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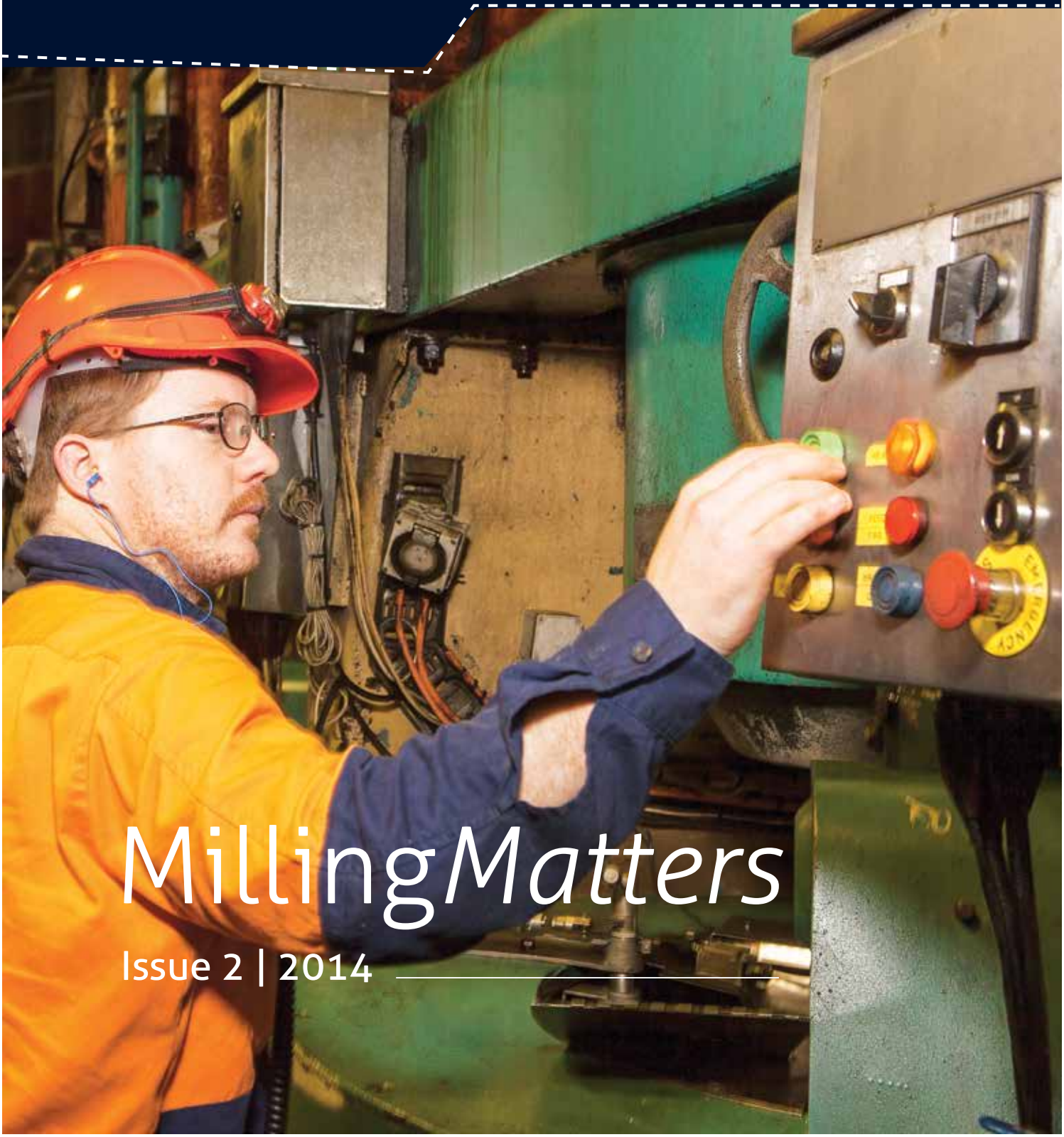

Milling*Matters*

Issue 2 | 2014

Welcome to Milling*Matters*

Dr Andrew Ward

Executive Manager

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In this edition we examine research projects throughout the milling process, starting with a 12-module structured training package developed to enhance the training of traffic officers.

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We also look at innovations and efficiency in the mill process – how evaporator station efficiency can be improved by lengthening the time between cleans, how steam efficiency may be enhanced, and whether Vacuum Belt Press Filters are viable in Australian factory conditions.

Environmental pressures on our industry are only likely to increase over time. Wet scrubbers are an important tool in reducing dust emissions but are prone to operational problems, and we feature an article with possible solutions to this problem.

