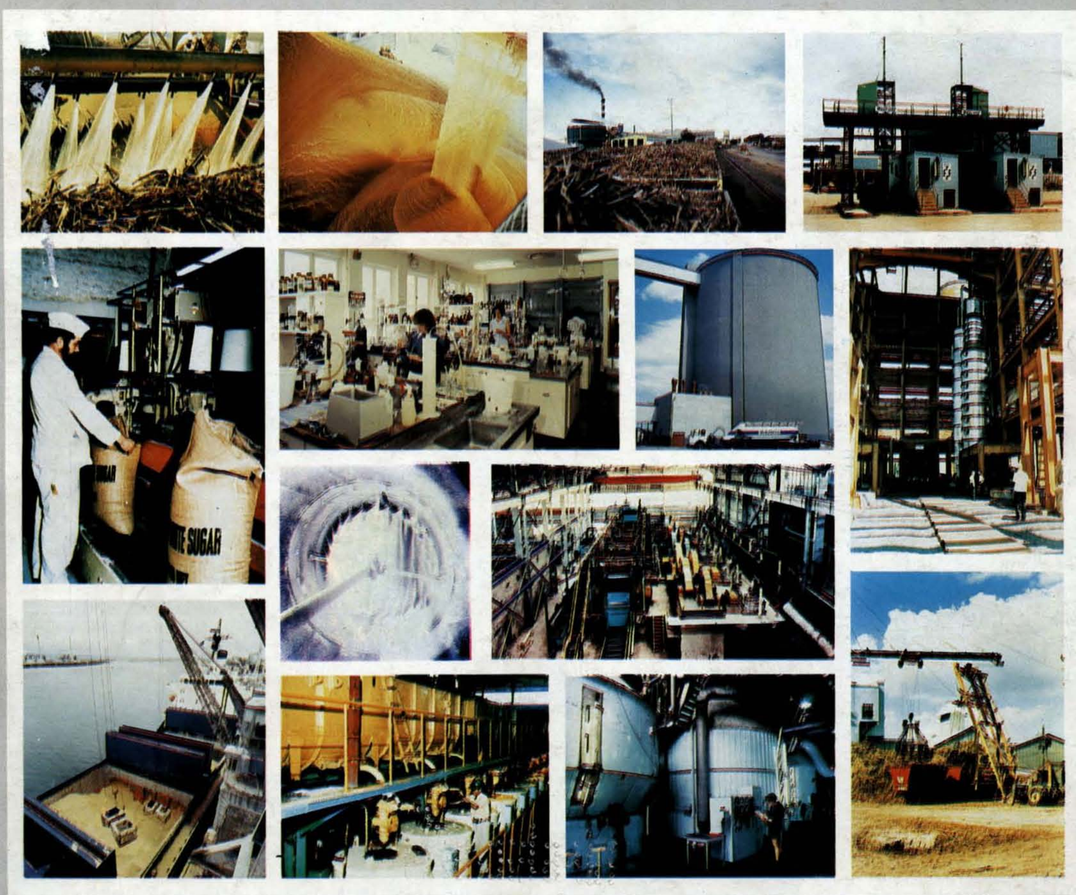
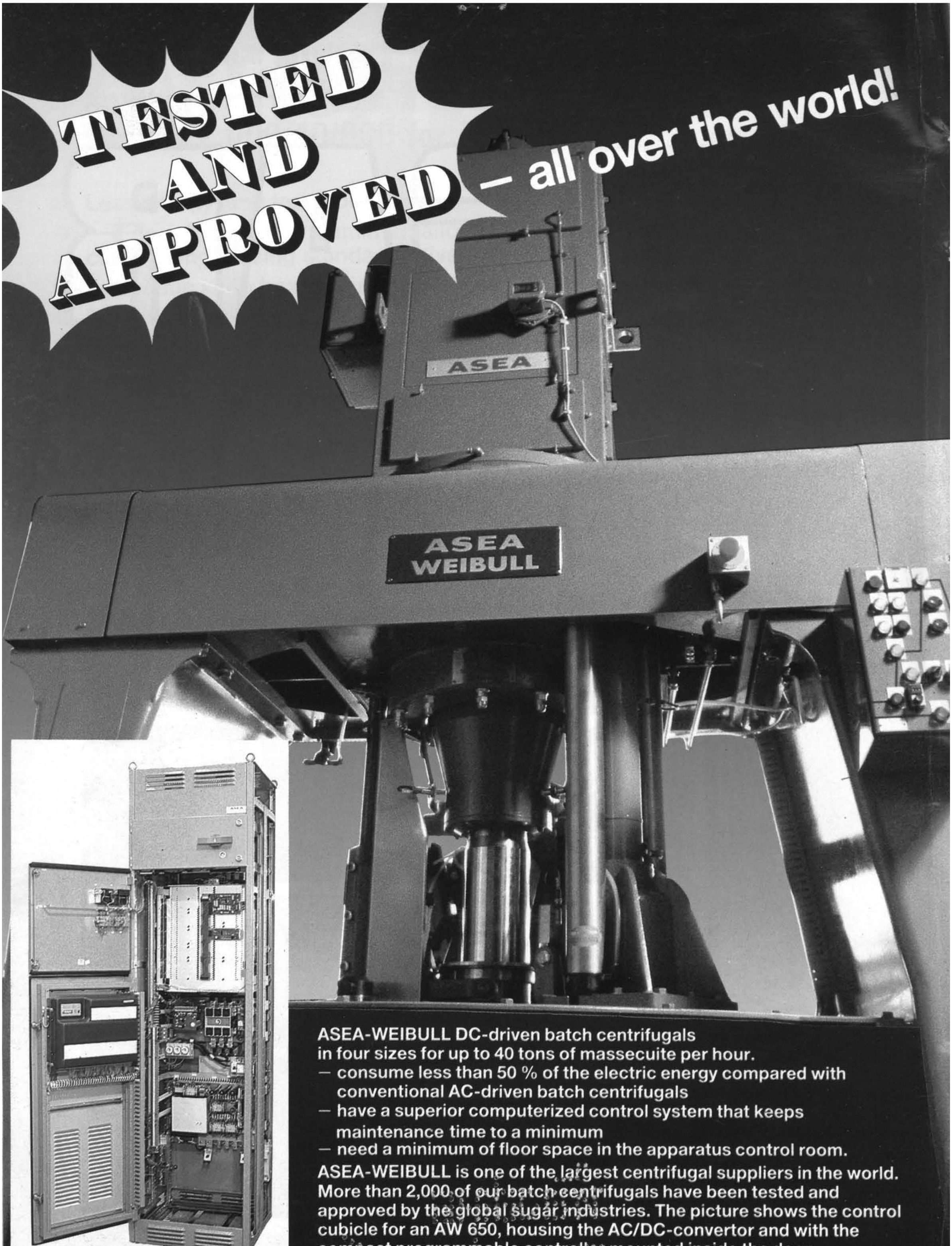
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXIX/ISSUE No. 1061

