DESIGN, MANUFACTURING AND MAINTENANCE OF SUGAR MILLING EQUIPMENT: OBSERVATIONS FROM THE 2008 ISSCT ENGINEERING WORKSHOP

By

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Abstract
AN International Society of Sugar Cane Technologists (ISSCT) Engineering Workshop was held in Piracicaba, Brazil from 30 June to 4 July 2008. The theme of the workshop was Design, manufacturing and maintenance of sugar mill equipment. The workshop consisted of a series of technical sessions and site visits. The Brazilian sugar industry is growing rapidly. The growth has occurred as the result of the sugar industry’s position as a key provider of renewable energy in the form of ethanol and, more recently, electricity. The increased focus on electricity is seeing investment in high pressure (100 bar) boilers, cane cleaning plants that allow an increased biomass supply from trash and digesters that produce biogas from dunder. It is clear that the Brazilian sugar industry has a well defined place in the country’s future. The ISSCT workshop provided a good opportunity to gain information from equipment suppliers and discuss new technology that may have application in Australia. The new technologies of interest included IMCO sintered carbide shredder hammer tips, Fives Cail MillMax mills, planetary mill gearboxes, Bosch Projects chainless diffusers, Fives Cail Zuka centrifugals and Vaperma Siftek membrane systems.

Introduction
An International Society of Sugar Cane Technologists (ISSCT) Engineering Workshop was held in Piracicaba, Brazil from 30 June to 4 July 2008. The theme of the workshop was Design, manufacturing and maintenance of sugar mill equipment.

The workshop consisted of a series of technical sessions and site visits. The workshop was held in conjunction with SIMTEC (Symposium and Technology Exhibition on the Sugar and Alcohol Industry).

SIMTEC is an annual event held in Piracicaba that provides a forum for technical presentations and discussion and showcases products and services from manufacturers and service providers.

The authors were two of four Australians who attended the workshop. This paper describes some of the highlights of the workshop from an Australian perspective and the potential significance of the highlights for the Australian sugar industry. Kent (2008) provided a more complete summary of the workshop activities and discussions.
The Brazilian sugar industry

Overview

Brazil has approximately 6 million hectares of cane land, producing 470 million tonnes of cane, 29 million tons of sugar and 17 billion litres of ethanol (Beauclair, 2008). About 20 million tons of sugar and about 4 billion litres of ethanol are exported. There are 357 factories producing combinations of sugar, ethanol and electricity.

An investment of US$17 billion by 2010 is expected to result in the construction of a further 88 factories. Most of the projected increase in sugarcane production will be utilised for ethanol production. Brazil has a further 106 million hectares of land available for agriculture.

Brazil’s ethanol program began in 1975 at a time of high oil prices and low sugar prices. The Federal Government promoted the use of E20 fuel blends, provided credit guarantees and low interest loans for new distilleries and used a Government-owned distribution company to distribute ethanol throughout the country.

The Government also signed agreements with car manufacturers to produce cars to run on 100% ethanol. After a difficult period in the late 1980s, the Government again assisted the industry in the 1990s by mandating 20% ethanol in petrol, signing further agreements with car manufacturers to develop ‘flex fuel’ vehicles that can run on any blend of petrol and ethanol, and reducing sales tax on flex fuel vehicles. The first flex fuel vehicles were available in 2002 and now account for 88% of vehicle sales.

Renewable energy supplies about 45% of Brazil’s overall energy needs. Sugarcane alone supplies about 14% of Brazil’s energy needs, about a third of their renewable energy. Brazil’s sugar mills and distilleries generate about 3% of Brazil’s electrical power, although much of that electricity is for self-consumption. Most of the energy supply is in the form of ethanol.

Strategic direction

It was clear from several Brazilian speakers at the workshop, from the SIMTEC presenters and exhibitors and from the site visits that there is a demonstrable commonality of purpose exhibited at all levels of the Brazilian industry toward a future built on sustainable energy. A level of partnership appears to exist between Government, Industry and the Community, with sugar at the centre of an energy industry designed to provide for the country’s future sustainable energy needs.

The transition from a ‘sugar’ industry to an ‘energy’ industry has occurred over the past 40 years and is still a work in progress. Mandu and De Barra factories, where site visits were hosted, are typical of the current generation of Brazilian mills. Both produced a range of sugar products and ethanol and have the ability to vary the production of each product stream.

Both factories also cogenerated electricity on a modest scale, primarily for their own processing requirements, from traditional low to medium pressure boilers (22 bar to 66 bar).

In contrast, new factories and factory upgrades are focussing heavily on the addition of very high pressure boilers (100 bar) to produce a substantial third revenue stream in the form of electricity (Olivério, 2008).

As part of this strategy, a proportion of the cane trash (about 13% cane) is being harvested with the cane to significantly increase the supply of biomass for energy production. The Brazilian industry has invested in the development of cane cleaning technology over the
past 15 years to separate the trash from the cane at the factory (Delfini, 2008). In addition to the bagasse and trash fuels, factories now exist where dunder from the ethanol plant is being digested to produce biogas for electricity production (Olivério, 2008).