The final three articles look towards the future and how value-adding to bagasse can be achieved through the production of biofuels, levulinic acid and other chemicals from sugarcane fibre.

In August, we invited the milling community to join our first-ever webinar to learn more about competency-based training of supervisors and operators. We were very pleased that 46 milling staff joined the webinar. Based on this success, we will present a new milling research topic each month through this platform. I encourage you to join future webinars and view recorded webinars. More information about our webinar series is provided on page 06.

SRA is your industry-owned company. If you have any suggestions on how we might keep the milling sector informed about our research, please let us know.

Andrew Ward

Executive Manager

Sugar Research Australia

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A new approach to traffic officer training

Dr Geoff Kent & Meredith Godat
Queensland University of Technology and
M Godat Consulting, respectively

Traffic officers supervise the mill rail transport system. Their significant responsibilities include supervising the locomotive crews, and ensuring the mill and the harvesters receive their cane bins on time.

To date, traffic officer training has been largely provided on the job. That situation has now changed, with the introduction of the TOTrain package of 12 training modules that comprehensively address the traffic officer job description.

What's in the package?

The modules can be grouped into three sets: technical; supervision and management; and general.

The technical modules cover specific traffic office tasks such as train separation and scheduling.

The supervision and management modules cover topics such as supervising locomotive crews, and managing relationships and risk.

The general modules address broader topics such as communication, improving the workplace and time management.

The modules have been developed using an innovative work-integrated learning approach. They still contain study notes but the main focus is on working through activities that reinforce learning. Trainees will complete the modules on-site while supervised by a trainer who most likely will be an experienced or former traffic officer.

The TOTrain package is hosted on QUT's Blackboard learning management system, which is designed for the development and delivery of courses.

Mill staff have been granted access to Blackboard to use the modules. Blackboard has other features that are expected to be used, including a forum facility that allows users from across the industry to share their learning experiences.

Traffic officer workshops

Transport staff across the industry have been intimately involved with this project from the start, helping to design the modules, define the activities and the content, and then review the finished product.

To facilitate this process, QUT has run a workshop for traffic officers every year since 2009.

The traffic officer workshops have provided a forum for the industry to collectively agree on the make-up of the training package and to review each of the training modules to ensure their suitability for each site.

In addition, they have provided a mechanism to conduct training into topics such as supervisory skills. The workshops have enabled the formation of a traffic officer community across the industry and have allowed considerable sharing of knowledge between sites.

Research project
Improving the efficiency of traffic office operations through improved traffic officer training
Project leader
Dr Geoff Kent, Queensland University of Technology
Project end date
1 August 2014

What's next?

Now that the package has been developed, the industry has started to adopt the training modules and to integrate the formal training resources into their existing training programs.

While integration remains a work in progress, plans have been made to share these integration experiences at the 2015 traffic officer workshop to hasten the adoption of the package across the industry.

Above: Sarah Blakey working with TrackSafe in the Mackay Sugar traffic office.

Managing evaporator station efficiencies and capital investment

Dr Ross Broadfoot

Queensland University of Technology

Scaling of the heating surfaces in evaporators determines when the factory must stop crushing to undertake chemical cleaning. In addition to this impost on factory operations, the evaporators are also the major user of process steam and so determine the factory's process steam efficiency.

Research project

Improving the performance and specification of evaporator stations

Project leaders

Dr Ross Broadfoot, David Moller and Hakan Bakir, Queensland University of Technology

Project end date

May 2014

This project sought to boost the performance of the evaporator station to allow longer operating times between cleans, and to provide better specification of the equipment when large improvements in steam efficiency are required.

The evaporator station is a major capital investment for a sugar factory and is the critical station for determining the total process steam consumption.

As well, because of scale deposition on the evaporator tubes, the juice-processing capacity of the evaporators generally limits the crushing rate after two weeks and the factory must be stopped for chemical cleaning of the evaporators.

The evaporators therefore have a major influence on factory operations and financial viability.

Two issues associated with the evaporators in Australian factories

The first task is to increase the juice-processing capacity of the evaporator set with relatively cheap retrofitted changes so that the operating time between cleans can be extended beyond the typical two-week period.

This task is best addressed by changing the juice-flow pattern within the evaporators at the tail end of the set in order to increase heat-transfer efficiency. Reduction in the temperature difference of vapour across the final evaporator will provide the greatest improvement in juice-processing capacity of the set.

The retrofitted changes that were trialled included installing baffles within the juice space and fitting gutters onto the outside of an evaporator in order to remove juice from above the heating surface rather than from below.