MAY 1987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UK ISSN 0020-8841

Annual Subscription:
£50.00 post free

Single Copies
£5.00 post free

Airmail: £24 extra

Claims for missing issues will not be allowed if received more than two months from date of mailing, plus time normally required for postal delivery of journal and claim.

Published by
International Media Ltd.,
P.O. Box 26, Port Talbot,
West Glamorgan SA13 1NX, U.K.

Tel: 0639-887498 *Telex:* 21792 REF 869

Printed by Adams & Sons (Printers) Ltd.,
Blueschool Street, Hereford.
Telephone: 0432 54123

INTERNATIONAL SUGAR JOURNAL

Volume 89
Issue No. 1061

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May 1987

Published by

International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: 0639-887498 *Telex*: 21792 REF 869
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News and views

Brazil sugar sale problems

One contributory factor to the recent rise in the level of world sugar prices has been the efforts made by Brazil to postpone the supply of sugar already sold in forward contracts. These have been generally to the sugar traders who have been asked to "roll the contracts forward" to allow shipment later than the originally specified date. This has met considerable resistance because the traders would have to turn to the world market to replace the supplies required and current prices around 7.5 cents/lb are almost double the world price at which the original contracts were made. They are therefore asking for compensation, but this is not likely to be forthcoming in the present fragile state of the Brazilian economy.

Another possibility mooted has been that Brazil should buy from the world market to meet its commitments, but this again would cost hard currency and has been ruled out by the Sugar and Alcohol Institute. The impasse continues, with the contracted traders unwilling to yield but not ready to press too hard in case Brazil declares the contracts void because of *force majeure*, in which case they would not be compensated at all.

Originally, Brazil wanted to postpone shipment of 800,000 tonnes out of a total of 2.3 million tonnes sold; subsequently, this quantity has been reduced to 400,000 tonnes but to eliminate this would mean cutting the sugar available for the domestic market in the face of increasing demand.

US sugar policy

It is not surprising that the sugar exporting countries which have lost the greater part of their market in the USA over the past few years have been vociferous in the condemnation of the sugar policy which has increased domestic sugar production, provided support for the growth of HFS as an alternative sweetener, and reduced imports to their lowest level for almost 100 years. Less expected, however, was a blistering attack by a US State Department official who also attacked the policy of the EEC[1].

Douglas McMinn, Assistant Secretary of State for Economic and Business Affairs, told the International Sweetener Colloquium in California in February that there is an urgent need for US sugar policy reform. He said not only will the US stop importing sugar in the next couple of years but it may well become a net sugar exporter in the next 2 - 4 years.

The State Department has long been critical of the US sugar program as it limits imports from Caribbean nations, where the US would like to aid the failing economies of allies there. McMinn warned that the sugar policy is driving such nations as the Dominican Republic closer to the Soviet Union as that country becomes a larger buyer than the US. He also charged that the program, which supports US sugar prices well above the world market, will cost US consumers an additional $3200 million this year and supported producers at a level significantly more favourable than programs for other crops.

World sugar balance[2]

In their second estimate of the 1986/87 world sugar balance, F. O. Licht GmbH have raised their estimates of initial stocks, production, imports and consumption for both the current and last seasons and for exports for 1986/87. As a consequence, final stocks are raised in absolute terms for both seasons but, expressed as a proportion of consumption, the latest balance shows a small fall in the final stocks at the end of August 1987. It is still set at 35%, however, above the traditional level of 25%.

While production forecasts for Western Europe are reasonably certain, there are doubts about some important areas, notably Brazil, Cuba, India, and the USSR. Licht's consumption estimate has been lifted by unexpected growth in Brazil, Mexico and Pakistan, but the import/export trade figures are little different from the earlier estimates. Using the ISO method of calculating surplus stocks these are assessed at 4.8 million tonnes, nearly 300,000 tonnes down from the first estimate and far below the 10 million tonnes surplus of 1983 and 1984. Most of the surplus is concentrated in the hands of the EEC and a few other exporters and is mostly as white sugar, so that a shortage of raw sugar could develop if there were a production failure.

Thus prospects are brighter but could be dashed if the green light was given to an expansion of sugar production before the present recovery has developed to its full potential.

World sugar consumption trends[3]

Despite the almost universal degree of protection affecting sugar industries and consumption around the world, there are signs that the very low level of world market prices over the past two years has begun to have an impact on growth rates for consumption. The average annual increase during the first half of this decade has been less than 2%, whereas it appears that offtake in 1986 has risen by nearly 4% over the previous year.