Brazil continues to invest in technologies to increase revenue from energy production. It was claimed that one tonne of sugarcane had the energy equivalent of 1.2 barrels of oil (Beauclair, 2008; Olivério, 2008). Areas of investment in research include gasification of bagasse for increased electricity production and bagasse hydrolysis for increased ethanol production.

Technologies of interest

Introductory remarks

The workshop and SIMTEC exhibition provided opportunities for manufacturers from around the world to showcase their technologies. In this section, relatively new technologies that may have application in Australia are discussed.

IMCO shredder hammer tips

IMCO is an Indian company that uses a different process to manufacture shredder hammer tips (Duttagupta and Rama Mohan, 2007). The process involves producing a sintered carbide consisting of tungsten carbide blended with fused ceramics in a chrome matrix to form an alloy powder block (Figure 1). The arrangement was reported to increase crack resistance and extend life. Comparison information was presented against traditional white iron tips and so it is possible that these tips will perform well relative to white iron. It is unlikely that the tips will have wear resistance comparable with tungsten carbide tips.

Fig. 1—Sintered carbide shredder hammer tips (Duttagupta and Rama Mohan, 2008)
While the focus of the presentation was on shredder hammer tips, the technology has also been applied to leveller knives, trash plates, and shredder grid bars.

**The MillMax three-roll mill**

The MillMax is a three-roll mill design from Fives Cail in France (Figure 2). Although the first MillMax milling unit installation occurred in 1991 (Bonin and Govaert, 1999), there was little interest in this design until recently. Since 2006, 21 mills of this design have been installed.

![Fig. 2—Schematic of MillMax three-roll milling unit (Trancart, 2008).](image)

The MillMax has a roll configuration similar to that of a pressure feeder, giving it reasonably high capacity in a three-roll configuration. Existing mills have capacities from 180 t/h to 900 t/h. The maximum capacity of the 102’ MillMax design was stated to be 1000 t/h.

The presentation claimed 12% lower capital cost, 40% lower maintenance cost and 30% lower power consumption than an equivalent four-roll mill.

**Mill planetary gearboxes**

Conventional mill gearing is being replaced by direct coupled planetary gearboxes for individual mill roll drives. TGM, a Brazilian company that hosted a site visit, has supplied over 500 planetary mill drives in the past three years.

The drives have been used to completely replace turbines or to provide *assist* drives to increase mill power through providing additional power on one roll. They can also be used to replace conventional gearing on turbine driven mills.

The planetary gearboxes were claimed to be more efficient than traditional mill gearing. They require considerably less space than conventional mill gearing (Figure 3).
An alternative drive configuration was presented by ISGEC John Thompson of India. One feature of this design is that the electric motors are vertically mounted to reduce the bending moment on the top roll shaft (Figure 4).
The chainless diffuser

The chainless diffuser concept from Bosch Projects in South Africa involves the replacement of conventional chains with moving floor sections (Schröder et al., 2007) as shown in Figure 5. This type of floor mechanism removes a significant restriction on the width of a diffuser. With this floor mechanism, there is no need for the headshaft and tailshaft, items that have traditionally limited the width (and hence capacity) of a diffuser. The floor mechanism also removes the need to keep the underside of the diffuser clear for the chain. Consequently, structural supports can be placed under the diffuser to reduce the size of the structural members.

Fig. 5—The Bosch Projects chainless diffuser (Schröder et al., 2007).

Dedini (Brazil) and Bosch Projects (South Africa) have joined forces to market Bosch Project equipment designs, including the chainless diffuser, into Brazil. Already Dedini have orders for nine of the chainless diffusers. The first of these diffusers was being commissioned in 2008 and is 15 m wide with a capacity of 800 t/h cane.

Zuka batch centrifugals

Zuka batch centrifugals (Pilot and Buyck, 2006) from Fives Cail in France reportedly have higher capacity and lower power consumption than earlier designs.

The designs (Figure 6) have capacities from 1500 kg to 2250 kg and operate from 26 to 31 cycles per hour. The design has a second discharger which is presumably responsible for the high number of cycles.

The consumed power reported was of the order of 0.7 kW.h/t massecuite, reportedly 30% to 40% less power than earlier designs.
Siftek membrane systems

Vaperma from Canada have developed a revolutionary membrane system for alcohol distilleries (Bernier, 2008). This system replaces the conventional rectification column and dehydration process and reduces energy consumption by up to 50%. The technology is quite new, with two demonstration plants using corn-based feedstock and one demonstration plant now constructed in Brazil using sugarcane feedstock. The system offers additional revenue from electricity due to the lower energy requirements for the plant, a continuous process and a flexible system allowing the production of both hydrous and anhydrous alcohol.

Conclusions

The Brazilian sugar industry is growing rapidly. The growth has occurred as the result of the sugar industry’s position as a key provider of renewable energy in the form of ethanol and, more recently, electricity. It is clear that the Brazilian sugar industry has a well defined place in the country’s future.

The ISSCT workshop provided a good opportunity to gain information from equipment suppliers and discuss new technology that may have application in Australia.

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