These investigations were undertaken at the Broadwater and Rocky Point mills, where staff at both mills helped with the changes and in monitoring performance. Recommendations on the preferred modifications were provided to the syndicate mills.

The second issue exists when a factory plans for major improvements in energy efficiency, for example, implementing cogeneration, and the evaporator station requires major reconfiguration and investment.

One problem always arises – the vapour rates to the later vessels in the set reduce substantially and the heat-transfer efficiency declines by an unknown amount.

Capital investments, often amounting to millions of dollars, depend on decisions about which the industry has previously had a poor technical understanding.

To address this second issue, the heat-transfer efficiency of the evaporator set at the Broadwater factory was investigated by monitoring performance for a wide range of vapour flow rates.

Broadwater Mill was able to implement the required changes within their existing plant and logged the performance data for the set over several weeks. The data were analysed and the changes in heat-transfer efficiency, when vapour rates were reduced or increased, were quantified.

This information will be very useful for the industry in guiding investment decisions when major changes to the configuration of the evaporators are required.

Acknowledgements

The management and staff at Sunshine Sugar's Broadwater Mill and the Heck Group's Rocky Point Mill are thanked for their assistance in this project. Special thanks are extended to Bruce Tyson (Rocky Point) and Gregg Mitchell, Brian de Beer and Steve Bell (Broadwater Mill).

Because this project was part-funded by a syndicate of mills, only limited data can be made available.

Vacuum Belt Press Filtration: an alternative mud filtration technology

Hakan Bakir and Dr Ross Broadfoot

Queensland University of Technology

Over 600 Vacuum Belt Press Filters (VBPFs) have been installed in sugar factories across South and Central America, as an alternative to Rotary Vacuum Filters (RVFs) for mud filtration.

VBPFs were not used in Australian mills prior to 2012, however a syndicated project has created an understanding of how this technology can be applied in Australian factory conditions.

Research project

Evaluate Brazilian mud filtration technology to increase the profitability and environmental performance of Australian factories

Project leaders

Hakan Bakir and Dr Ross Broadfoot, Queensland University of Technology

Jonathon Gilberd and Doug Sockhill, Wilmar

Project end date

August 2014

A comparison of VBPFs to RVFs

The successful operation of RVFs relies on a well-maintained and high source of vacuum and the supply of bagacillo of a certain size range and quantity to be mixed with the mud. Often, after a wet weather stop, it is difficult to obtain sufficient bagacillo, which limits the mud-processing rate and may necessitate a reduction or stoppage in crushing.

During start-up, RVFs require manual intervention as the vacuum must be introduced steadily and carefully to the wash zones so that sufficient vacuum is available for the pick-up zone to establish and hold a cake on the screen.

Compared to RVFs, the VBPF technology is simpler, more suited to automation and does not require a high vacuum source. Benefits of the VBPF technology also include:

- lower capital cost
- lower maintenance cost
- lower moisture mud
- less bagacillo requirements.

The production of lower moisture mud is environmentally beneficial as the filter mud is then able to be economically distributed over a wider area of canefields.

Investigating the VBPF

QUT staff have investigated other mud filtration technologies for the Australian sugar industry for a number of years. The VBPF manufactured by Technopulp Industrial in Brazil was identified as a viable alternative to RVFs.

The VBPF achieves filtration in three distinct sections – the gravity drainage section where approximately 70 per cent of the filtrate is removed; the vacuum section (<10 kPa); and the press section where a second belt is introduced to squeeze the mud over several S-bends.

In 2012, Wilmar purchased and installed a VBPF at their Pioneer mill. The performance and operational characteristics of the VBPF were evaluated and compared to the existing RVFs. Financial analyses were undertaken to determine the attractiveness of installing a VBPF instead of an RVF on the basis of a greenfield site, as well as for an existing mill installing a single filter unit.

Benefits of the study

The study has defined the operational and performance characteristics for VBPFs operating under Australian factory conditions and, importantly, has provided a direct comparison of VBPFs and RVFs operating with the same filter feed composition.

The study provided recommendations to the syndicate mills so that they can make an informed decision on whether a VBPF or RVF is the preferred filter technology for their mill.

What's next?

While the VBPF technology is well established in Brazil it is considered that further improvements in performance can be achieved in the use of this technology in Australian mills.

Acknowledgements

The decision taken by Wilmar Sugar to install a VBPF and provide the opportunity to undertake trials is acknowledged. The management and staff at the Pioneer Mill are thanked for their assistance in this project. Special thanks are extended to Pioneer Mill management, Robert Borg and the laboratory staff.