The greatest potential for expansion continues to be among the less developed countries and it is not surprising that, even including the decline in Japan, overall growth in Asia over the past six years has averaged 6%. The average expansion in Africa over the same period has been more modest at 2.75%. The trend in South America has been dominated by Brazil and, after five years when no growth took place on average, there has been an annual increase of nearly 11% for the entire continent in 1986. There has been an annual decrease of 4.4% in US consumption between 1980 and 1986 and the likelihood that this fall has been arrested or possibly reversed will benefit the overall trend from now on.

The reaction to low world prices is inevitably delayed when filtered by the numerous barriers which exist for trade but there are now signs that budgetary constraints are prompting a more searching examination of agricultural

1 *Public Ledger's Commodity Week*, February 28, 1987.
2 F. O. Licht, *Int. Sugar Rpt.*, 1987, 119, 57 - 62.
3 *Carnikow Sugar Review*, 1987, (1758), 23 - 24.

funding, especially where this applies to surplus production. Also, the low prices, to some extent maintained in terms of local currencies by the falling value of the US dollar, have encouraged countries like India and Pakistan to resort to imports in order to maintain consumption.

UK beet campaign, 1986/87[4]

The 1986/87 campaign, which ended on February 14, was one of the longest and most successful in the history of British Sugar. Just over 8 million tonnes of beet were processed at the 13 sugar factories to give about 1.3 million tonnes of sugar and 750,000 tonnes of animal feed. The main feature of the campaign was the record level of sugar content which averaged just over 18% on beet. Mild and generally dry weather, together with a healthy crop and the absence of any severe frost were the main reasons for this. As a result, the crop continued to grow until almost Christmas and was virtually disease-free. Several factories broke daily and weekly production records. The reduced molasses outturn reflected increased sugar extraction. A new four-crew, three-shift system of working has been an unqualified success.

Major savings in fuel usage were made in both sugar processing and pulp drying. Lime usage at all factories was at its lowest ever level. New capital installations helped to increase production, raise product quality and reduce energy costs. They included a new falling-film evaporator at Bury, a new tarehouse and vertical crystallizers at York and a new prescalder at Brigg.

EEC sugar offered for intervention

Sugar produced under quota in the EEC which is surplus to consumption needs is usually exported with the aid of a subsidy which is additional to the levy charged to the producers. Recently the Commission has set these subsidies at levels at which the producers have complained that they were making losses on their export sales. There has always been a "safety net" provision, widely used by the producers of grain, butter, wine, beef, etc., whereby the producers sell their commodities into intervention. The Commission is required to buy the commodity at prices which have already been established; in the case of sugar, this is 541.8 ECU per tonne, about 5% lower than the European market price. Only if the sugar does not meet quality standards can it be refused.

In mid-March a group of traders, in an unprecedented action, offered almost a million tonnes of sugar into intervention, with the object of embarrassing the Commission and highlighting their protest at the situation. Commission officials referred to "blackmail" and said that the sugar would, if necessary, be sold straight back on the European market, which would depress prices and would be highly disruptive for the market. A major problem for the Commission is that the sugar can be stored for only a relatively short time and, under its rules, the stocks would have to be cleared by September 30, putting the Commission in a weak position as a major seller.

Later in the month, however, the Commission authorized higher subsidy levels for 60,000 tonnes of export sugar although it declared that there was no relationship between the increase and the intervention sugar. The traders have the opportunity of withdrawing their offer up to May 6 but no indication had come at the time of writing as to whether this was likely to occur following the higher subsidies.

World sugar prices

Purchases by the USSR strengthened the London Daily Price of raw sugar at the end of February so that March started with an LDP of $203 per tonne. Problems for Cuba in meeting export commitments tended to keep the price firm for the first third of the month but indications that Brazil's difficulties would be eased, the shock of the EEC intervention offer and reports of higher than expected sugar production levels in India all contributed to a weakening of prices which brought the LDP to $173.50 by the end of the month. The strength of the raw sugar market at the start of March was reflected in a low premium – about $10 per tonne – between the white and raw sugar prices; as the prices declined this increased to around $15 and then to $20. Consequently, the LDP(W) started the month at $212 but fell to $193.50 on March 31.

Australia sugar crop, 1986[5]

The 1986 Australian cane harvest will be remembered by some cane growers as outstandingly good and by others as absolutely disastrous. Mills at Mackay, Proserpine and Ingham crushed bumper crops, in some cases record tonnages, whereas abysmal weather in other areas made survival difficult. Growers in the Cairns, Innisfail and Tully mill areas had their cane flattened by Cyclone Winifred, resulting in a crop down by 700,000 tonnes on the previous season, while suppliers to mills at Bundaberg, Childers, Maryborough, Nambour and Beenleigh were hard-hit by the effects of a drought-affected season which reduced their cane crop by some 700,000 tonnes. Cane growers at Rocky Point, who had to contend with frost as well as dry weather, produced less than half of their 1985 crop.

When the season started in mid-June, the Queensland cane crop was estimated at a 7-year low of 22 million tonnes. The bumper crops in the Central Area brought the final crop to a record 24 million tonnes, however. The volume of sugar produced in Queensland was 3,208,655 tonnes, N.T., only 45 tonnes more than produced in 1985. Outturn in New South Wales was 160,200 tonnes, almost 10,000 tonnes less than in 1985 and well below the 1982 record of 211,677 tonnes. Cane yield was 81.4 tonnes/hectare in Queensland and 81.9 tonnes/ha for Australia (against 78.2 and 79.4 for the previous season). Yield of sugar fell from 11.00 to 10.86 tonnes/ha in Queensland but rose from 10.80 to 10.95 tonnes/ha in New South Wales. The total harvested area was 310,033 hectares against 304,007 ha in 1985.

4 *British Sugar News*, 1987, (77), 1; (78), 1.
5 *Australian Canegrower*, 1987, 9, (2), 10 - 11.

Sugar Industry Technologists Inc., 1987

The 46th Annual Meeting of Sugar Industry Technologists is to be held during May 10 - 13 at the Regent Hotel, Sydney, Australia, the first time the group has met in that country, although members from Australia have been attending meetings in the USA and elsewhere for many years.

