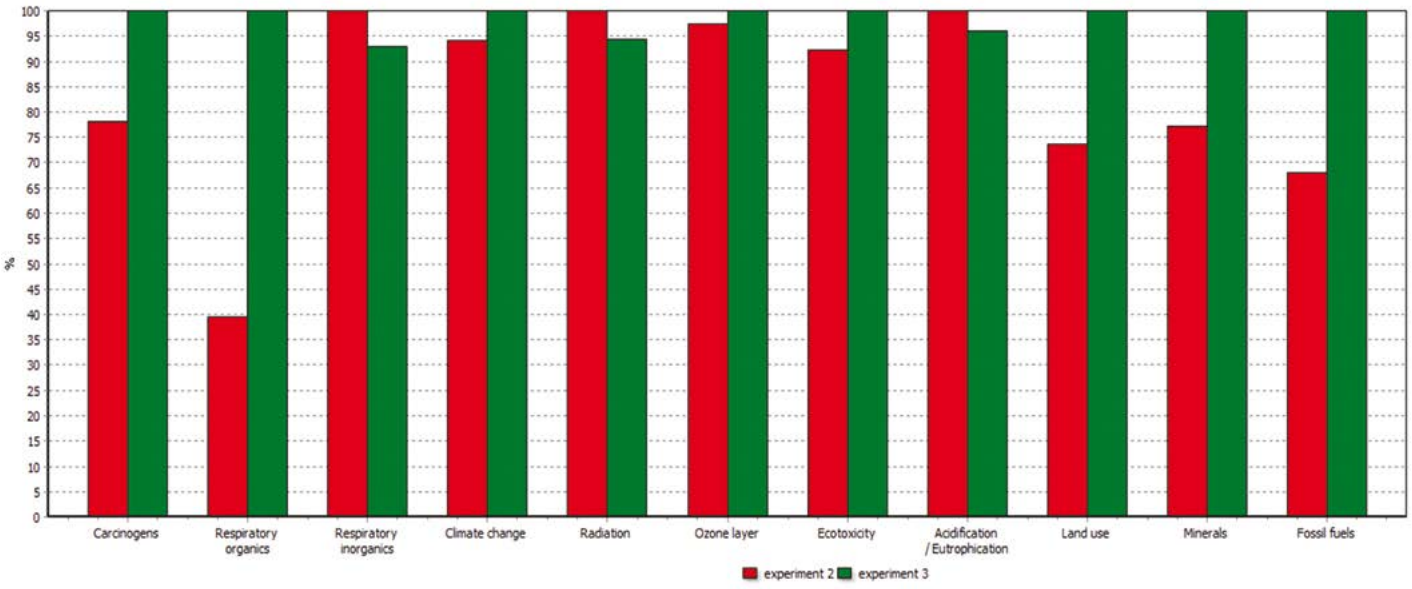


Figure 3: Impact assessment results of biodiesel from methanol using different amounts of alcohol, Eco- indicator 99 (E) V2.08 / Europe EI 99 E/E' method/ characterisation

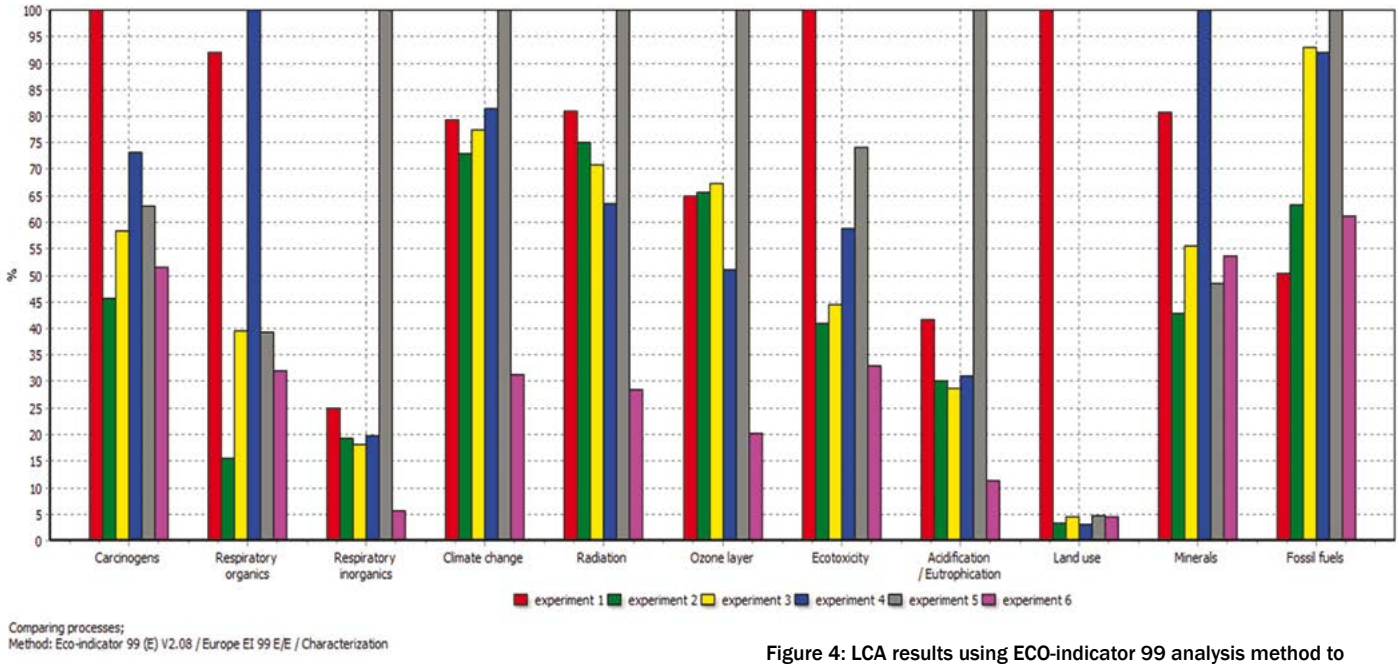


Figure 4: LCA results using ECO-indicator 99 analysis method to compare all the experiments

Results

Methanol vs. ethanol using KOH as a catalyst (experiment 3 and 4)

Figure 1 on page 9 shows the impact assessment associated with the production of 1 kg of biodiesel using the waste cooking oil and KOH using methanol (experiment 3) compared to that of using ethanol (experiment 4) using the 'ECO-Indicator 99 (E) V2.08 / Europe EI 99 E/E' method. Out of the 11 impact categories, experiment 3 has higher contributions on radiation, ozone layer depletion, land use and fossil fuels. It shows lower impacts on the human health categories; 80 % carcinogens, 39 % on respiratory organics and 92 % contribution on the respiratory inorganics. Experiment 3 also shows lower impact on toxicity and eutrophication as well as on the minerals.

KOH vs NaOH catalyst, using methanol

When comparing biodiesel production using the 'ECO-Indicator 99 (E) V2.08 / Europe EI 99 E/E' method, using KOH or NaOH catalysts with methanol for the esterification process, Figure 2, the impact assessment shows that the biodiesel with NaOH as a catalyst has higher contributions on 9 impact categories except the minerals and the radiation categories. The use of KOH catalyst has however shown lower contributions for the rest of the impact categories. The respiratory inorganics were reduced by approximately 82 %, climate change by 23 %, while radiation, ozone layer depletion and eco-toxicity were reduced by approximately 29 %, 32 % and 40 % respectively. Eutrophication was reduced by 71 %; land use was reduced by 3,5 % and the use of fossil fuels reduced by almost 7 %.

Different volumes of methanol in the presence of KOH

The reduction of the methanol volume to 80 ml led to the reduction of carcinogens, respiratory inorganics, climate change, ozone layer, eco-toxicity, minerals, land use and fossil fuels by 22 %, 61 %, 6 %, 2,5 %, 7,5 %, 16 %, 23 % and 32 % respectively. Methanol production process is energy-intensive and has fossil fuels as feedstock; as a result its production is responsible for large waste generation and high emissions. The respiratory organics, radiation and acidification all increased by less than 10 % because the quantity of the catalyst used in experiment 2 was higher than the amount used in experiment 3. Overall it is evident that the use of a smaller volume of alcohol results in a lower environmental impact (Figure 3).

Comparison of all the processes

The 'Eco-Indicator 99 (E) V2.08 / Europe EI 99 E/E' SimaPro method was used to compare the LCA scores for all 6 experiments. Figure 4 shows that experiment 5 which was conducted using ethanol and sodium hydroxide had the highest score in six of the 11 impact categories making it environmentally unfavourable. Experiment 6 which used 160 ml of methanol had the lowest environmental impact out of all the process. The impact of 5 of the 6 experiments in the land use category is under 5 % except for experiment 1 which had an impact of 100 %, which may be a result of an error while entering the data. Figure 4 only shows the percentage that the different biodiesel production processes contribute to different impact categories excluding the transportation and utilisation of the fuel.

Conclusions

During the trans-esterification process, electricity has the highest environmental impact followed by the alcohol. The complete Life Cycle Assessment showed the use of a van to distribute the final product had a high environmental impact compared to the other stages of the biodiesel process. From the LCA point of view, the process that has the lowest environmental impact is the one that uses waste cooking oil and methanol in the presence of KOH as a catalyst.

References

References for this article are available from the editor at chemtech@crown.co.za.

OPASCEP™ PACK redesigned to meet the new challenges faced by public authorities

OPASCEP™ PACK constitutes a range of skid-mounted systems which turn surface water into drinking water in compliance with the World Health Organization's (WHO) recommendations. Ready-to-connect, the OPASCEP™ PACK systems combine well-known and efficient technologies on a single skid: coagulation, flocculation, lamella clarification, pressure sand filtration and disinfection. The modular design allows larger treatment capacities up to several hundreds of m^3 per hour.

The OPASCEP™ PACK range (seven models) can treat larger flow-rates from 10 up to 125 m^3 per hour (100 m^3 per hour previously). Tank height was increased thanks to the use of Hi Cube containers during transport, allowing for higher flow-rates and an overall increase in settling and filtration performances.

The settling part is now equipped with the latest generation of reinforced LVE 100 lamella blocks, which lightens the structure supports and reduces overall fabrication lead time by up to one week for the larger models.

Full automatic mode is now available as a pure standard, while manual operation remains available as an option.

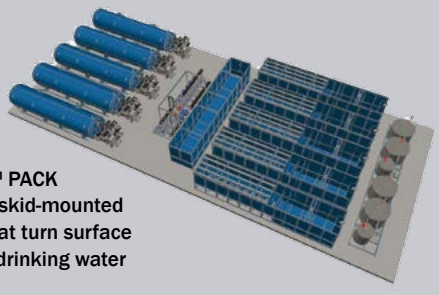
OPASCEP™ PACK is a cost-effective solution because it does not require heavy civil work: a simple reinforced concrete slab is enough to install it. Assembled and tested in France before delivery, they have short lead-time and can be quickly installed on site (10 to 15 days depending on the model).

Veolia group is a global leader in optimised resource management. The Group designs and provides water, waste and energy management solutions that contribute to the sustainable development of communities and industries. Through its three complementary business activities, Veolia helps to develop access to resources, preserve available resources, and to replenish them.

In 2013, the Veolia group supplied 94 million people with drinking water and 62 million people with wastewater service, produced 54 million megawatt hours of energy and converted 38 million metric tons of waste into new materials and energy.

For more information contact Ian Lemberger, General Manager – Engineered systems, Veolia Water Technologies, on tel: +27 11 281 3600, or email ian.lemberger@veolia.com or go to www.veoliawaterst.co.za

OPASCEP™ PACK is ideal for small and medium cities



OPASCEP™ PACK comprises skid-mounted systems that turn surface water into drinking water

OPASCEP™ PACK is a cost-effective solution that requires no heavy civil works

Big effect on small cause – **Valve technology under stress**

Maintenance can be defined as the degradation management of engineered materials (equipment and systems) to retain their performance within their designed operating parameters.

Just as stress can accelerate deterioration of metals in a corrosive environment, operational stress moves equipment and systems toward failure. Limiting stresses within the operating environment maintains reliability.