Because this project was part-funded by a syndicate of mills, only limited data can be made available.

Value-adding to bagasse to grow industry's future

Associate Professor Ian O'Hara

Queensland University of Technology

The Australian sugar industry is heavily reliant on crystal sugar as the major revenue stream from sugarcane. It is widely recognised, however, that revenue diversification is required to build a long-term, economically viable, and sustainable future for the industry.

Value-adding to bagasse offers significant opportunities for improving industry sustainability and improving financial returns for both sugarcane growers and processors.

Research project

Revenue diversification from sugarcane fibre: novel technologies for the processing of bagasse for low-cost biofuels production

Project leaders

Associate Professor Ian O'Hara, Dr Zhanying (Jan) Zhang and Professor William Doherty, Queensland University of Technology

Project end date

August 2014

Filling the global demand for biofuels and biochemicals

The use of renewable agricultural biomass, such as bagasse, for the production of biofuels and biochemicals is emerging as a new global industry.

With sugarcane bagasse widely recognised as one of the best potential feedstocks for this new industry, interest in Australia's bagasse resource for biofuels and biochemicals production is growing rapidly.

Investment in new bioproduct technologies will deliver not only new markets and revenue streams but also new regional industries, employment and services in sugar communities.

New technologies to produce low-cost cellulosic biofuels

One of the key challenges to unlocking low-cost sugars from bagasse for the production of biofuels and biochemicals is to develop better pretreatment and enzyme technologies.

The cost of biomass pretreatment and enzymes accounts for approximately 50 per cent of the total cost of bioethanol production.

There has been rapid change in this industry in the past 12 months, with commercial-scale facilities in construction and operation in Europe, the United States of America and Brazil.

In late 2007, QUT commenced a research collaboration with Syngenta to meet the challenge of producing low-cost cellulosic biofuels from sugarcane.

At QUT, the Syngenta Centre for Sugarcane Biofuels Development (SCSBD) was formed to develop technologies for efficient biofuels production.

This capacity at QUT to both develop new technologies and simultaneously undertake pilot-scale trials is rare, with limited publicly accessible facilities for demonstration of biomass technologies available anywhere in the world.

The goal of this project was to develop new processing technologies for sugarcane bagasse based on the use of low-cost, green organic solvents. The project focused on using glycerol (a waste product from biodiesel production) for bagasse pre-treatment and was one of the first major projects to use the Mackay Renewable Biocommodities Pilot Plant (MRBPP) for technology demonstration.

The financial benefits of glycerol process technology

In this project, the glycerol process technology was developed and demonstrated at the laboratory and pilot scale.

The benefits of the technology were assessed through the use of a techno-economic model comparing the new technology to other state-of-the-art technologies.

The economic modelling showed a clear financial benefit from the use of the glycerol process for bagasse processing, which makes the uptake of cellulosic ethanol from bagasse in Australia more likely.

As well as developing technology, the project also developed skills and expertise in diversification technologies – an area of critical importance to the future of the sugar industry in Australia.

What's next?

Cellulosic ethanol production from bagasse in Australia has the potential to add more than $800 million of revenue to the sugar industry.

Diversification is critical for the future viability of the Australian sugar industry.

By investing in research, Australia can continue to be at the forefront of innovation in new products from sugarcane.

Commercial implementation, however, will require the engagement of companies prepared to invest in the deployment of this technology in Australia, as well as industry and the research sector working closely together to identify and advance new product opportunities.

The implementation of this new technology will also be influenced by the policy and market environment for biofuels.

The SRA Milling Webinar series provides milling staff with the opportunity to not only learn more about expert milling research topics, but also discuss the information being presented, and provide input and feedback.

The series also allows attendees from any cane-growing region to participate without the need to travel.

Every webinar is recorded and hosted on the SRA website to allow those who weren't able to participate on the day to watch it later or, for those who did participate, to view it again.

To join our webinars you will need a stable internet connection, headphones (if you plan to listen via VoIP), or a telephone (if you plan to listen via teleconference).

You will also need a recent version of Adobe Flash Player.

If you would like to receive email invitations for our webinar series, simply click 'Subscribe to Updates' on the home page of our website www.sugarresearch.com.au and select the Milling Webinars option.

Our next webinar, 'A new approach to traffic officer training', will be presented by Dr Geoff Kent, QUT, and Meredith Godat, M Godat Consulting, on Wednesday 22 October at 10am (Queensland time).

If you would like to join the webinar, register by visiting the events page of the SRA website > Your SRA at work > Events or by clicking the link on the email invitation you receive from us.