Members are to assemble on Sunday May 10 and will be entertained to a reception, with the business and technical sessions starting on the morning of May 11.

Papers to be presented include the following:

"Alternative methods of polarizing sugar" by Dr. Chung Chi Chou, of Amstar Corporation;

"Raw sugar analysis by chromatographic methods" by W. S. Charles Tsang, Margaret A. Clarke, Mary An Godshall and Marta M. Valdes, of Sugar Processing Research Inc.;

"High pol refining using continuous affination" by Geoffrey E. Mitchell and C. G. Smith, of Millaquin Sugar Co. (Pty.) Ltd.;

"Deep bed filters" by P. C. Alder, A. Byers, N. Coote and M. J. Fell, of Tate & Lyle Process Technology;

"Liquor decolorization with granular carbon — Experience at two Australian refineries" by Peter J. Field, of CSR Refined Sugars Group;

"The use of radio frequency for control of a white pan at Hulett Refineries — a preliminary trial", by D. J. Radford, D. J. Tayfield and M. G. S. Cox, of Hulett Refineries Ltd.;

"Plant runs on decolorization from fresh bone char" by Leon Anhaiser, of Imperial Sugar Ltd. and R. L. Wagner, of I. B. P. Inc.;

"Large colorant and polysaccharide molecules in raw cane sugars" by Mary An Godshall, Margaret A. Clarke and Earl J. Roberts, of Sugar Processing Research Inc.;

"Resin beds for fine liquor polishing" by Bernard Hickey and Michael Elliott, of Redpath Sugar Ltd.;

"Improvement in the design of a sugar colorimeter" by John T. Rundell, of Tate & Lyle Process Technology;

"Distributed process control system at two CSR refineries" by G. Weiss, V. Lawrie and Peter J. Field, of CSR Refined Sugars Group;

"Scope for energy savings in sugar refineries" by J. D. Kumana, of Linnhoff March; and

"Facing NSPC with porous ceramic filters" by J. F. Zievers, C. J. Novotny and E. C. Zievers, of Industrial Filter & Pump Mfg. Co.

The Banquet is to be held on the evening of May 12, during which the Meade Award for the best paper given at the 1986 Meeting will be presented to Dieter Frank, Lincoln D. Metcalfe and John Park, authors of "Sure: a new sugar decolorization process"[1]. At the end of the evening, the outgoing President, David M. Humm, of C & H Sugar, will pass the gavel to the new President for 1987/88, Mr. Leon Anhaiser, of Imperial Sugar Ltd.

Before the meeting, members will have had the opportunity of taking part in a pre-conference tour of Queensland, as reported earlier[2], while, following the meeting, a tour is to be provided of the Pyrmont refinery in Sydney, described elswhere in this issue.

1 *I.S.J.*, 1987, **89**, 46 - 54.
2 *ibid.*, 80.

Pyrmont – an Australian sugar refinery

By Peter Field
(CSR Limited, Sugar Division, Sydney, Australia)

Introduction

On Wednesday, May 13, CSR Limited's Pyrmont Refinery in Sydney will host a visit by delegates attending the 46th Annual Meeting of Sugar Industry Technologists Inc. (SIT). The meeting is being held in Australia for the first time.

Founded as a sugar refiner in 1855, CSR has grown in the sugar business but also diversified into a wide range of other activities in Australia and overseas.

Peter Field

It continues to be a major sugar producer, making over 880,000 tonnes of raw sugar and 700,000 tonnes of refined sugar each year. CSR also provides financial and marketing services to the Australian sugar industry.

Besides the sugar operations, other current CSR operations and investments range from building materials manufacture to coal, gold, tin and bauxite mining, alumina smelting, shipping and ethanol manufacture*.

* It was recently announced that CSR Limited had sold its oil and gas interests for almost $A 1000 million and had ploughed back $A 150 million into its traditional sugar business. It has made a $A 2.20 per share bid for the 70% it does not already possess of Pioneer Sugar Mills Ltd. which owns the raw sugar factories at Pioneer, Inkerman and Plane Creek, in Queensland. If successful – and Pioneer Sugar was expected to recommend acceptance of the bid – CSR would increase its ownership of Queensland sugar factories to ten and would have by far the largest stake in the Australian raw sugar industry as well as sugar refining.

Historical background

Pyrmont Refinery commenced melting on February 16, 1878. It was not the first refinery to start operations in Sydney, nor was it the first refinery owned by CSR. However, Pyrmont was the only refinery to survive and grow in Sydney with unbroken operations since 1878.

Plant for the 1878 refinery was almost completely imported from England and Scotland. Cast iron columns, tanks, pumps, engines, the vacuum pan – all came from overseas. The refinery was erected under the supervision of Frederick Poolman, then the company's consultant engineer, and James Muir, who had come to Australia to erect a competing refinery in Melbourne. Melt capacity was initially 400 long tons per week, and the early process included char paste clarification, bag filtration, and char treatment of filtered liquor. There was a vacuum pan for refined sugar crystallization, refined sugar centrifugals, and trays for drying crystal sugar. Employees hand-turned the crystal to speed drying.

Sugar refining was a precarious business in the late nineteenth and early twentieth centuries. Imported sugar provided intense price competition, and later came government intervention in the sugar industry. However, Pyrmont Refinery continued to grow in line with three CSR strategies of the time; these were to:

(a) increase throughput to meet the market by both increasing capacity and buying out competitors (and thus reducing refining costs per ton of refined sugar),

(b) reduce sugar losses, and improve technical control of the process, and

(c) change the process to improve product yield, quality and to reduce costs.

Implementation of these strategies led to installation of affination centrifugals about 1900, carbonatation in 1912, and electrically-driven centrifugals in 1929. Growth was not without incident, however. The refined sugar store was destroyed by fire in 1918, and there was a serious sugar dust explosion in the refined sugar store in 1926.