The elements of the maintenance which are relevant are:

1. Protecting components from stress
2. Monitoring their condition, and
3. Undertaking component(s) replacement prior to the failure threshold level caused by stress excesses.

The impact of maintenance costs over time spans which can easily reach 25 years or more is finally much higher than savings made on the investment side when purchasing inappropriate valve technology, or when choosing solutions not being 'state of the art' technology. The aim of this article is to show, using the example of industrial (butterfly) valves, how quality of components is effectively influencing the cost efficiency of industrial production plants.

As a general rule valves contribute 1 %–3 % of the total investment costs of industrial production plants. Therefore valves often suffer from a certain lack of consideration, even though, in the worst case scenario, one valve failing can lead to a plant shut-down. Hence it is important, from the beginning, to choose the most suitable flow control technology. This commences with the choice of the adequate valve type, and the definition of the appropriate valve materials to be used. Once the valves have been installed, and the plant put into service, operational and maintenance costs start running. Quality aspects of the valve have a considerable impact on operational cost, as, for instance, on pumping capacity, power demand of actuators, and energy efficiency of the entire plant.

Corrosion is one of the major threads in industrial processes, having an important influence on cost aspects. Therefore it is important to design the valves by using innovative materials and adapted solutions in order to prevent such corrosion damages and thus additional costs.

The expectations for a production plant are evident: safety to the employees and the environment, constantly high product quality and plant as possible and operating and maintenance costs as low as feasible.

Finally the dilemma often lies somewhere between aspects of CAPEX and OPEX. As an example, when using components with a low average material lifetime (AMLT), savings on the CAPEX side can be made, but, on the other hand, OPEX will be higher because they are replaced more frequently. On the other hand, attempts to reduce specific costs of maintenance or repair, most often end in higher CAPEX. Consequently, using high end components and advanced technology will provide a safer operation of the plant, higher production quality and a more favourable total cost of operation (TCO).

One to three percent of the investments costs of an industrial plant are caused by low and medium pressure valves, while maintenance costs including replacement and repair of such valves are estimated to be in the range of 4 – 7 % of the OPEX.

Lifetime expectation of valves used in production processes generally is in the range of 5–10 years, depending on the quality of the valve, the working conditions, the frequency of operation and quality of maintenance. A standard quality valve is expected to provide ten years of trouble-free service in these applications. Speciality valves can give reliable service for time spans of 15 or more years. In extreme cases, valves only last about two weeks, and quite often valves have to be replaced after three to six months. In such cases it is mainly corrosion, abrasion and scaling that are the cause of these very short lifetimes. The main effects are internal and external leaking, with all the consequent effects.

When looking at butterfly valves, for example, various aspects affect the lifetime expectation (AMLT). One of the most important sources of valve malfunctioning results from the design and quality of the sealing elements. The lifespan and reliability of elastomeric seated butterfly valves is largely dependent on the valve liner which is the heart of the valve. Careful evaluation of this seemingly simple element should

go well beyond the material grade alone. The liner is responsible for containing the media within the valve body, providing shaft sealing and valve to flange sealing. When this primary seal fails, shaft and body will be in contact with media, and leaking of the valve will occur.

Interference between seal and the disc determines pressure rating and operating torque. Consistent, repeatable and accurate manufacture of the seal results in reliable operation, whereas compound mix determines physical properties such as hardness, chemical resistance (eg, volume change or material degradation), tear strength and age hardening of the elastomeric material. The better the finishing or polishing of metallic discs at all sealing points is, the lower the torque value and internal tightness will be.

Design of the liner and accuracy in selecting the most suitable rubber determines the stability and the reliability of actuation of the valve. Larger diameter butterfly valves (>DN300) have historically suffered from stalling, hesitation, and subsequent uncontrollable opening rates when coupled to an actuator. This usually happens as a consequence of alteration of the elastomeric liner material, and due to poor valve design that results in flange compression increasing the valve break torque.

Butterfly valves using metal pins to transmit to the valve disc the rotation power when quarter-turning the shaft, represent a potential danger of media penetrating to the interior of the shaft, where we then have an excellent point for galvanic corrosion with dissimilar metal contact (as the shaft, the body and the disc will be made of different materials).

Coated discs (eg, Halar, Epoxy, Rilsan) generally have a coating thickness of 0,3 – 0,6 mm, which, in theory, appear very good. A coated disc is ultimately fully reliant on the total and complete encapsulation of the disc. Any breach of surface continuity will result in heavy corrosion and ultimate breakdown. The photograph shows a butterfly valve used in a demineralised water application (boiler water).

Specific costs of valve replacement

Depending on the quality of an installed valve, the lifetime expectation and the maintenance cost can vary greatly.

The following example shows cost development of low cost commodity valves versus standard branded valves (unit comparison by index figures). In the case of the low cost valves, they have to be replaced once a year. In the case of the standard quality valve, no replacement is required, merely only service. After ten years of operation, savings of approximately 30 % of the TCO can be recorded when using quality technology.

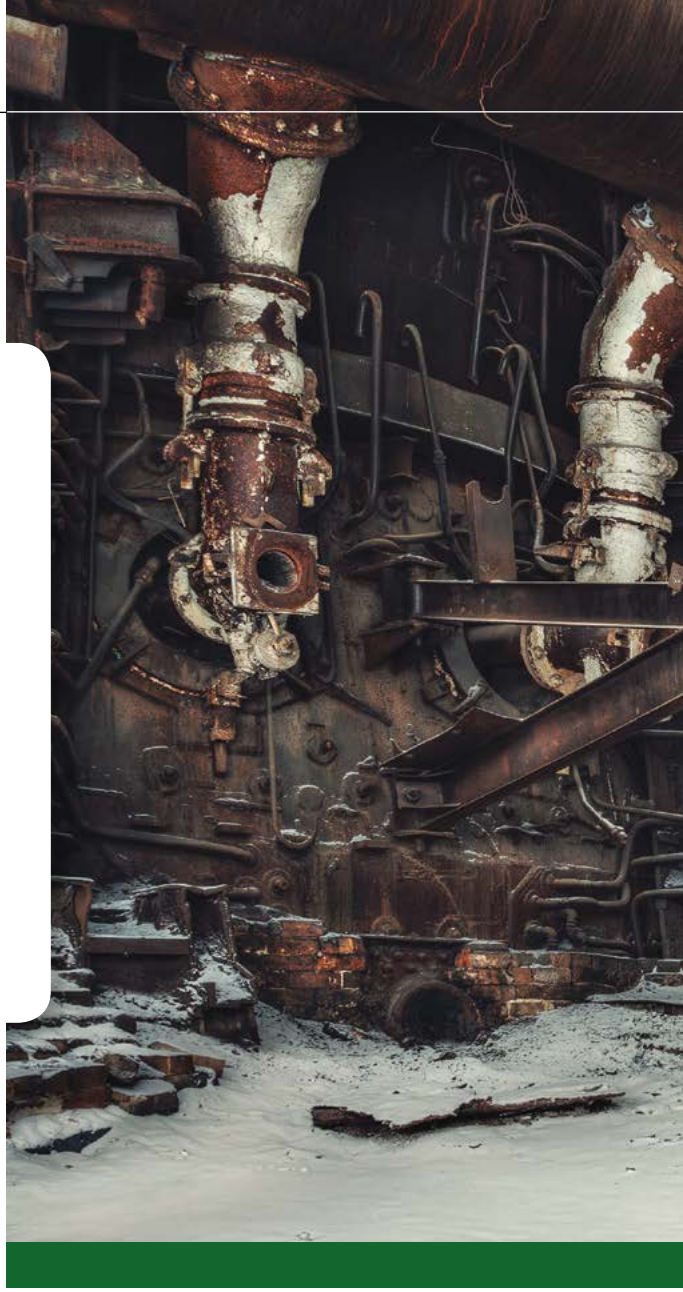
	Low price butterfly valve, to be replaced once a year	Standard quality butterfly valve, to be serviced once a year
Purchase Cost Valve	100	140
Cost of installation	5	5
Cost of inspection	5	5
Cost of service	Replacement 15	Maintenance Service 50
Cost of new valve	100	0
Cost of spare parts	0	20
Total Costs at beginning	105	145
Total Costs after 10 years	1200	750

IInvesting in high-end technology has a direct impact on the total costs of a production plant, resulting in a positive return on investment. Consequently CAPEX are expenditures which create future benefits. Even though capital costs of industrial plants have decreased significantly over the past ten years, costs of operation, maintenance and repair are still significantly onerous. A valve is not just an irrelevant component in a process. Rather it is an element which can exert a big effect on a small cause. It is therefore worth having a closer look at it when designing, building, operating and maintaining an industrial production plant.

For more information contact Claudio Darpin at GEMÜ Valves Africa at claudio.darpin@gemue.co.za

Equipment failure prevention **needs defect elimination strategy**

by Mike Sondalini, Managing Director, Lifetime Reliability Solutions, Lean Manufacturing, Enterprise Asset Maintenance and Work Quality Management Consultant Services



To reduce maintenance costs and production downtime it is necessary to reduce their causes. Both are effects and not causes which can be traced back to defects and errors: defects lead to future equipment failures, production downtime and lost profits. Thus strategies prevent their occurrence and eliminate them if they do occur.

All equipment starts life new. It comes from the manufacturer fresh. If you do nothing about controlling it, it also comes with future failures built into it.

These future failures are the design errors, the materials selection errors, the fabrication errors, the assembly errors and any transportation damage. When installed, further causes of future failures arise from incorrect installation, incorrect site assembly, incorrect mounting practices, inadequate environmental protection and deficient foundations/supports.

Some of these errors, along with commissioning errors and operating errors, cause failures early in the equipment's operating life and explain early-life or 'infant mortality' failures. Those defects and errors that do not appear during equipment infant-life, will eventually surface and cause failures sometime later, during its operating life.

The preferred terminology is to call the errors 'defects', because that is what you see as a consequence of the mistake. But the truth is that a wrong action (or no action) was taken at some point in time and as a consequence a defect resulted.

Another truth is that most times, most things go right. Failure is not the normal situation. The problem with failures is not the failure in itself. It is the consequences resulting from them. When the consequences of failure are bad, you want to do everything possible to never again let them happen!

Defect elimination is the answer

Starting from new, a part properly built and installed, without any errors, will operate at a particular level of performance. If looked after properly it should, ideally, deliver its design requirements all its operating life.

As its operating life progresses, any of those previously hidden manufacturer's and installer's errors noted above start to make their effects known. For some reason the equipment starts to fail. Failure causes can be introduced at any time. They can appear during operation from management decision errors, operating errors, repair errors, abuse and even acts of Mother Nature.

If you want superbly reliable equipment you must prevent the introduction of defects and errors at all stages of the equipment life cycle, and also act to remove the defects and errors already present in it. By getting rid of the defects that generate future failures, you will greatly reduce your future maintenance requirements, and hence guarantee great production performance.

An average item of equipment has several dozen direct and consequential failure modes. The best maintenance

strategy to adopt is not to allow failure modes into the equipment from the start. Such strategies require that you put in place management controls and quality standards that must be followed to detect, control and stop the introduction of errors and defects into the equipment.

For example, a wise strategy at the design stage is to look for every failure mode possible and remove it whilst it is still on the drawing board. You take each part of the equipment, assembly by assembly, component by component and list its possible defects and errors and then introduce strategies and plans to address every one of those failure paths in the design.

A spreadsheet can be developed of all component and assembly failure modes and this becomes a checksheet to assess all future equipment purchases and designs. It also identifies where you should use preventative and planned replacement maintenance strategies. Some people call this RCM (Reliability Centered Maintenance). But I call it just plain common sense!

Maintenance is used to address the effects of the continually growing number of defects. You will often hear people say "well add another PM into the system", hoping that it will prevent the problem in future. But all they have done is add more cost and resources requirements into the production costs! More maintenance is not the answer; it only adds more expense without benefit of defect elimination.

Figure 1 highlights where most failure-casing defects and errors come from and explains that eventually you will have so many problems in your operation that your bucket overflows and you drown in strife!

Maintenance can only act to 'drain away' the impact of defects. It hides and masks their effect. But it cannot remove them because maintenance only replaces like-for-like. The original defect remains.