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A new approach to traffic officer training

When: 10 am 22 October 2014

Presented by: Dr Geoff Kent, Queensland University of Technology

SASTA and ISSCT workshop highlights

Date: 19 November 2014

Presented by: Dr Geoff Kent and Dr Ross Broadfoot, Queensland University of Technology

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Improved modelling of wet scrubbers

Competency based Training of Supervisors and Operators (SOTrain)

RECORDED
22 October 2014
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A cleaner sugar industry for a greener world

Dr Anthony Mann
Queensland University of Technology

Wet scrubbers are a highly effective means of reducing dust emissions but are prone to operational problems, such as blockages and droplet carryover.

Measurements on a lab scale model of a wet scrubber and computational fluid dynamics (CFD) modelling are being used to optimise the design and operation of wet scrubbers to try to fix these problems.

Improving wet scrubber performance

Recent record high levels of electricity export from sugar factories have corresponded to record low levels of dust emissions from sugar factory boilers. One of the main reasons for low emissions is the increased use of wet scrubbers for removing dust from boiler flue gas.

Although wet scrubbers collect a lot of dust, operational problems associated with many wet scrubber installations reduce boiler steam output and, therefore, factory crushing rates. These problems include the following:

- Blockages increase the pressure drop across the scrubbers, which reduces the gas flow through the boiler and, therefore, boiler steam output.
- Droplet carryover causes build-up on and wear of boiler induced draft fans.
- Build-up on boiler induced draft fans often leads to excessive vibration.

To remove the build-up, boiler steam output has to reduce as the fans are slowed for cleaning. In some cases, fans cannot be cleaned adequately during operation and boilers have to be shut down.

How CFD can help to guide factory decisions

The design of wet scrubbers has traditionally been based on rules of thumb and knowledge gained through experience. Furthermore, as boilers age or are modified, the operating gas flow to a scrubber may not be the same as the design gas flow. In most cases, this will reduce scrubbing efficiency and cause operational problems.

Corrective action, such as adjusting the scrubber water flow rate or modifying the internal design of the scrubber, will be required. CFDs can play an important role in determining the appropriate corrective action.

A laboratory scale model of a wet scrubber has been constructed. This model, along with the extraction fan and connecting duct work, form the test rig that is being used for CFD model validation and flow visualisation. The test rig can also be used, in conjunction with CFD modelling, to evaluate scrubber design modifications.

At various sites in the model, such as the inlet duct, around the scrubbing vanes and around the demister vanes, air velocities and pressures are being measured for CFD model validation. Flow visualisation will be carried out by placing a source of smoke or small particles near the entrance to the inlet duct.

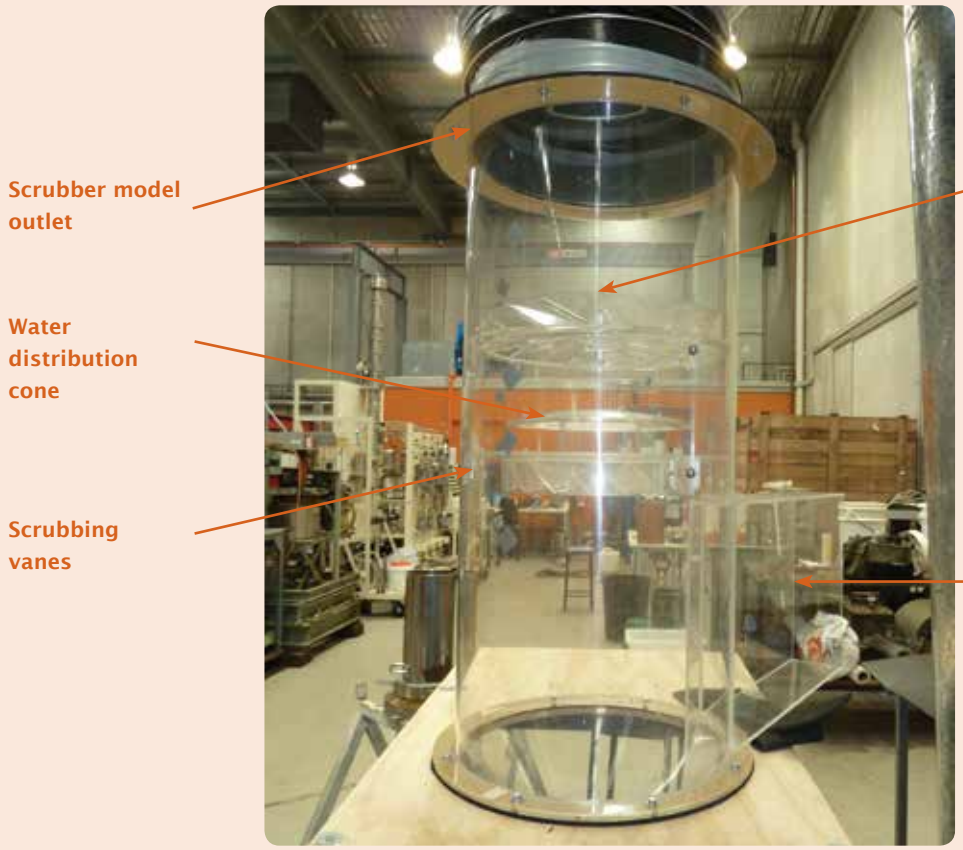
CFD modelling of the wet scrubber scale model is also being carried out. The results will be compared with test rig measurements to determine the preferred modelling approach.