Other Australian refineries

While sugar refining was growing in Sydney, similar developments were taking place in other capital cities in Australia. Yarraville Refinery, in Melbourne, then owned by Joshua Brothers, started in 1874. It was purchased by CSR in 1875 after the CSR Melbourne refinery was destroyed by fire.

Glanville Refinery, in Adelaide, commenced melting in 1891 and New Farm Refinery in Brisbane, in 1893. Cottesloe Refinery in Perth, the smallest CSR refinery, did not commence operations until 1930. Development of all the CSR refineries in the 20th century followed the general strategies outlined earlier.

The result of this development was the foundation for the present structure of sugar refining in Australia – five CSR refineries located in Brisbane, Sydney, Melbourne, Adelaide and Perth, and a sixth refinery, owned by the Millaquin Sugar Co., located in Bundaberg, 300 km from Brisbane, in a raw sugar growing area. Apart from Millaquin, their locations follow the trend for the population of Australia, and the major markets, to be concentrated in large cities on the coast. Millaquin is unique in Australia in that it is part of a raw sugar mill, refinery and distillery complex. It processes high pol raw sugar direct from the mill, allowing a refining process simpler than that used in CSR refineries.

The total Australian market for refined sugar for the year ended March 1987 is estimated at about 760,000 tonnes, of which CSR refineries produced 730,000 tonnes and Millaquin 30,000 tonnes.

Pyrmont Refinery – 1987

While a number of the early refinery buildings can still be seen at Pyrmont (for example, the raw sugar stores, and Numbers 1 and 2 Pan houses), sections of the old refinery, such as the three char houses, have been demolished as part of the ongoing redevelopment of the site. Over the last few years that redevelopment has led to replacement of char decolorization with granular activated carbon, installation of new vacuum pans, refined sugar centrifugals and packaging plant and the upgrading of the sugar dryer station and dust removal systems.

Pyrmont now melts about 250,000 tonnes of raw sugar per annum. All raw sugar is Australian and comes from south and central Queensland or northern New South Wales. Melt pol is generally in the range 98.8 - 99.1, depending on the raw sugar source. Raw sugar is shipped from Queensland bulk terminals to Pyrmont in 15 to 30,000-tonne bulk carriers, and unloaded at the refinery by two cranes fitted with grabs.

In some ways, the refining process shows little change from that used early in the twentieth century. However, automation and computer-based process control systems have substantially changed the way in which the refinery is organized and operated. From a total of about 700 employees in the 1940's, the refinery now has 400 salaried and wages employees, of whom about 200 are directly engaged in production and packaging work, and the remainder in service or administrative functions.

Pyrmont uses a conventional refining process based on affination, carbonatation of washed raw sugar liquor, pressure filtration, decolorization with granular carbon and crystallization.

Affination

The affination station, which was commissioned in 1965, has six 1220 mm × 762 mm (48 in × 30 in) ASEA centrifugals. On current melt rates of 50 - 60 tonnes/hour, these centrifugals run to a 130-seconds cycle to produce a washed raw sugar liquor of 0.10% reducing sugars. Cycle control is based on individual programmable logic controllers for each centrifugal, and is linked to the supervisory process control system.

Carbonatation

Washed raw sugar liquor is mixed with sugar liquor from high-grade recovery boilings, and then treated in the CSR standard two-tank carbonatation system. Scrubbed boiler flue gas provides the carbon dioxide source for the carbonatation process. Flue gas is added to the first tank under conductivity control, to achieve about 85 - 90% reaction of free lime. Carbonatated liquor overflows to the second tank, where the remining lime is gassed out under pH control to maintain a final liquor pH in the range 8.0 - 8.5.

Filtration

Carbonatated liquor is then filtered on Sweetland leaf filters (94 sq. metres filter area) fitted with monofilament polypropylene cloths. Although five filters are available, only two or three are required on liquor at any one time to maintain current melt rates. Refinery engineering staff have automated the filter sluicing and cleaning sequence and provided a hydraulic opening and closing system for the filter body. This last change has allowed removal of the traditional filter body counterweights.

A sixth Sweetland filter is used for sweetening-off carbonatation mud. Sweetened-off mud is discarded as a water slurry to the sewer. For environmental reasons, this system is to be replaced by a horizontal plate and frame mud filter to be installed later in 1987. This filter will produce a mud cake of less than 50% water which can be discarded as a solid to land-fill tips.

Decolorization

Since 1986 all filtered liquor has been decolorized with granular active carbon in fixed beds. Each absorber column holds about 35 tonnes of carbon. The normal operating system is to have three columns in the "lead" position treating filtered liquor, to produce an intermediate liquor. A further three columns are used in the "trail" position treating intermediate liquor to produce fine liquor for pan feed. Columns are staged from trail to lead positions, with a fresh carbon column running liquor for about 200 hours in a trail position before moving to a lead position for a further 200 hours liquor running. Design decolorization performance, which has been exceeded, is 90% colour removal from filtered liquor to fine liquor at 0.8% carbon burnt on melt.

Spent carbon is reactivated in a conventional multiple-hearth kiln, fired with natural gas. Originally designed to reactivate 0.5 tonnes of dry carbon per hour, the kiln has been upgraded to have a capacity of 0.7 tonnes per hour.

The carbon plant installation, carried out in two stages (1981 and 1986) was the outcome of a lengthy study into the most cost-effective replacement for the generally out-dated char houses which characterized CSR refineries in the 1970's.

That study led first to replacement of the char house at the Glanville Refinery by an anion exchange resin decolorization plant in 1972-74. Subsequent operation of that plant has not completely met design expectations, with overall decolorization insufficient for consistent production of white granulated sugar of 20 ICUMSA colour from the combined crystal obtained in a straight three-boiling system. However, it is still in use as the sole decolorization process at Glanville.