You now have an equipment defect model that explains why there is so much crisis and 'fire-fighting' by maintenance crews. Doing maintenance does not fix problems; it can only

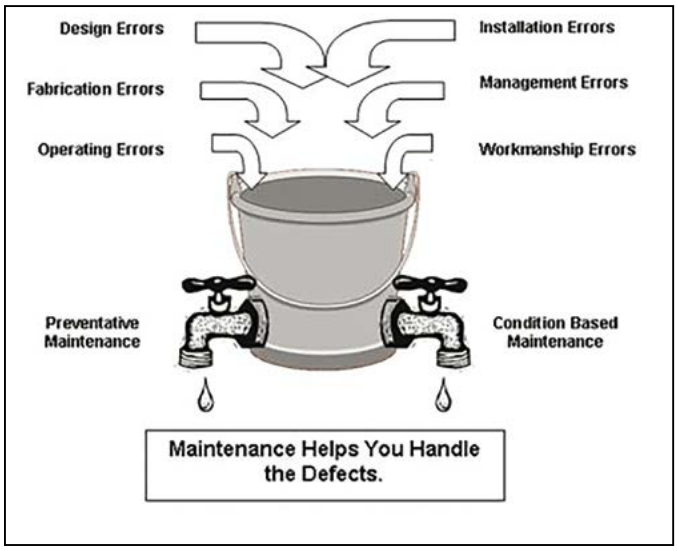


Figure 2 shows how maintenance can only act to 'keep your head above water' by addressing the impact of defects.

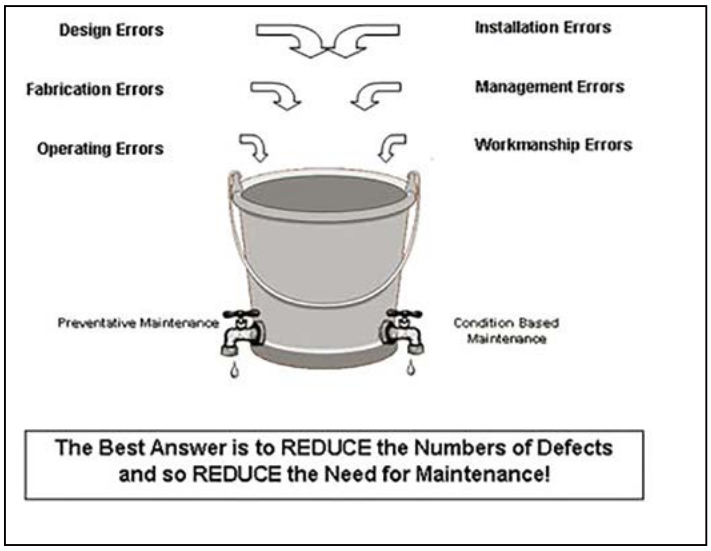


Figure 3 shows you that when you reduce the number of defects entering your operation you can also reduce the amount of maintenance you need to do.

rejuvenate equipment. If the cause of the problem is not removed ... it remains to reappear again in future.

As you introduce more defects into the business, so must you increase the size of your maintenance crew and maintenance resources to deal with them.

A simple defect elimination process

Only by intentionally reducing the size and quantity of defects entering your operation will you be able to reduce the maintenance you now need to do to stop defects from flooding and drowning you out of business.

Each of the defect categories needs to be addressed systematically. Effective mechanisms must be introduced by you to combat and defeat the cause of the defects. Unless the causes are controlled and stopped you will be continually battling failures.

Defects will never stop, unless you act to stop them! They are forever being introduced and perpetuated by poor procedures and practices, poor quality control and poor management systems. Unless you purposefully act to stop defect introduction, every new piece of equipment, every new part, every new person that joins your company bring with them defects and errors, to one day cause future failures. How catastrophic those failures will be will depend on the internal controls you have in place in your organisation to prevent and control them.

"You have to intentionally, proactively, with the future well-being of your business in mind, put into place a strategy to eliminate and eradicate your defects forever!"

You have to intentionally, proactively, with the future well-being of your business in mind, put into place a strategy to eliminate and eradicate your defects forever!

This logic is sound and sensible: get rid of the defects causing the problems, so that you can reduce the amount of maintenance you need to do, because you now have fewer defects to address. That way you get both lower maintenance costs and more production.

Here is an easy, simple and powerful model to guide you in removing the equipment defects you have in your operation.

- Select one failure and identify where defects and errors were first introduced through the use of root cause failure analysis.
- Use resources skilled at eliminating the root cause and action a plan to engineer-out the causes forever. (I implore you not to use work procedures to control engineering failures. If you do that you will soon run out of people in the company to make responsible for controlling the causes you will find. They will also consider it an imposition on their job and sub-consciously lower its importance so they do nothing about it and the failure will repeat. Use work procedures to direct people's attention, not to compensate for equipment defects.)
- Introduce clear, written, quality production and engineering standards into the appropriate levels and locations in the organisation that contain checks and tests to prevent the defects from again entering into your company.
- Train and re-train your people to meet the new standards.
- Measure their performance against the new standards.
- Repeat the above until the defects are so few that your operation is the world-class leader in your industry.

It is necessary to use a quality system because a quality system is self-improving, self-correcting and self-developing. With a quality system properly applied, your company will continuously improve because continuous improvement is built into the way you do business. Without a working quality system you require individuals to remember to do the right things every time. This approach means that you are counting on a lot of good luck for things to go right!

You can remove defects and stop failures by taking a personal stand and start introducing the right quality management practices into your operation, especially in your own personal work. Only by your adopting better systems and methods, and causing the introduction of better practices and standards at every stage of the production, engineering and maintenance processes, will you ever reduce the equipment failures in your operation.

If you want to master equipment maintenance and have outstandingly reliable production, you must stop the introduction of defects and errors into your operation. If you want to seriously reduce maintenance costs then reduce the number of ways your equipment can randomly fail.

No more fugitive valve emissions

New generation LiveStar live-loading system

Valve live-loading systems are complicated. Most require the use of torque-measuring tools and incorporate a disc spring stack that is often too long for the available bolt length. As a result, valve bolts usually need replacing.

Now, British multinational AESSEAL has launched LiveStar, a new-generation live loading system designed to be compact without requiring extra bolt length to accommodate the uncompressed disc spring stack.

LiveStar has been designed as an encapsulated disc spring configuration with defined compression length to automatically adjust the gland and maintain constant pressure on the valve packing set. It is likely to find a major market in control valves installed in environmentally sensitive applications such as those found in petrochemical refineries.

The system fits on existing gland bolts and is tightened on installation until the visible assembly gap closes. During operation, this closed gap serves as an indicator of valve packing wear or consolidation, either or which will cause the gap to reappear, whereupon the assembly is simply retightened to its optimal set point. No torque wrench is required.

A major advantage of the AESSEAL design over other live-loading systems, according to a recent report, is that the disc spring, which is encapsulated against environmental impact by an outer cylinder, slides on an even, machined surface rather than on a bolt thread. The disc spring can therefore never become over-compressed, hang up on threads or shift asymmetrically on the bolt.

Further, LiveStar needs no new bolts fitted to the valve to accommodate the system. The extended nut is screwed onto the existing valve bolt. Other features include compensation for thermal expansion of the valve and flange parts, optimum and pre-determined compression set by the dimension of the spring housing, protection of the spring set from dirt and outside contaminants, and sustained maintenance of a constant gland load and sealing force.

Available for all standard metric bolt diameters from 8 mm to 27 mm and Imperial UNC from 5/16” to 1”, the complete LiveStar range can be sourced from AESSEAL branches and distributors throughout Africa.

For more information contact Rob Waites on tel: +27 11 466-6500, or email rwaites@aesseal.co.za.

The methods, practices and systems that deliver productivity, high plant reliability and maximum 'tool time' from maintenance crews

Maintenance Planning and Scheduling for Reliability – 3-Day Course

23 – 25 March '15 Midrand, Johannesburg
03 – 05 June '15 Rustenburg, North West
21 – 23 Sept '15 Witbank, Mpumalanga

This course is accredited by the Southern African Asset Management Association (SAAMA00996) and licensed and supported by Lifetime Reliability Solutions. A certificate of training is provided at the end of the course.

Improve maintenance crew productivity and accuracy

You save large amounts of time, lost production and money when maintenance work is fully prepared and well scheduled. Learn the maintenance planning methods and business systems that maximise 'tool time' by ensuring jobs are ready, with all resources and information at-hand, so tradesmen go from job to job uninterrupted, doing their work with 100 % right-first-time quality. Move your maintenance planning and scheduling performance from where it is today to the Pacesetter levels shown in the table below.

\ Key Performance Indicator	Poor Performance	Pacesetter Performance
'Hands on tools time' % possible	20	> 50
Mechanics per Planner	8 - 10 : 1	20 - 27 : 1
Maintenance Backlog	8 – 10 weeks	4 weeks
% Planned Work	< 50%	> 80%
Schedule Compliance	< 50%	> 90%
Urgent Job Requests	70%	5%

There is a great difference between being a top artisan and a top planner. The skill sets are totally different. The decisions required from a planner involve strategic thinking and business systems optimisation. This course prepares people to be top-class planners by teaching them the systems, the information, the knowledge and the skills they need to use to be successful in this role in a company. Documented evidence confirms that a good maintenance planning and scheduling process can deliver the following business benefits:

- Twice the maintenance work done of reactive methods.
- Planned work is 3 – 9 times less expensive than reactive work.
- Planned work is 4 – 12 times more efficient than reactive.
- On larger jobs each hour of planning saves 3 – 5 hours execution time.
- Up to 90 % of your work can be planned.
- Up to 95 % of planned work can be done when first scheduled.

Registration for the course

Register now for the course and secure your place by telephoning +27 072 141 5941. Registration is limited by the room size and seat allocation is on a first-come-first-served basis. The public training course costs R7 200 per person, excl VAT, while companies with four or more delegates attending qualify for a 10 % discount. For more information email Kate.Moleme@strivingminds.net, or fax: 086 2124 984.

A brief outline of the course content

Day 1

Maintenance Strategy and Reliability: The Foundations of Maintenance Planning

- The Purpose of Maintenance
- Defect and Failure True Cost
- The Purpose and Role of Maintenance Planning and of Scheduling
- How Maintenance Planning and Scheduling Reduce Costs
- Plant and Equipment Life Cycle
- Risk Management Fundamentals for Maintenance
- Equipment Criticality Analysis – identify plant and equipment at risk

Day 2

Planning Maintenance Work

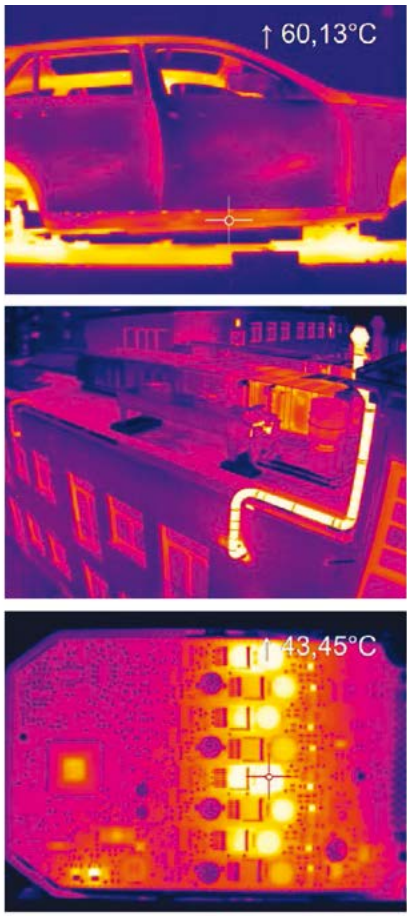
- Specifying Workmanship Standards
- Data Capture for Maintenance
- Inventory Purchasing and Management
- The Work Planning Process
- Shutdown and Outages Planning

Day 3

Project Management Principles and Practices

- Failure Prevention and Defect Elimination ACE 3T Maintenance Procedures
- Standardising Planning Procedures and Scheduling Procedures
- Planning and Maintenance Key Performance Indicators
- Scheduling Maintenance Work
- Visual Management in All Occasions
- Relationship Building
- Production Requirements and Limits
- Important Time Management and Scheduling Concepts
- Preparations before the Job Starts
- Addressing On-site Issues and Changes in the Plan with Team-based Risk Analysis
- Monitoring Job Performance and Schedule
- Backlog Management.