Research project
Improved modelling of wet scrubbers
Project leader
Dr Anthony Mann, Queensland University of Technology
Project co-investigators
Hassan Ali, Dr Floren Plaza, Neil McKenzie and Dr Phil Hobson, Queensland University of Technology
Project end date
May 2017

What's next?

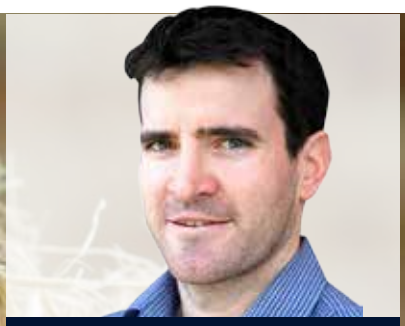
The CFD modelling code will be upgraded to better account for flow processes inside a wet scrubber, such as the atomisation of the scrubber water into droplets and the interaction between dust particles and water droplets.

The upgraded code will be used to model a full-scale scrubber and variations to its design for improved performance.



Above: Wet scrubber scale model used for CFD validation measurements.

Biochemicals from Bagasse: It's not ethanol



Darryn Rackemann

Queensland University of Technology

Conversion of biomass into higher value chemical products is receiving global attention as the world seeks to reduce its dependence on fossil resources.

However, the process for producing these chemical products is expensive. This research project sought to develop an environmentally friendly and cost-effective process for the manufacture of levulinic acid, furfural and other chemicals from bagasse.

Research project

Production of Levulinic Acid and Other Chemicals from Sugarcane Fibre

Project supervisor

Professor William Doherty, Queensland University of Technology

Project end date

January 2014

A new approach to converting bagasse

There are several methods of converting bagasse into liquid fuels and chemicals based on thermochemical or biochemical routes.

At present, the production of cellulosic ethanol from biochemical routes cannot compete with fossil fuels due to high production costs. Fermentation of pentose sugars (from hemicellulose) is not as efficient as hexose sugars (from cellulose), thereby reducing biofuel yield.

A different approach, which is possibly more viable, is to use a low-temperature, acid-hydrolysis process for the manufacture of levulinic acid and furanics (e.g. furfural). These compounds are versatile platform chemicals that can be used to produce fuels, solvents, polymers, pharmaceutical and agrichemical products.

The performance of methanesulfonic acid catalyst

This project examined an environmentally friendly, biodegradable organic acid – methanesulfonic acid – to limit corrosion and waste disposal issues associated with the use of mineral acids.

This catalyst was found to:

- produce significantly higher furfural yields and comparable levulinic acid yields to mineral acid catalysts typically used
- produce high yields of levulinic acid (>75 per cent from cellulose) and furfural (>85 per cent from hemicellulose) from bagasse.

Optimum product yields were achieved with a two-stage process.

The solid residues from the acid-hydrolysis process were a suitable combustion fuel to substitute for bagasse in sugar factory boilers, although some boiler modification may be necessary.

Figure 1 illustrates the potential value from processing 1t of bagasse. For a bagasse cost of $100/t (dry basis), the value addition is ~7:1 to bagasse.

Figure 1 also illustrates that to achieve this value a biorefinery approach producing multiple products rather than a single product is needed.