Early studies for replacement of the Pyrmont char house had assumed that resin would be the new adsorbent system, as did studies for replacement of the New Farm char house. However, the Glanville operating experience, as well as environmental problems associated with disposal of dark brine regenerant,

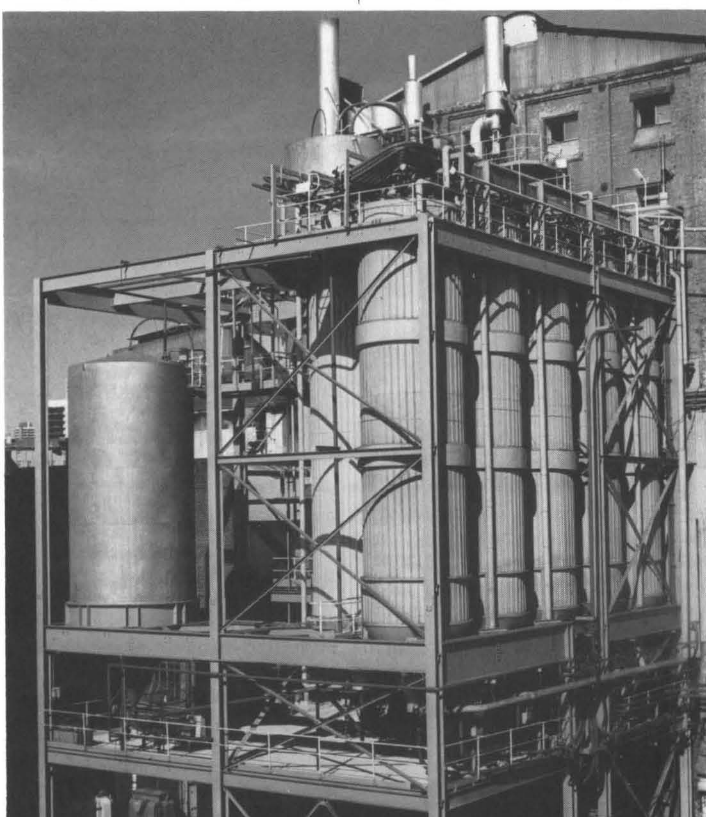


Figure 1. General view of the granular carbon decolorization plant at Pyrmont Refinery, including carbon columns and fresh carbon tank

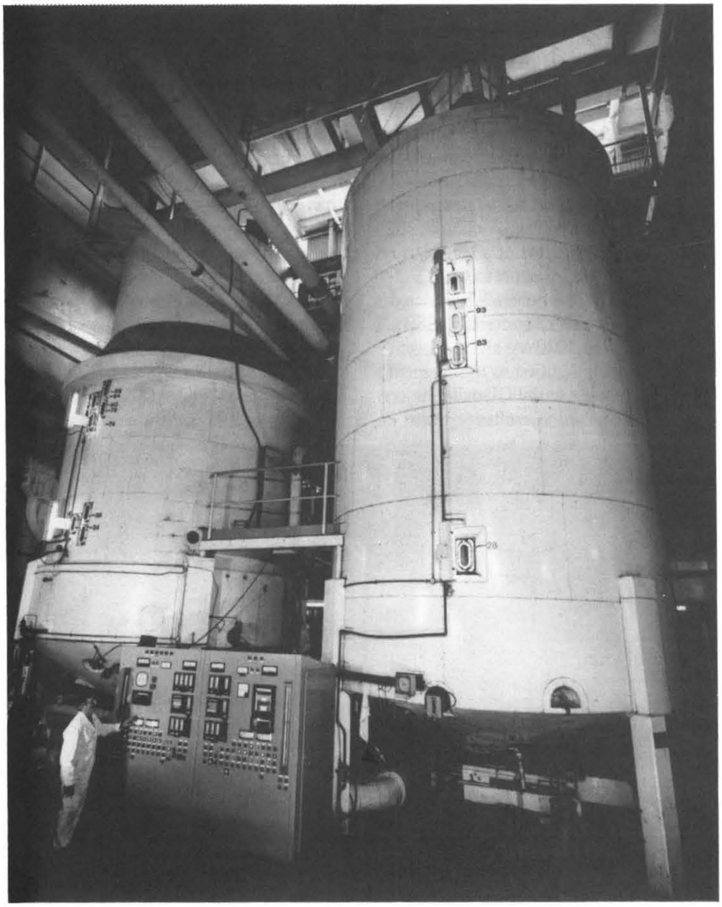


Figure 2. Refined sugar vacuum pans at Pyrmont Refinery

led to the selection of granular activated carbon instead for both Pyrmont and New Farm. Consideration was also given to pulsed bed systems. While the lower capital cost of a pulsed system was attractive, the simplicity and consistent high performance of fixed bed systems made them a logical choice where only one decolorization step was preferred.

Evaporation and crystallization

Fine liquor from the decolorization stage (colour typically 100 - 150 ICUMSA units) is concentrated to 71 - 72° Brix in a double-effect evaporator for pan feed.

Refined sugar is crystallized in three stirred calandria pans, fitted with refractometers and microscopes. Pan capacities are 60, 65 and 69 cubic metres, respectively, and typically work to a 150-min overall cycle. All refined massecuite is shock seeded at a target supersaturation inferred from pan refractometer observations. Once the grain has been established, stirrer drive motor power loading is used as the basis for feed control up to full strike volume. The pan down-time sequence is automated.

Pyrmont uses a straight three-boiling system with excess syrup from the third strike returned to white recovery or soft sugar boilings.

Massecuite from the refined pans is treated in ASEA-Weibull batch centrifugals, comprising four 1270 mm × 1067 mm (50 in × 42 in) machines and one 1220 mm (48 in) machine in two batteries. Wet granulated sugar is then dried in three modified Weibull dryer-cooler units.

After drying, granulated sugar is sieved to produce the specified product size fractions, and stored in aluminium-sheathed bins prior to packing or bulk delivery.