Optris launches world's smallest IR camera



Optris, specialists in non-contact temperature measurement, have launched the OPTRIS PI 640, said to be the smallest measuring video graphics array (VGA) infrared camera, worldwide. With an optical resolution of 640x480 pixels, the PI 640 delivers pin-sharp radiometric pictures and videos in real time.

With a body sized 45x56x90 mm and weighing only 320 grams (lens included), the PI 640 counts among the most compact thermal imaging cameras on the market. It can be delivered with industrial thermal imager equipment and comes with an extensive license-free thermography software which enables users to monitor and document measurements and to edit infrared video imagery.

Key specifications of the PI 640 are its temperature range of between -20 °C and 900 °C, the spectral range of 7,5 to 13 µm and the frame rate of 32Hz.

The PI 640 high-resolution infrared camera finds application in industrial applications where pin-sharp infrared pictures and videos are essential for process monitoring and optimization.

The real-time thermographic images prove especially valuable for surveillance and quality assurance in the automotive sector, plastics, as well as semi-conductor and photovoltaic industries.

For more information on the Optris PI 640 IR camera, contact Scott Hunter at Instrotech on tel: 010 595 1831 or email sales@instrotech.co.za.

'Fundamentals of Process Safety Management' course

The Institution of Chemical Engineers (IChemE) " Fundamentals of Process Safety Management" (PSM) course is being held at the Birchwood Hotel and OR Tambo conference Centre, Boksburg, from the 25-29 May 2015. The proceedings will cover the entire five-day UK IChemE course.

Course leaders are Rod Prior, a chemical engineer with over 30 years of experience in process industries, including production, commissioning and health and safety management; and Nigel Coni, who has over 40 years' experience in the chemical industry, in design, project, production and consulting positions.

The course is aimed at process plant management, supervisors, engineers, designers and safety experts. The course will cover, inter alia, a model for PSM and basic hazard science, performance measurement and learning from accidents, design safety, legal framework and much more. By using case studies and team work, knowledge is transferred on how to prevent and minimize fires, explosions and the release of toxic gases.

The course has been approved by IChemE and is both ECSA and SAIChE accredited. Please contact Rod Prior for details. Cell: 082 554 0010. Email: r.prior@mweb.co.za.

Application of membrane separation technology **for developing novel dairy food ingredients**

by Marella Chenchaiah, Assistant Professor and Leprino Chair in Dairy Products Technology, Dairy Science Department, California Polytechnic University, San Luis Obispo, California, USA, K Muthukumarappan, Distinguished Professor and Graduate Program coordinator, Agricultural and Biosystems Engineering Department, South Dakota State University, USA and L E Metzger, Professor and Alfred Chair in Dairy Education, Dairy Science Department, South Dakota State University, USA.

Membrane separation technology continues to advance as the demand for new dairy products grows.

In several processing industries, separation technology is widely used to separate and in some cases to purify a particular component from the rest of the mixture. The target component might be the desired product or an unwanted component, separated to increase the purity of the original mixture. Separations take advantage of differences in physical or chemical properties of the mixture of components [1-3]. Of the several separation technologies available, membrane separation technology brought a significant change in dairy food processing. There are several advantages of membrane separation technology when compared to other processes. These include, separation of components at a lower temperature, separating the component in its native state, less energy use, etc.

Reverse Osmosis (RO), Nanofiltration (NF), Ultrafiltration (UF) and Microfiltration (MF) are four commonly used membrane separation processes in dairy food processing. These have evolved from consistent research and development in the area of new membrane material development as well as in applications [4]. Membrane separations have been extensively used in the dairy process industry and are used for selective separation of different species. Commonly used separation processes are Microfiltration, Ultrafiltration, Nanofiltration and Reverse osmosis.

These processes differ in membrane characteristics, pore size and operating pressures to which they are exposed. Reverse osmosis is mainly used to concentrate all the solutes present in a mixture, while removing water in the process. Nanofiltration is used to concentrate the solutes while partially allowing the passage of some lactose and monovalent salts, thereby minimizing the effect of osmotic pressure. Conventional ultrafiltration is used to remove lactose and soluble salts from dairy mixtures. Microfiltration is widely used to remove bacteria, somatic cells, fat and lately micellar casein from skim milk [5].

Applications in the dairy industry

Milk is an essential constituent of many foods. It is a complex mixture of different components like fat, protein, lactose, minerals, etc. These components have specific nutritional and functional properties. Fractionation of these components will enable pure ingredients to be produced that have the advantage of constant quality [4,6]. Accordingly membrane processing is implemented in the dairy industry on a wide scale. The dairy industry accounts for the lion's share of the total membrane area installed in the food industries. It is estimated that about 500,000 m^2 of membrane area is installed in dairy applications worldwide, and more than 70 % of this area is in whey processing [7] especially in preparation of whey protein products. Specific applications of membrane processing in the dairy industry include fractionation of milk fat from whole milk, removal of bacteria and spores from skim milk, production of milk protein and native casein concentrates recovery and fractionation of whey proteins, etc. Various applications of membrane separations in the dairy processing have been extensively reviewed [8-10].

Novel membrane processes and applications

Pervaporation

In the pervaporation process, feed liquid flows on one side of the membrane, and the permeate is removed as vapour from the other side of the membrane. Pervapouration is the only membrane process where a phase transition occurs with the feed being liquid and permeate being vapour. This is made possible by maintaining partial vacuum on the permeate side of the membrane. The components to be separated from the mixture need to be absorbed by the membrane, should diffuse through it and is expected to easily go into the gaseous phase on the other side of the membrane [11]. The required vapour pressure difference across the membrane can be maintained by a vacuum pump or by condensing the vapour produced which spontaneously creates a partial vacuum.

The pervaporation process can be effectively used for removal of water from liquid organics, water purification and organic/organic separations. Novel application of pervapouration is in purification/ separation of ethanol from fermentation broths. As ethanol forms azeotrope with water at 95 % concentration, pervapouration process appears promising because simple distillation will not work under these conditions. Pervapouration process is successfully used in production of pure water. A variety of membranes has been tried in these applications [5].

Electrodialysis (ED)

Electrodialysis is a membrane-based demineralisation process and uses ion exchange membranes. It is widely used in demineralisation of liquid foods such as milk and whey and is used extensively in desalination of sea water. The principle of ED process is based on the fact that when an aqueous solution containing ions of different mobilities is subjected to an electric field, the ionic species migrate to the respective opposite polarities of the field [11]. The ionic mobility is directly proportional to the specific electrical conductivity of the solution and is inversely proportional to the ionic concentration.

In an ED system, anionic and cationic membranes are arranged in a plate and frame configuration (just like the classic plate heat exchanger) and are placed alternately. The feed solution is pumped to the cells of the system, and electrical potential is applied. The positively charged ions migrate towards the cathode and negatively charged ions move towards the anode. Cations easily pass through the negatively charged cationic exchange membranes but are retained by positively charged anionic exchange membranes. Similarly, anions pass through anion exchange membranes but are retained by the cation exchange membranes. The net result is that one cell (pair of anionic and cationic membrane) becomes enriched / concentrated in ionic species while the adjacent cell becomes depleted of ionic species. The presence of impurities and precipitated materials, as in the case of biological material causes

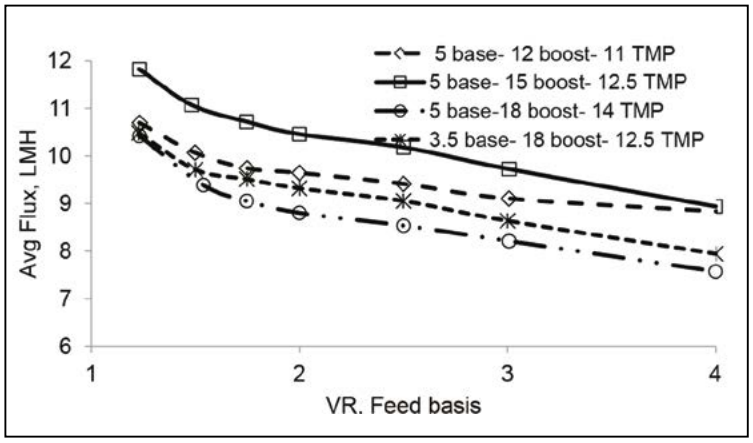


Figure 1: Effect of operating pressure on performance of spiral wound microfiltration process during production of Micellular casein concentrate from skim milk. Flux is L per m² h, TMP is transmembrane pressure and VR is volume reduction. Experiments were conducted at 65 F temperature using 0,5 µ polyvinyledene membrane.

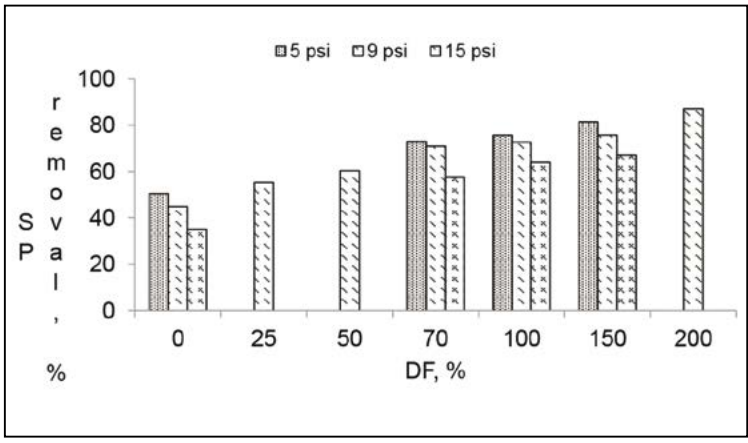


Figure 2: Effect of operating pressure on serum protein removal efficiency during spiral wound microfiltration of skim milk. SP is serum protein, DF is the amount of diafiltration water added during the process.

severe concentration polarisation of the membranes. The problem is more severe with anionic membranes which are clogged by large organic anions (such as amino acids), precipitated calcium phosphate and denatured proteins [11]. This anionic membrane specific problem can be partially overcome by using neutral membranes in the place of anionic membranes. The advantages of using neutral membranes are that concentration polarisation is reduced, easier cleaning cycles and extended process runs. However, the disadvantage includes a low degree of separation because only one set of membranes is selective.

Membrane distillation

Membrane distillation is an evapouration process for separating volatile solvent from one side of a non-wetted microporous membrane. The evapourated solvent is condensed or moved on the permeate side of the membrane. When a hot solution and a cold aqueous solution are separated by a non-wetting membrane, water vapour will diffuse from the hot solution/membrane interface to the cold solution/membrane interface and condense there. So long as the membrane pores are not wetted by both solutions, the pressures on both sides can be different. The microporous membrane in this case acts as liquid phase barrier as water evaporation continues. This arrangement is called the direct contact membrane distillation. The main advantages associated with membrane distillation are: no possibility of entrainment, possibilities of horizontal configurations, low temperature energy sources can be used, reduction of the problem of fouling due to the use of hydrophobic membranes, possibility of highly compact designs such as hollow fibre configuration [5].

Separations using liquid membranes

In separation processes using liquid membranes, the solutes diffuse through liquid contained in a porous support. These separations can be either gas or liquid separations. The solute molecules undergo dissolution in the membrane at the feed/ membrane interface. The dissolved solutes diffuse through the membrane and are desorbed at the other membrane surface. Applications using liquid membranes include waste water treatment: removal of phenol [12], removal of thiomersol from vaccine production effluents [13], trace metal treatment from natural waters. Other applications include removal of citric acid, acetic acid from fermentation broths, separation of gas mixtures, toxic heavy metal ions, separation of sugars, etc.