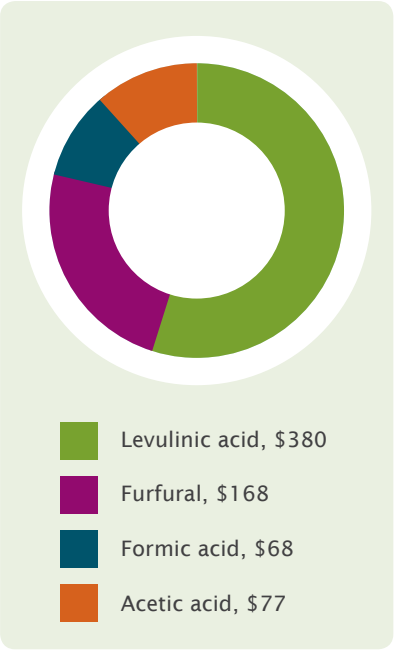
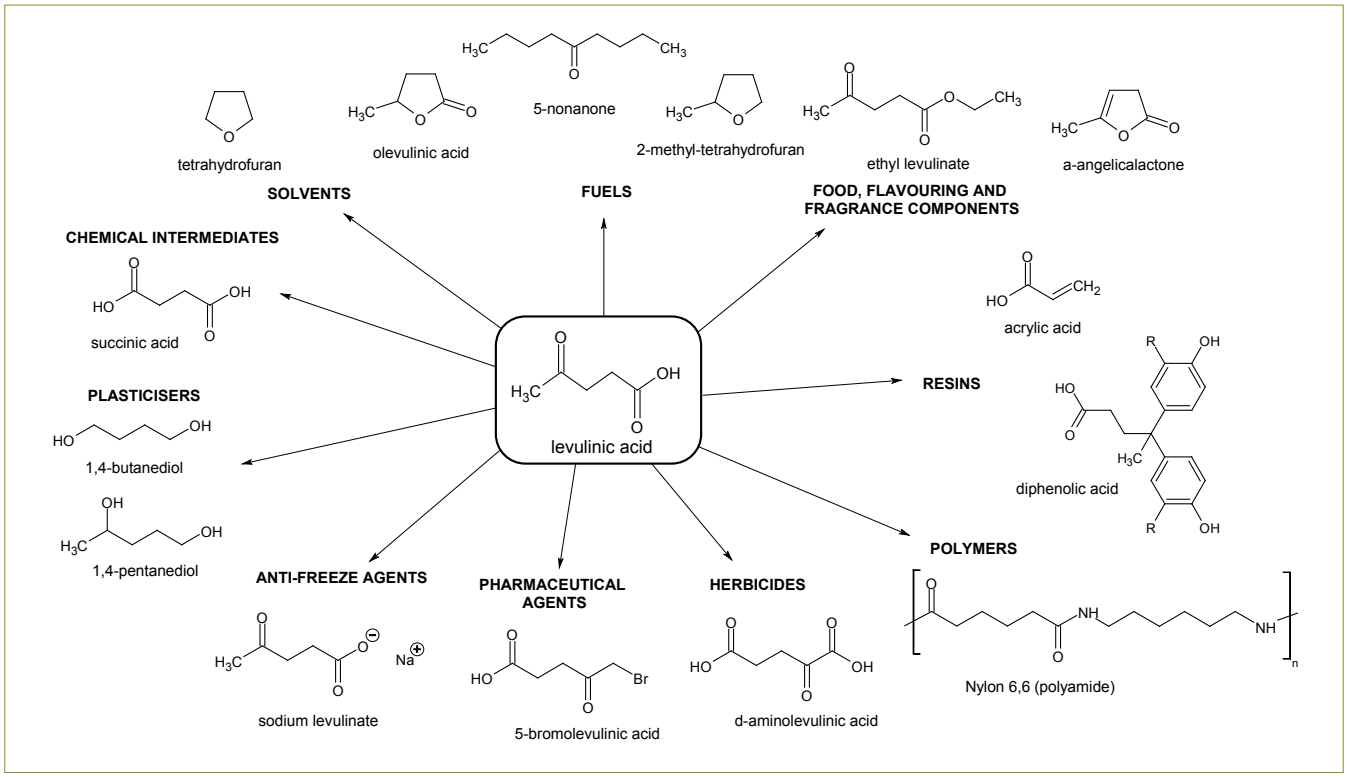