Process control

During 1986 Pyrmont commissioned a supervisory process control system intended to maximize throughput by balancing flows through the "wet end" of the refinery (including evaporation), to avoid any process stoppages. The system is a distributed one, based on individual station programmable logic controllers or Bailey Network 90 microprocessor units linked with a small DEC process control computer. This system is still at the development stage.

Products

Pyrmont produces a wide range of granulated, liquid and specialty sugars. Most granulated sugar is sold at a mean aperture of 0.6 mm, but a fine granulated grade is also made.

For industrial sugar customers there is a continuing trend away from 30-kg bagged granular sugar to bulk granulated delivery in road tankers carrying up to 20 tonnes. Some customers also receive granulated sugar in 1-tonne re-usable bags. Bulk granulated deliveries have now reached 35% of melt, with a further 20% of melt sold as liquid sugars.

The liquid sugars range includes a premium grade made by redissolving granulated sugar suitable for bottler's use, as well as a fine liquid sugar made from carbon plant fine liquor. Invert liquid sugar is also available.

There is a range of retail packages,

including 1 and 2-kg Hesser packs of granulated sugar. Specialty sugars, including soft brown and dark brown sugars and cube sugar, are packed in polyethylene film using form-fill seal machines.

Better to meet market requirements and competition from outside sugar repackers, retail package operations have been rationalized over the past two years. New packaging plant, including a 3 kg Rovema form-fill seal machine, has been installed to increase packaging productivity.

Product rationalization has also resulted in Pyrmont ceasing golden syrup and treacle production in 1986. These products are now made at Yarraville Refinery, where syrup production facilities have been upgraded. At the same time, Pyrmont now produces all soft brown sugar marketed by CSR.

In summary, Pyrmont in 1987 is a mix of some old plant and some new, continuing to change to meet customer requirements, as well as competition from alternative sweeteners or outside repackers. The refinery is still firmly established on its original site, despite redevelopment of adjacent areas, and the buildings remain as the inner city's landmark which they have been for over 100 years.

Figure 3. Process operator at a VDU in the wet process control room of Pyrmont Refinery

Acknowledgement

The author wishes to acknowledge the work of Dr. C. W. Davis which formed the basis of the historical detail in this article: "The Pyrmont Sugar Refinery with particular reference to char", Ph.D. Thesis, University of Sydney, 1984.

ENERGY MANAGEMENT

Fluid bed drying of bone char*

By J. P. Merle, L. H. Bates and L. A. Zemanek
(Calfornia and Hawaiian Sugar Company, Crockett, CA, USA)

Introduction

Drying bone char before thermal regeneration was the subject of a survey and careful investigation reported by Revere Sugar[1] early in the Bone Char Research era, using louvred dryers connected to retort kilns. Later, reports[2,3] in the bone char literature described experience with louvred dryers in conjunction with multiple-hearth furnace regeneration. In subsequent years, however, very little has been reported on new approaches to drying bone char.

When C & H installed a Herreshoff multiple-hearth furnace in 1968, we were anxious to avoid reported problems with louvred dryers mounted on top of the furnace. These were problems of blowing, drifting char and of char fires. Back in those "energy-innocent" days of the 1960's, we were concerned first with avoiding char dryer problems with our proposed new furnace and with the need to provide a process step to dewater bone

* *Paper presented to 45th Meeting Sugar Industry Technologists*, 1986.

1 Bemis & Reed: *Proc. 1st Tech. Session Bone Char*, 1949, 61 - 93.
2 Fairrie: *Proc. 4th Tech. Session Bone Char*, 1955, 119 - 128.
3 Allen: *Proc. 5th Tech. Session Bone Char*, 1957, 89 - 90.

char slurry following counter-current washing in a deashing column. Only secondarily were we looking for energy savings.

Nichols Engineering, our turn-key contractor, assisted us in evaluating alternative dewatering options such as separate vessels to drain and blow-down the char/water slurry from the washing step. After conducting pilot scale testing with a dewatering filter manufacturer, however, they recommended dewatering filters. This was the option we chose.

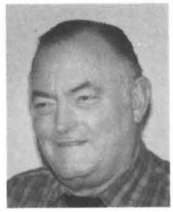
Dewatering filters

The dewatering filters were designed to drain water from a continuous, moving bed of char. The char would be partially dried by hot air pulled through the bed by a vacuum fan. Hot air comes from discharge of heat exchangers used to cool regenerated char leaving the multiple-hearth furnace. Since no other use was available for the heat in this dicharge air, any drying provided by the air represented energy savings through reduced fuel consumption in the furnace.

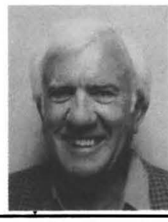
Performance of the two Straightline dewatering filters was discussed in an earlier paper[4] describing the C & H Herreshoff furnace system. Briefly reviewing subsequent experience, we found the filters consistently dewatered the slurry of char and water in about the first ten feet of filter belt travel. At that point, average moisture of the char bed was about 20%, wet basis. But at the discharge of the filter, moisture still was just under 20%, averaging close to 19% for typical operating conditions. The final twenty feet of travel accomplished very little drying because the resistance across the polypropylene cloth and the 2- to 4-inch thick cake of damp char was too great to be overcome by the fan's vacuum (18 inches w.g.). The drained and settled char cake allowed passage of very little air through the cake from the hot air hood enclosing each filter. The drying that occurred was at the surface of the moving char bed where the top $^1/_8$ inch of char was dry (less than 10% moisture) and free-flowing, while most of the cake below was damp.

Over the years, we made repeated attempts to improve drying with the

J. P. Merle



L. H. Bates



L. A. Zemanek

dewatering filters. Small ploughs, for example, were mounted above the char bed so the moving char surface could be turned over. However, exposing more char to surface drying by hot air made only minor improvements in char drying. So we continued to be faced with having 19% moisture char entering the furnace while the same time exhausting hot discharge air from the coolers to atmosphere for lack of a practical way to use its heat.