Novel applications of membrane separations in production of value added dairy ingredients

Spiral wound microfiltration in production of Micellular casein concentrate

In recent years, there has been increased interest in use of microfiltration in production micellar casein concentrate. Micellar casein concentrate is obtained from microfiltration of skim milk during which most serum protein and non protein nitrogen components are removed into permeate thereby increasing the ratio of casein to total protein and casein to true protein. The retentate obtained from this process is a concentrated colloidal suspension containing casein in micellar form, lactose, minerals and some serum proteins. Micellar casein concentrate has potential uses in cheese making, process cheese (as rennet casein replacer), nutritional meal replacements, whipped toppings, coffee whiteners, etc [14-16].To date most of the research on microfiltration of skim milk for production of Micellar casein concentrate used ceramic microfiltration membranes. Ceramic membrane systems are capital intensive and membrane replacements are expensive. When compared to these systems, membrane separation systems using polymeric membranes requires less footprint, are inexpensive and familiar with most of the US dairy processors. In recent years, there has been increased interest in assessing the suitability and efficiency of polymeric membranes for production of micellar casein concentrate. It has been shown that using ceramic membranes, more than 95 % of serum protein could be removed in a 3-stage process in which diafiltration to a level of 200 % (on feed volume basis) was used. Diafiltration is a process in which water is added to the retentate during microfiltration and further concentration is carried out. This step is intended to improve

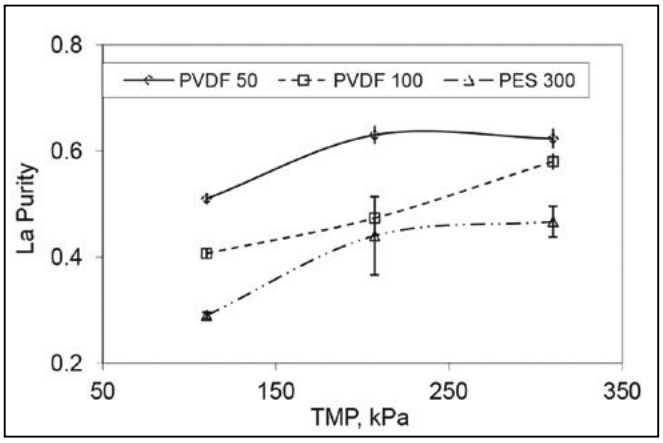


Figure 3: Purity of α-Lactalbumin obtained from wide pore ultrafiltration experiments conducted using cheddar cheese whey as feed material. La is αLactalbumin, PVDF 50 and 100 are polyvinyledene fluoride membranes with 50 and 100 kDa molecular weight cut off. PES 300 is Polyehtersulfone membrane with 300 kDa molecular weight cut off. TMP is transmembrane pressure.

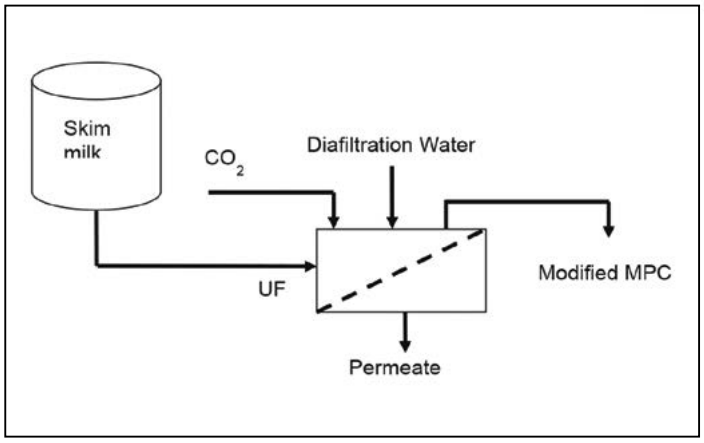


Figure 4: Purity of α-Lactalbumin obtained from wide pore ultrafiltration experiments conducted using skim milk microfiltrations permeate as feed material. 30, 40 and 100 kD are polyvinyledene fluoride membranes with 30, 40 and 00 kDa molecular weight cut off. 300 kD is Polyehtersulfone membrane with 300 kDa molecular weight cut off. TMP is transmembrane pressure. Bars with same letter are not statistically different (P <0,05).

the serum protein removal and to control the membrane polarisation phenomenon. A few studies conducted on the use of polymeric membranes for production of micellar casein concentrate showed that serum protein removal of the order of 40 % was possible without diafiltration and with the use of diafiltration to the extent of 200 % of feed volume, serum protein removal to the extent of 70 % could be achieved [16]. However, these processes were carried out at elevated temperatures with the associated problems with energy consumption, bacterial quality, etc. Marella *et al* and Metzger *et al* [14,17] carried out extensive research with the use of polymeric membranes for production of Micellular casein concentrate from skim milk. In this work, operating parameters such as operation pressure, level of diafiltration, etc. were optimised for maximising the serum protein removal from spiral wound microfiltration process. From this research, it was shown (Figure 1) that operating microfiltration process at a base and differential pressures of 5 and 15 psi resulted in better flux rates. This research further showed that the microfiltration process is extremely sensitive to pressure and operating the process at lower pressure results in maximum serum protein removal (Figure 2).

Wide pore ultrafiltration process for production of value added dairy ingredients

α-Lactalbumin enriched whey protein concentrate: Traditionally ultrafiltration used in dairy applications utilizes Polyether sulfone membrane with a molecular weight cut off of 10 kD. As these membranes have extremely tight pores, the ultrafiltration process using these membranes concentrates all the proteins present in either cheese whey or skim milk that is processed. When cheese whey is processed using the conventional ultrafiltration process, whey protein concentrates and whey protein isolates are obtained. These protein products are mixtures of individual and valuable protein fractions. In order to realize the true value of individual protein fractions, it is essential to fractionate these mixtures into products of individual components. One such high value protein present in cheese whey is α Lactalbumin. Previous research has used polymeric membranes in hollow fibre configuration [18,19], combination of ceramic and polymeric membranes [20-22] and spiral wound polymeric membranes [23,24]. Using cheese whey as feed material, this research has demonstrated that α-Lactalbumin enriched whey protein concentrate can be produced with purity of 62 % can be produce, (Figure 3). When skim microfiltration permeate (serum whey) is used as feed material, α-Lactalbumin purity of as high as more than 80 % can be obtained with proper selection of membranes and operating conditions (Figure 4).

Milk mineral from dairy process streams

Milk contains a variety of essential minerals and trace elements. The concentration of these minerals ranges from 8 to 9 g/l. Calcium, Magnesium, Sodium, and Potassium are the main cations present in the milk. Phosphate, Citrate, and Chloride are the main anions. Some of these minerals are present in dispersed form in milk serum while some of these are partially associated with milk components such as proteins (Casein, α-Lactalbumin, etc.). This partial association with milk proteins gives structure and stability to milk and milk components. During manufacture of milk products, milk is subjected to various technological treatments such as filtration, acidification etc. These treatments partition the minerals present in the milk between different streams. For example, in cheese-making Calcium, zinc, magnesium and phosphorus go with whey and end up in whey powders. Mineral content is higher in acid whey than in sweet whey [25]. Harvesting of milk minerals from dairy by-product streams not only help overcome the fouling problems but also help the dairy processors to realize the true value of milk minerals. At present, milk minerals are harvested from dairy by-product streams using some publicly known and some proprietary processes. For example, US Patent 5,639,501 describes a process wherein the pH of whey permeate stream containing about 15-24 % solids is adjusted to 7,2 using a phosphate compound, heated to 155 °F, and held at this temperature for 20-35 minutes in order to allow calcium phosphate to flocculate and precipitate out. Vyas and Tong [26] developed a process for recovering milk minerals from permeate stream using a combination of pH adjustment and heat treatment

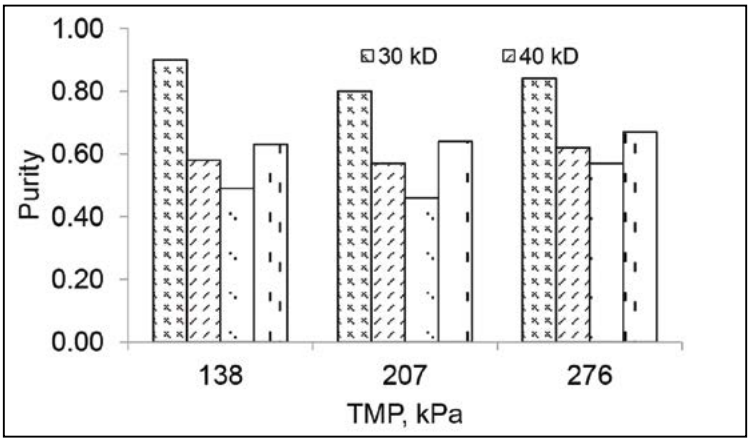


Figure 5: Mineral harvest data from wide pore ultrafiltration experiments. Ultrafiltration permeates obtained from milk protein concentrate manufacturing process were concentrated to 11% solids in reverse osmosis unit. Control is the feed that has normal level of minerals, High mineral is the feed that has higher mineral content. PES 20 is Polyether sulfone membrane with 20 kDa molecular weight cut off. PVDF 30 and 40 are Polyvinyledene membranes with 30 and 40 kDa molecular weight cut off.

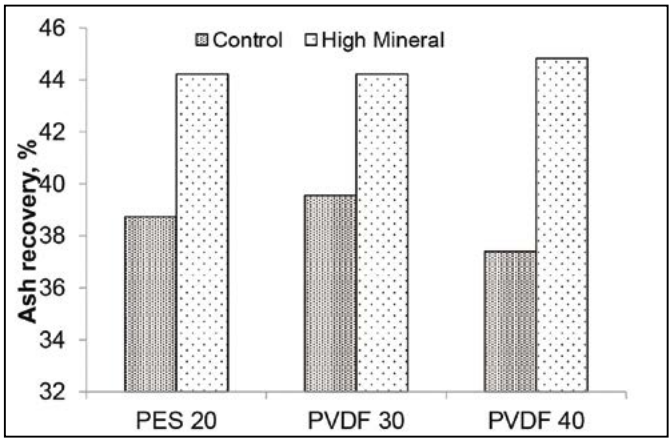


Figure 6: Process for production of milk protein concentrate with a modified mineral content. UF is ultrafiltration and MPC is milk protein concentrate.

and reported a calcium recovery of 70 %. In this research, conventional ultrafiltration membranes with a molecular weight cut off of 10 kD was used. With the purpose recovering minerals and to develop a wide pore ultrafiltration process that has high permeation rates, Mealy *et al* [27] conducted mineral harvest research using wide pore ultrafiltration membranes and reported ash recovery of 44 % (Figure 5). This process using 40 kD PVDF membrane has exceptionally high flux rates of more than 100 LMH.

Filtration technology to produce mineral modified milk protein concentrates

Milk protein concentrate (MPC) is produced by ultrafiltration (UF) of skim milk to produce a product that is partially or completely delactosed and high in protein. During UF, water, lactose, NPN and some soluble salts are removed into a permeate stream. Higher molecular weight constituents such as caseins, whey proteins and some minerals are concentrated into a retentate stream. In the production of MPCs, UF membranes with a molecular weight cut off of 5 and 10 kD are used to concentrate higher molecular weight components such as fat, protein and some salts. UF membranes allow passage of water, lactose, non protein nitrogen and some dissolved salts [28,29]. In some applications, a diafiltration step is used in order to wash out more lactose and thereby increase the protein content. Depending on the volume reduction (VR) and extent of diafiltration (DF) applied, a variety of products are produced that range in protein content from 56 to 85 %. MPCs with higher protein levels suffer from loss in solubility during storage of the product after production. Several researchers studied the reasons for loss in solubility and mineral mediated aggregation of proteins is one of the primary reasons for loss in solubility of high protein MPCs [30-32]. In order to improve the solubility of MPCs, Baskhar *et al* [33] developed an ion exchange process and showed that depletion of calcium from MPCs prevented loss in solubility of MPCs during storage. Mao *et al* [34] used filtration technology wherein diafiltration was conducted with the addition of sodium chloride at 50, 100 and 150 ppm and showed that this process produced MPC with a modified mineral content. Marella *et al* [32] developed a process (Figure 6) for production of mineral modified MPC 80 with injection of carbon dioxide and showed that these MPCs retained its solubility when stored at room, as well as elevated, temperatures for up to 180 days. The mineral modified MPCs developed from this process showed superior functional properties [35].