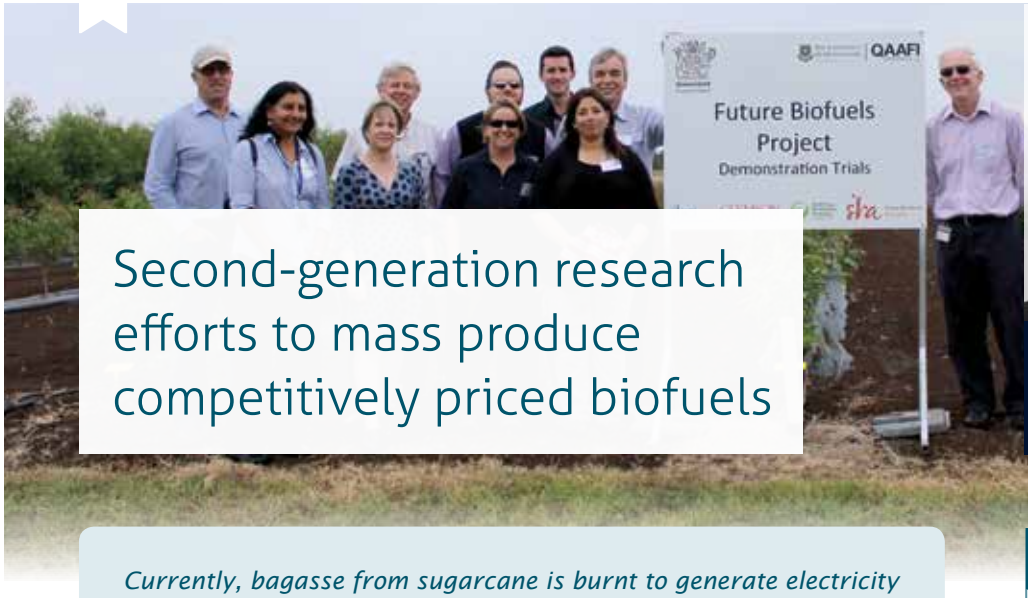
Figure 1: Products obtained from one tonne of dry bagasse, and production costs.

What's next?

Promising results with simple acid-hydrolysis technology have been achieved. However, to take this technology further will require demonstration at pilot scale to determine ongoing process and equipment maintenance costs, and to examine the feasibility of product-recovery processes.



Above: Levulinic acid as a platform chemical.



Second-generation research efforts to mass produce competitively priced biofuels

Professor Robert Henry
QAAFI

Currently, bagasse from sugarcane is burnt to generate electricity in sugar mills. In this project, the process being developed aims to continue to allow co-generation of electricity from the residue after the fuel is extracted.

Research project

Advancing technology for production of biofuels from sugarcane bagasse

Involved organisations

University of Queensland
Clemson University
Joint Bio Energy Institute
Sugar Research Australia

Project end date

November 2015

The Future Biofuels project

The Future Biofuels project is a major international collaboration supported by the Queensland Government, the University of Queensland and the US Department of Energy. Other collaborators include Sugar Research Australia and Clemson University.

The project's main process was originally used in the USA to convert switch grass and sweet sorghum to fuels. It was supported by the US Department of Energy. Now, that technology is being adapted for sugarcane. So far, the research has achieved efficiencies of yield and cost that will support the development of commercial-scale, second-generation biofuel production.

This project, based in Queensland, is developing a range of improved feedstocks and conversion processes for production of second-generation biofuels and biomaterials. Other technologies are also being refined. These are for improving the composition of sugarcane bagasse and its efficient conversion to fuel.

Biomass conversion

Enzymes are essential for the conversion of biomass (i.e. plant material) into fuel. As part of this research, novel enzymes are being identified in our local Queensland biodiversity. They support these processes and also increase commercial viability.

To identify ways to cut costs in the conversion process, researchers have worked on several topics – selecting more-efficient enzymes, selecting biomass with more amenable composition, and developing cost-effective pretreatments.

Queensland sugarcane varieties are being evaluated as sources of second-generation biofuel. So too are new energy-cane varieties (developed by the Cooperative Research Centre for Sugar Industry Innovation through Biotechnology).

The composition of biomass and its potential for conversion to fuel have to be assessed. For this part of the project, staff at the Joint Bioenergy Institute in San Francisco are developing new biomass chemistry tools.

In their laboratory, they are using robotics for sample processing, and a wide range of advanced spectroscopic instruments.

Because the composition of biomass influences its efficiency at being converting to fuel, project researchers are analysing this influence.

They want to gain a better understanding of how the chemistry of biomass causes variations in fuel conversion efficiency or fuel extraction efficiency.

They are identifying factors that limit conversion yields and efficiencies, and also defining new targets for genetic selection in biomass improvement.

These critical advances will allow for the establishment of commercial programs to select and breed new biomass and biofuel crops for local and global production.

Other benefits of the research project

This project is making a major contribution to sequencing the sugarcane genome by engaging the Joint Genome Institute of the US Department of Energy in large-scale sugarcane sequencing.

This research platform will benefit sugarcane improvement more broadly.

The genetic control of these key traits is being established by advanced genomics approaches.

This will reveal strategies to design novel biomass especially altered to facilitate efficient conversion to sugars for fuel production.

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