Conclusions

Application of membrane separation technology in the dairy processing industry has brought a sea change in availability of a wide variety of dairy ingredients. Dairy applications account for a major share in total membrane surface area installed in food processing industries. As more and more demand for novel dairy ingredients is growing, research is focusing on development of new processing technologies that help production of value added dairy ingredients. Membrane separation technology continues to hold a key role in selective fraction and development of novel dairy ingredients. In this article, several new applications of membrane separation technology were discussed, and research results were presented.

References

References for this article are available from the editor at chemtech@crown.co.za.

Acknowledgement

F L Smidth supplies filter press for Mufulira smelter

Mining and minerals processing equipment manufacturer FLSmidth is in the process of delivering an EIMCO®-Clarifier-And-Thickener (E-CAT®) and a Shriver® filter press to Mopani Copper Mines in Zambia for its Mufulira Smelter. The equipment removes and dewaters dust particles from the water system.

Ricus van Reenen, Sales Manager: Products at FLSmidth, explains that FLSmidth's E-CAT® technology, which boasts no moving parts at all, combines optimised flocculation, high rate clarification and high density in a single compact unit. It streamlines liquid-solid separation flow sheets by optimising chemical settling aids and providing a dedicated escape route for displaced free liquid.

The fact that there are no moving parts translates into a lower cost and lower energy consumption, meaning reduced maintenance in the long run. The E-CAT® also has a smaller surface area than conventional thickeners, and therefore a smaller footprint that optimises space on constrained sites, particularly in remote locations in Africa.

In addition, the self diluting feed makes for optimal flocculant utilisation, while no external dilution pumps are necessary either. Good overflow clarity means that effluent can be re-used, while the dense underflow cuts down on the energy needed for drying. The smaller ponding area necessary also means a reduced handling volume.

For more information contact Terence Osborn on tel: +27 010 210 4820, email marinda.kerr@flsmidth.com, or go to www.flsmidth.com

FLSmidth's Shriver® filter press is an industrial grade heavy-duty machine, designed for long life, low maintenance, easy operation and cost-effective filtration.

FLSmidth's Shriver® filter press is ideal for liquid-solid filtration, with more than 30 000 presses installed globally to date.

Outotec filtration solutions

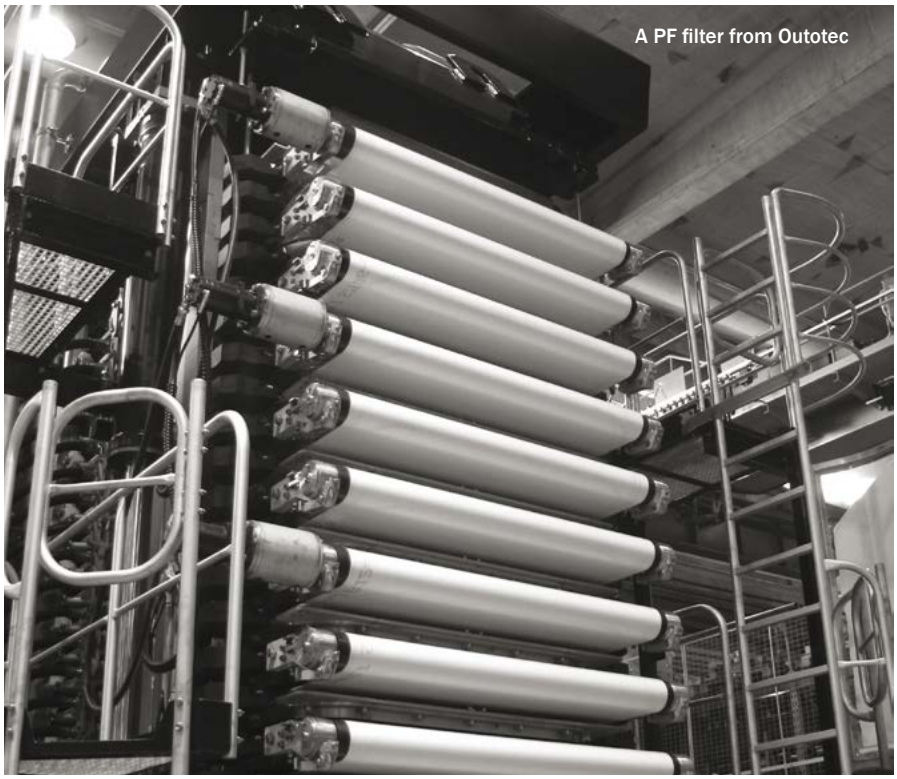
Outotec offers solid-liquid separation solutions for the mining, metallurgical and chemical industries. The company's expertise is based on the Larox trademark and previously known trademarks of Ceramec, Hoesch, Pannevis, Scanmec and Scheibler. Most of the products have served the markets for several decades and all of them are supported by Outotec life cycle services.

All Outotec filtration technologies are based either on over-pressure, including automatic vertical pressure filters, horizontal filter presses and polishing filters, or on under-pressure, including horizontal vacuum belt filters, ceramic disc filters and conventional vacuum disc and drum filters

Outotec filter products and services include: filtration plants, filter applications, ceramic filters, pressure filters, membrane filter presses, rotating disc filters, polishing filters, horizontal vacuum belt filters and filters testing.

Process expertise ranges from coal mines to food manufacturing, and from traditional to emerging applications, and aids customers in achieving their performance and sustainability targets. Outotec guarantees the performance of its solutions by conducting comprehensive test work, using the latest equipment and material technology, and by making innovation a continuous process.

A spokesperson for the company said "OutotecLarox filters are built to last, delivering maximum production performance, availability and the best process results at the optimum operating cost for a wide range of processes and process environments."



A PF filter from Outotec

Outotec is also at the forefront in meeting the filtration needs of mining and metallurgical industries worldwide. All solutions are designed for application-specific needs to meet all process performance requirements of customers.

In fact,Outotec has gained a solid reputation through Larox as "a truly reliable filtration solution provider for the chemical industries". Combining Outotec's technical know-how with the customer's own chemical and process expertise can, the company says, generate major cost-savings and improvements in the production process.

For more information go to www.outotec.com

The falling oil price won't kill renewables **but energy storage is still an issue**

by Gavin Chait

Wind turbines and photovoltaics are alternative energy sources to hydrocarbons. However, the cost to produce this energy and the means to store it are still being explored.

Asked, "What in my pocket actually contains more energy, my Zippo or my smartphone?" Randall Munroe in his XKCD column, What if?, responds: "Your hand."

Complex hydrocarbon chains are fantastic energy stores and so a quantity of propane the volume of a phone battery would power the phone about 13 times longer than the battery. A person's hand, though, weighs about a pound and contains sufficient stored energy in fat to provide 500 watt-hours of energy, about ten times the energy in the Zippo.

That's about the same energy stored in a car battery. Or a sandwich.

There is a difference between the stored energy of the source and the lossy process of conversion into useable energy.

Wind turbines and photovoltaics are not energy stores. You can't pile up a bag of wind or a pool of sunlight for a rainy day. So even though oil or gas prices can be extremely chaotic, the provision of consistent wind or sunlight is similarly uncertain.

Right now, though, the future price for oil has become monstrously speculative. Over the past few months oil has gone from $115/barrel to $45 and back up to $60. That makes investors extremely nervous. It is also making governments uncomfortable.

Headlines across the world have screamed "Low energy prices will kill renewables" and "Falling oil prices have no impact on renewables". Which is a bit confusing but, strictly, true.

What is an investor to do? Build a renewable energy plant now in the hopes that subsidies improve or hydrocarbon prices increase? Or recognise that politicians and consumers can't reconcile the contradiction wanting a transition to a no-carbon energy economy while keeping energy prices low, and so invest in new gas production?

We have two key energy requirements: for vehicles and for everything else. Anything moving needs to have a mobile store of energy for which carrying around a bucket of hydrocarbons works tremendously well. For everything else, we can connect them to a distribution network of cables from centralised energy production plants.

Wind and solar have tended to compete against gas and coal rather than oil. So the lower oil price hasn't become a burden. But gas has fallen steadily from a high of $6 per million BTU to half that over the last 12 months. At that price, the only renewable that is in any way competitive is onshore wind turbines. Gas would have to be twice as expensive before solar becomes cost-effective and off-shore turbines aren't competitive until gas increases five times in price.

Politically, politicians respond to voters who say they don't like looking at power-lines or at wind-turbines. That means either off-shore turbines or roof-bound solar panels. Subsidies to producers and consumers help offset the price difference with gas. And the more the price falls, the costlier are those subsidies.

What governments should do is take the opportunity to impose a hefty carbon tax to raise the price of oil and gas,

stabilising the prices, and permitting renewables to become competitive in their own right.

But enough of the politics. A few people are taking some hefty bets on renewables. While Apple, Google, Uber and Chrysler have all announced self-driving electric car projects, Elon Musk has focused on the real opportunity.

Musk's Tesla is collaborating with his cousin, Lyndon Rive of SolarCity, to provide an integrated energy production and storage solution. SolarCity leases solar panels to residents at prices slightly less than they'd be paying to their local utility and then sells surplus power back to the grid at "net metering" prices.

Under these rules, utilities must buy energy back at the same price they sell it. SolarCity has almost 170 000 residential customers across the US and the utility companies are starting to balk at the cost of paying out. At some stage net metering rules will be adjusted to reduce the squeeze on utilities.

Home-owners too are caught out since, firstly, the majority of the energy produced by photovoltaics is when they're not at home and aren't using it, and, secondly, they still have to buy energy from the utilities at night when they are. Musk and Rive are aiming to solve that problem by installing home-based lithium-ion batteries produced at Musk's new Gigafactory battery producer.

Bloomberg New Energy Finance (BNEF) estimates that a German household installing 5 kWh of solar panels and 3 kWh of batteries would cut their grid energy consumption by 80 %. But at a cost of $22 000 which would then yield only a 2 % return on their investment.

Musk believes he can cut battery storage costs from $250 per kWh now, to $100 per kWh. Photovoltaics are, similarly, falling in costs and have dropped by about 80 % in price over the past five years. With these changes, BNEF estimates the yield on a solar-battery combo could increase to almost 10 % a year.

That becomes quite compelling for households and allows them to consider abandoning the grid entirely. That transition could be messy since not everyone can afford the investment, and neither can governments afford to subsidise installation at every home.

The main beneficiaries are likely to be the wealthier middle-class. The same people who also subsidise lower energy prices from the utilities to the poor. Utilities are going to be left being margin-producers to the grid during periods of peak demand. A major adjustment will be required to respond to such market changes.

There is an additional consideration. 3 kWh of batteries is about 0,8 cubic metres. Where will you put it? And that is a lithium-ion battery. Musk thinks you'll be keeping it in your car, but that's the same car you'll unplug and drive to work each morning. What we are going to need are new types of battery and new types of photovoltaic if we really want to reduce the costs of production.

Former US Energy Secretary Steven Chu was recently asked what he thought the most interesting scientific

advances are in the field of clean energy. His response: perovskites.

The problem with existing photovoltaics is that they rely on slabs of crystalline silicon which are expensive and difficult to grow. Perovskites can be produced from simple bulk chemicals. Methylammonium lead halide is the current leading perovskite material having gone from a 3,8 % conversion of sunlight to electricity to 19,3 % over the five years to 2015. Researchers believe they can get it to 50 %.

Henry Snaith, a physicist at the University of Oxford, has already spun out his research into a new company called Oxford PhotoVoltaics. They are working with glass manufacturers to create perovskite glazing materials. This will add 10 % to the price of existing glass, give it a slight grey tinge, and permit electricity generation at 6-8 % efficiency. They want to follow that up with perovskite-embedded roofing tiles.

There are some concerns about the use of lead in the current formulation, even though Snaith points out that existing coal produces 10 times the lead for the amount needed in a 1 terrawatt perovskite array. Researchers are already looking for alternatives, with tin perovskites being a recent prospect.

The next problem is energy storage, but even here there are numerous options, ranging from fast-charging capacitors for regenerative braking, and metal-air batteries.

Metal-air, and aluminium-air batteries in particular, are amongst the most interesting for future energy storage. They offer the most energy dense power storage currently known but are difficult to recharge. Aluminium, which is cheap and abundant, offers promise but the current approach converts the anode to hydrated aluminium. Technically, this can be recovered and converted back into aluminium, but you're still going to be physically replacing the anode when you need a recharge.

A recent announcement by Fuji Pigment is that they have solved the lifespan problem by incorporating a secondary battery into the design. They hope to commercialise this by 2016 which means we should see some prototypes demonstrated later this year.

Flow batteries are another alternative, and work by pumping liquid electrolytes of iron, zinc or potassium through a cell. Increasing the scale of the battery is a matter of increasing the electrolyte volume. The costs come from the electrolyte solution and the ion-exchange membranes.

The heavy subsidies aimed at residents have obscured a mature market message. It is not economic or efficient to distribute generation to individual home-owners. Imagine maintaining your own flow battery, or monitoring and replacing aluminium anodes in your metal-air battery in a dedicated battery-room at the bottom of the garden.

The likelihood is that local utilities will act as energy stores for residents and businesses, and they will buy energy from the most effective suppliers. Solar during peak sunshine, wind during appropriate weather, and from nuclear (if we're ever allowed, or Zuma has his way) or gas when nothing else is available.

Electric cars will still be able to act as peak energy stores in such a design but such a grid will need to be extremely flexible to handle multiple energy sources, load balancing, as well as mobile battery stores in motor-vehicles.

That also requires flexible regulators. And, as with so many things, the technology will become available long before the politics is ready to absorb it.

Does wind plus storage pose a threat to CSP?

Wind and battery storage could ultimately represent an even greater competitive threat to CSP than PV and batteries, recent levelised cost of energy (LCOE) data reveals.

An analysis of unsubsidised LCOEs for different energy sources, published last September by Lazard, a leading independent financial advisory and asset management firm, shows wind far outgunning PV in the US market.

While the LCOE for PV currently sits in the range of USD$72 to $86 per megawatt-hour (MWh), with the potential to reach $60 by 2017, onshore wind can already claim a range from $81 down to as little as $31.

CSP with storage, which has an LCOE of between $118 and $176, currently commands a premium over PV and wind because its thermal energy stores allow it overcome the problem of intermittency, and be dispatched on demand. For the time being, the battery storage that could level the playing field for PV and wind is prohibitively expensive. Its current LCOE is between $265 and $324/MWh, comparable to that of diesel generation at $297 to $332.

However, Lazard estimates that by 2017 the LCOE for 'next generation' batteries will have dropped to $168/MWh, close to the range for CSP with storage.

Perhaps more importantly, the LCOE for fuel cells, an electrical energy storage technology currently being eyed for use with the wind industry, is already between $115 and $176.

The implication is that the combined LCOE for wind farms with fuel-cell and next-generation battery storage could soon be significantly less than CSP and also PV.

In a recent report on the wind industry supply chain, FTI Intelligence found a growing interest in energy storage across the sector, both from suppliers and original equipment manufacturers. "A123

is one of those which has already worked with turbine OEMs in the wind industry," said Aris Karcanias, managing director and co-lead of the clean-tech practice at FTI.

"GE has been developing its own energy storage technology and recently moved its energy storage business into its renewables division, out of its transportation unit, where the technology was originally intended for train locomotives. And Siemens has been developing its own energy storage system, although it hasn't been deployed commercially with a turbine yet."

For the time being, however, KTH Royal Institute of Technology solar thermal power R&D engineer Rafael Guédez believes battery technology still is not quite up to the task of competing with CSP's thermal energy storage.

Dr Thomas Mancini, principal at TRMancini Solar Consulting, agrees the threat is not imminent. "This depends on the cost of storage," he said. "Right now, I don't think it is an issue. But in the future, wind or photovoltaic power could provide a very viable option with inexpensive storage."

Originally published on CSP Today (http://social.csptoday.com). Story by Jason Deign

Breakthrough in solar energy research

Australian scientists recently announced that they had made a breakthrough in increasing the efficiency of solar panels, which they hope could eventually lead to cheaper sources of renewable energy. In what the University of New South Wales described as a world first, the researchers were able to convert more than 40 % of sunlight hitting the panels into electricity.

"This is the highest efficiency ever reported for sunlight conversion into electricity," UNSW Professor Martin Green said in a statement. "We used commercial solar cells, but in a new way, so these efficiency improvements are readily accessible to the solar industry."

While traditional methods use one solar cell, which limits the conversion of sunlight to electricity to about 33 %, the newer technology splits the sunlight into four different cells, which boosts the conversion levels, Green told AFP.

The prototype technology is set to be harnessed by Australian company RayGen Resources for solar power towers, which use sun-tracking mirrors to focus sunlight on a tall building. Green is hopeful the technology can also eventually be used for solar panels mounted on people's roofs, which he said currently had a 15 to 18 % efficiency rate. Green added that strides in technology made in the solar industry such as the higher conversion levels, were helping to drive down the cost of renewable energy.

He was confident that in a decade solar-generated electricity would be cheaper than that produced by coal.

Source: http://www.news24.com/Green/News/Australian-scientists-in-solar-energy-breakthrough-20141207

Engen Petroleum pilots solar installation in Alexandra

Engen Petroleum recently signalled its commitment to sustainable energy sources with a pilot solar power installation at the Engen All Africa Convenience Centre, Alexandra in Gauteng.

The implementation of a solar photovoltaic (PV) energy production system on the site is among the first renewable energy initiatives in the retail fuel sector. Joe Mahlo, Engen's general manager of Sales and Marketing said that this initiative is in line with the company's drive to reduce its environmental impact and the national climate change response strategy.

"We believe that it is our duty to reduce our carbon footprint. With the largest network of service stations in the country, we saw it as a good opportunity to further reduce our GHG emissions. South Africa produces most of its electricity by burning coal, so the less power we consume from the grid, the better to protect the environment from harmful emissions, reduce outages and rein in the depletion of natural resources," continued Mahlo. Once installed, the solar PV panels are designed to be maintenance-free, apart from occasional cleaning. To minimise dust accumulation, the panels are affixed, where possible at a slope, to benefit from the self-cleaning action of seasonal rain. Mahlo confirmed that the entire site's daytime energy needs will be met by the new solar PV installation — including fuel pumps, LED lighting, chiller machines, coffee machines, refrigeration, ovens, computer systems, compressors and more. The Engen solar PV installations can be grid-tied, allowing the energy generated on site to be remotely managed and, if needed, reallocated elsewhere by feeding excess energy back into the Eskom grid. This has the potential of making Engen's retail network a 'net-zero' energy operation.

To investigate further opportunities and areas of energy efficiency and GHG emission reduction, Engen has signed an agreement with the National Business Initiative (NBI) of South Africa to implement the Private Sector Energy Efficiency (PSEE) project.

For more information go to http://www.publicityupdate.co.za

Meeting socio-economic challenges through sustained infrastructure investment

Consulting Engineers South Africa's (CESA) President, Abe Thela, recently presented his presidential message and theme for the year at a function held in Johannesburg. With the theme of 'Meeting Socio-Economic Challenges through Sustained Infrastructure Investment', Thela stated that this year CESA will be focusing on the role infrastructure plays in the socio-economic development of our country and how this role can be enhanced through an increase in infrastructure investment and skills development.

Social, political and economic realities

The National Planning Commission identified the two most pressing challenges facing the country as being the fact that too few South Africans are employed and that the quality of education for poor black South Africans is substandard. The unemployment rate is estimated at 25,4 % and of great concern is the fact that 50 % of unemployed South Africans are youths between the ages of 15 and 24 years. This figure escalates to 63 % if the discouraged youth job-seekers are added to the statistics.

Thela stated: "These problems, coupled with the rising youth population, reflect a generation at risk, contribute to socio-political disorder, increase the strain on the country's limited financial resources and arrest economic growth."

Increasing infrastructure investment

According to the NDP, South Africa will need to spend at least 30 % of its GDP on infrastructure development to allow infrastructure to have a meaningful contribution in eradicating poverty, halving the unemployment rate and contributing to economic growth to the desired level of between 5 and 7 % per annum by 2030. Currently the country is only managing 22,9 % of GDP on infrastructure spending with the public sector contributing 13,95 % and the private sector 8,95%. The respective targets for the public and private sectors are 20 % and 10 %.

He contends: "It is therefore clear that the starting point for addressing the country's socio-economic challenges is to increase investment in infrastructure development." In order for South Africa to address its socio economic challenges both public and private sectors will have to increase their spending on infrastructure with the public sector needing to increase more.

The use of the Public-Private Partnerships (PPPs) in the financing, design, building and operation of infrastructure has emerged as the most important model employed by governments around the world to close the infrastructure gap. South Africa has not yet realized the full potential of this model of infrastructure delivery. Many opportunities exist in various economic sectors such as renewable energy, transportation, water, alternative energy sources, education, etc, where the PPP model can be used to maintain the momentum of infrastructure development in the country. However, the process must be transparent, the project pipeline clearly defined, regulatory red tape removed and the public must get better and more cost-effective services.

CESA has, for some time now, been aware that there are inefficiencies in the way public-sector infrastructure projects are implemented. These shortfalls include lack of planning, inappropriate procurement approaches, lack of project management capacity and capability, lack of other desired technical skills in the public sector, rampant corruption, and so on. In addition these inefficiencies rob South Africa of multiple billions of rands annually, which could be effectively used to fund the much-needed increase in infrastructure investment

In November 2014 Moody's Rating Agency downgraded South Africa's 'investment grade' credit rating to Baa2 from Baa1 and adjusted the outlook to stable from negative. It is crucial for the country to improve its investment grade rating to continue to access credit from both local and foreign lenders at favourable interest-rates. Unfavourably high interest-rates on loans reduce the value of the loans and accordingly the amount spent on infrastructure.

Human capital development

The increase in infrastructure investment will require more engineers, technicians and artisans to implement new infrastructure projects and maintain the existing infrastructure. The availability of skills is one of the elements that investors wanting to invest in a country consider with the level of skills determining the country's productivity and competitiveness.

There are a number of concerns regarding human capital development in the country and these require unique programmes focused on addressing them. These concerns must be addressed as a minimum: poor quality of basic education including maths and science; youth unemployed and unemployable; structure of the education system; youth with qualifications but without experience.

Thela believes that failure to tackle these challenges decisively with a systematic approach will deprive a whole generation of opportunities to develop their potential, escape poverty and support the country's trajectory toward inclusive growth and economic transformation. "CESA, with the backing of our over 500 strong member firms, recommit ourselves to partner with Government and other role players in finding lasting and practical solutions to these problems, especially in relation to infrastructure development."

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The Bill Neale-May Gold Medal and the Innovation awards

Do you know someone who has made an outstanding contribution to the Chemical Engineering Industry? Then nominate them!

The Bill Neale-May Gold Medal and the Innovation awards of SAIChE IChemE are made in recognition of outstanding contributions by chemical engineers to the industry. SAIChE IChemE considers that such recognition will provide encouragement for the pursuit of technological advances and innovative thinking and that it will also enhance the professional status of our profession.

The awards are scheduled to be made at the Annual Dinner of SAIChE/IChemE (venue and date to be advised). Closing date for Nominations is 17 April 2015. More information on the awards and how to nominate are found via www.saiche.co.za.

In our Diary

More details found via http://www.saiche.co.za/event.asp

- Problem Solving and Decision Making (Kepner-Fourie) in Durban, South Africa, from 24 to 26 March (register before 27 Feb) and from 27 to 29 October (register before 28 Sep).
- Annual Infrastructure Project Financing Africa from 2-4 March in Cape Town, South Africa.
- Design and Analysis of Experiments: A Short Course (CPD) from 10-13 March at University of the Witwatersrand, Johannesburg, South Africa.
- HAZOP Course (CPD) from 17 - 19 March in Johannesburg, South Africa.

Some useful links

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What is chemical engineering? Around the world.
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From the scent of geranium to cough medicine: A simple catalyst helps to construct complex biological scaffolds

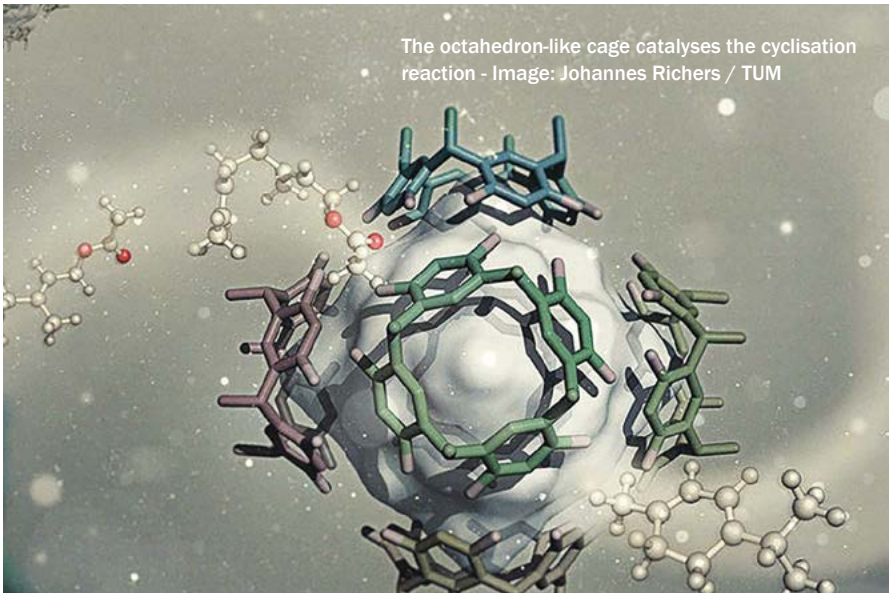
Terpenes and their derivatives exert important biological and pharmaceutical functions. Starting out from a few basic building blocks, nature elegantly builds up complex structures. Chemically particularly challenging are bridged ring systems such as eucalyptol. Chemists at the Technische Universität München (TUM) have now developed a catalyst that initiates the formation of such compounds. A special feature of the catalyst: it self-assembles from smaller units.

With great elegance, nature builds up complex structures from simple building blocks. A central class of compounds consists of terpenes. More than 8 000 terpenes and about 30 000 of the related terpenoids are currently known. They are the key substances for many biological and pharmaceutical functions.

Eucalyptol, or 1.8-cineole, for example, is contained in many medicines for coughs. It is an expectorant and works bactericidally. Chemically, it consists of a ring of six carbon atoms which is additionally bridged. Starting out from geraniol, the main constitutent of the scent of geranium, this double ring is formed by a so-called tail-head-cyclisation.

The biggest challenge of an artificial production is that as a first step, a high-energy intermediate state is formed, in which the molecule has a positive charge. Without a catalyst, the molecule could further react in different directions. The desired product would be one of many and the yield only low.

"Our catalyst stabilises the transition state and directs the reaction in the right direction,"



The octahedron-like cage catalyses the cyclisation reaction - Image: Johannes Richers / TUM

says Konrad Tiefenbacher, Professor of Organic Chemistry at the Technische Universität München. "In solution these reactions were previously not feasible."

The catalyst of the reaction is also special: four resorcinol molecules are linked to form a large ring consisting of 16 carbon atoms. Six of these molecules self-assemble in solution to a large, octahedron-like cage. In its interior the cyclisation reaction proceeds.

The electron-rich aromatic ring systems of the resorcinol-blocks appear to stabilise the positive charge of the intermediate state. Similar to the reaction pocket of the cyclase enzyme of the eucalyptus tree, the catalyst thus prevents undesirable side reactions.

Using parent compounds other than geraniol, a variety of other products could be feasible. "Eucalyptol is only a first step," says Konrad Tiefenbacher. "Our ultimate goal is the production of compounds with much higher complexity, such as taxol, which is used in the fight against cancer."

The paper, by Q Zhang and K Tiefenbacher was published as 'Terpene cyclisation catalysed inside a self-assembled cavity' in *Nature Chemistry*, Advanced Online Publication, on 16 February 2015. DOI: 10.1038/nchem.2181.

For more information contact Prof Dr Konrad Tiefenbacher TUM, Garching, Germany, or tel: +49 89 289 13332, email: konrad.tiefenbacher@tum.de or go to http://www.oc8.ch.tum.de.

SUDOKU NO. 102

Complete the grid so that every row across, every column down and every 3x3 box is filled with the numbers 1 to 9. That's all there is to it! No mathematics are involved. The grid has numbers, but nothing has to add up to anything else. You solve the puzzle with reasoning and logic. For an introduction to Sudoku see http://en.wikipedia.org/wiki/Sudoku

		3	4					
					8			3
	8				1	7		
		8	1			2	9	
6			5			3		4
3	2	4					1	
4		5		9				
	7				5			
						1	2	

Solution for SUDOKU 101

2	3	8	5	1	6	9	4	7
9	7	1	2	8	4	5	3	6
6	5	4	9	3	7	8	2	1
4	2	5	7	9	8	6	1	3
7	8	6	1	4	3	2	5	9
1	9	3	6	2	5	4	7	8
8	1	2	4	7	9	3	6	5
5	4	9	3	6	1	7	8	2
3	6	7	8	5	2	1	9	4

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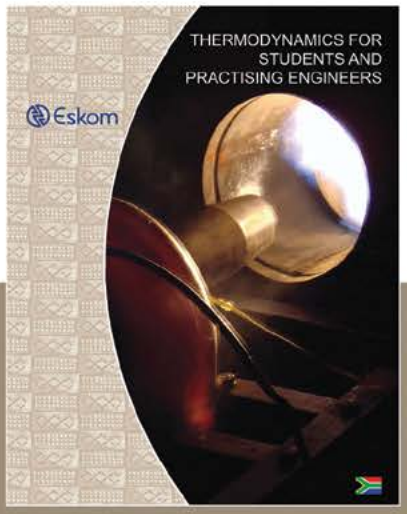

VOLUME 10

An understanding of thermo-flow processes requires a thorough understanding of the basic principles. In 'Thermodynamics for Students and Practising Engineers' the basic concepts are introduced with a ramp up to the analysis of operating engines, gas turbines and steam plant.

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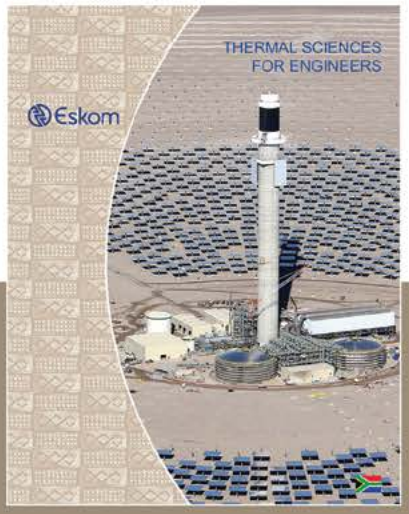

VOLUME 11

The key objective of 'Thermal Sciences for Engineers' is to present the influence of thermodynamics, fluid mechanics and heat transfer on the technical component of generating and new build businesses. More importantly, the application of the essential theory to operating plant and new designs is discussed using language familiar to engineers.

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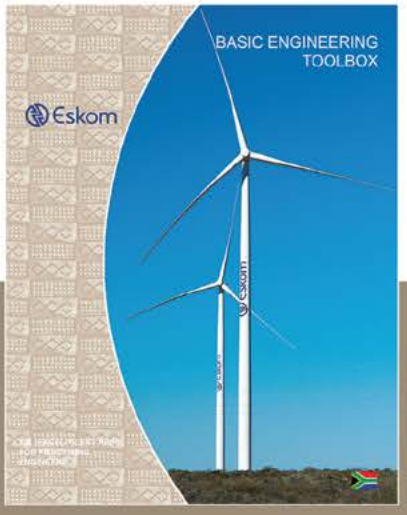

VOLUME 12

Basic Engineering Toolbox (six excellent apps) presents six indispensable tools that are excel based, require little set up and are easy to use. The apps are for simple fluid flow; basic generation plant for gas engines and gas turbines; wind turbine site classification for three year measured data sets; coal calorific value determination based on supplied volatile and non-volatile compositions; solar angle calculator based on the geographic plant location; and a concentrating solar plant levelised cost estimation tool for central receiver plants at 100 MW capacity. The last app is based on Upington (South Africa) data and is presented as a capacity factor versus solar multiple curve for various storage hours. The user will need to generate these curves using bespoke software for other locations.

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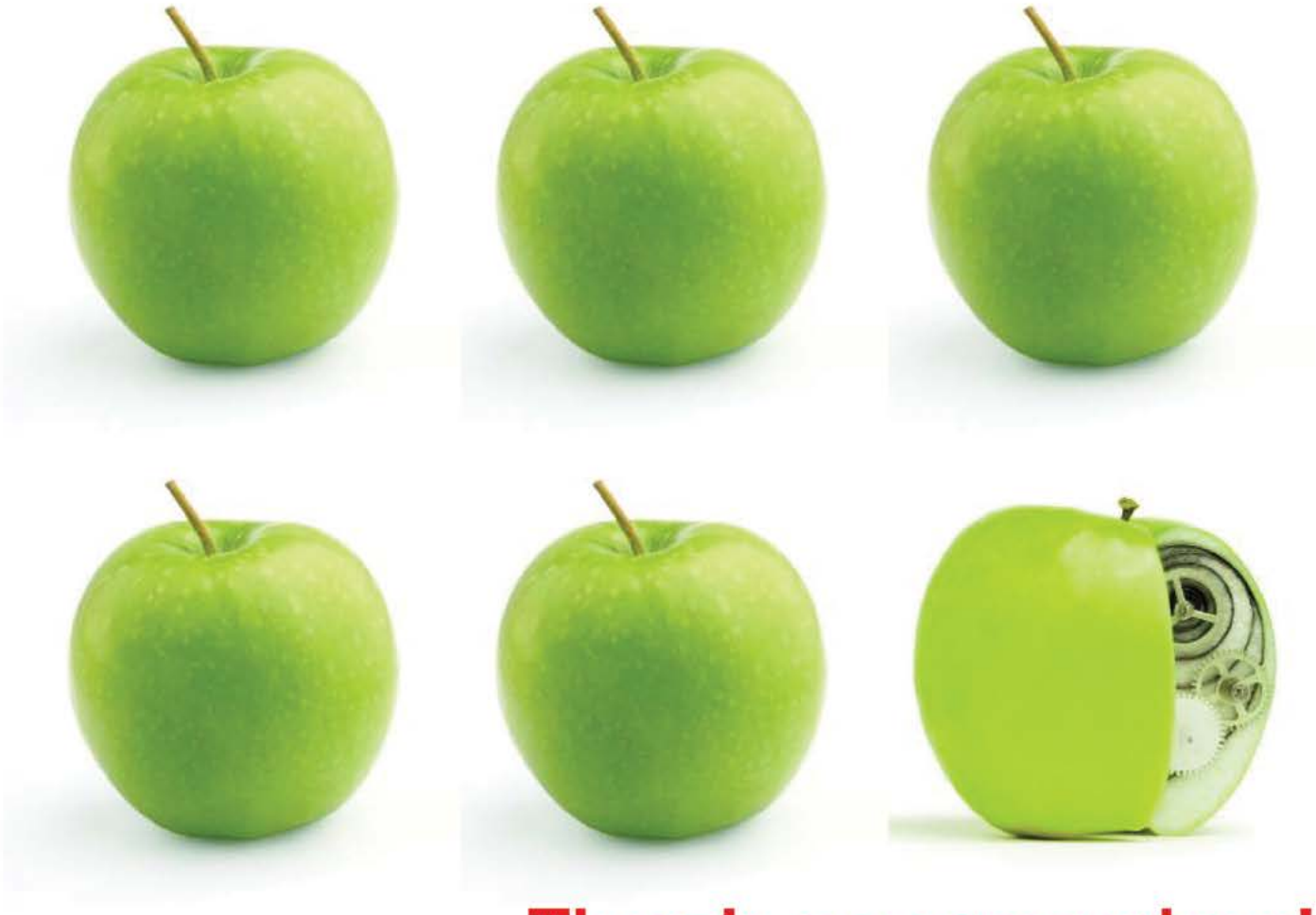
Comparing apples with apples?



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