Laboratory testing of fluid bed drying

In late 1982, arrangements were made to conduct drying tests for one of our specialty sugars on fluid bed test equipment at the Louisville, Kentucky, plant of Carrier Vibrating Equipment Inc. This presented an unexpected opportunity to also observe our No. 1 House char** being dried with fluid bed equipment. So drum size lots of both sugar and damp char were shipped to Louisville for testing.

At their test centre, Carrier maintains a pilot-scale vibrating fluid bed dryer having one square foot of fluidizing surface. A weighed sample of damp char placed on this surface can be subjected to a range of flow rates, air temperatures and drying times, each controlled at desired test levels from a central panel. A vertical, vibratory motion is imparted to the test dryer to simulate the conveying action of a full-scale fluid bed dryer. An induced draft fan draws fines and dust that become air-borne during drying and collects them in a small cyclone dust collector.

Each test run started with a 20-lb sample of damp char, giving a cake or bed depth about 3 inches thick at rest. Separate runs were made in which air flows ranged from 150 to 200 c.f.m., and air temperatures ranged between 250° and 280°F. The beginning moisture for all samples was 17.8%. Results are

** Throughout this paper, the test adsorbent referred to as "char" or "the adsorbent" is actually a mixture of char and Canesorb in an 80:20 volume ratio.

4 Zemanek: *Proc. Sugar Ind. Tech.*, 1973, 40 - 57.

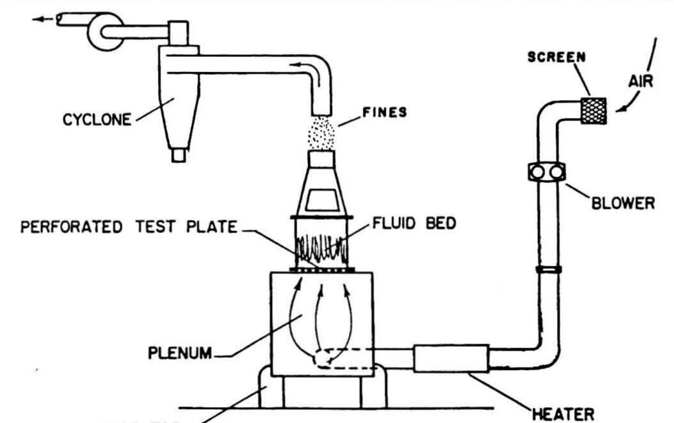


Figure 1. Carrier laboratory dryer

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shown in Table I.

These test results convinced us that fluid bed drying had a potential application in our Herreshoff regenerating system. Specifically, we concluded that:
1. A scaled-up dryer system might be expected to reduce char moisture from about 18% entering to about 7% leaving.
2. This could be accomplished with air volumes and temperatures typically available at the Herreshoff furnace.
3. Simple scale-up from the laboratory dryer, with its one square foot of fluidizing deck, indicated C and H char feed rates would require two dryers, each about 20 feet long. Space could be made available for these units.

As important as it was to get these encountering preliminary test results, it was equally important to actually observe a fluidized char bed.

In the past when we were investigating energy-saving drying equipment, we always assumed that attrition losses due to the relative movement of particles within fluidized bed would be excessive. Yet in these tests, the movement of particles as the test bed expanded and then became fluid was remarkably quiescent. Instead of severe random collisions, the particles appeared to be supported by the rising air stream with relatively mild interaction among moving particles. We were forced to reassess our ideas about attrition losses.

We ultimately made a decision about trying fluid bed drying based on these observations and this thinking:
(i) A pilot-scale investigation of particle size reduction due to attrition would probably not give clear-cut, unambiguous results either supporting or eliminating fluid bed drying technology.
(ii) Such a test program would be costly.
(iii) While there apparently are no references in the bone char literature to fluid bed dryers, there is ample evidence that bone char and granular carbon adsorbents are subject to moderate to severe handling in several widely used types of equipment. Examples are rotary drum dryers or kilns, vibrating conveyors, inclined screw conveyors, multiple hearth furnaces and the fluidizing deck of specific gravity separators. Adsorbents have been surviving such equipment for years.
(iv) In the final analysis, adsorbent make-up rates in operating systems would decide whether or not attrition was a serious problem.

Table I. Lab. results: Fluid bed dryer, char/Canesorb mix

Run No.	Time in dryer, min	Fines % original sample	Fluidizing air Flow, cfm/ft^2	Fluidizing air Temperature, °F	Discharge moisture, %
1	4	1.5	200	276	7.0
2	5	1.0	170	276	6.3
3	6	1.1	170	273	3.9
4	5	0.3	150	279	8.8
5	5	0.4	162	249	7.4
6	5	0.4	170	248	9.2
7	5	0.4	160	274	7.1

This thinking, plus the promise of significant energy savings, prompted us to proceed with installation of fluid dryer technology without further pilot scale testing.

Modification of dewatering filters

Since both dewatering filters were more than 30 feet long and only one third of their belt travel was effective, these units were a logical target for modification. Our Engineering Department undertook to shorten and simplify the filters and thereby provide floor space for two parallel dryers.

The feed end of the filters remained as before. About two-thirds of the filters, beginning at the discharge end were removed. The shortened filters provided about 12 feet of total belt travel, more than adequate for draining the adsorbent bed free of water. Drainage continued, as before, to be assisted by the existing vacuum fan. This fan had enough extra capacity to provide also for exhausting the two fluid bed dryer hoods.

The vacuum receiver, being continuously exhausted by the vacuum fan, receive drainage water from the dewatering filters together with char and char fines from filter cloth washings and from the filter catch pans. By connecting the vacuum receiver to the exhaust hood of each fluid bed dryer, we are able to remove the fluidizing air without requiring a separate cyclone and fan.

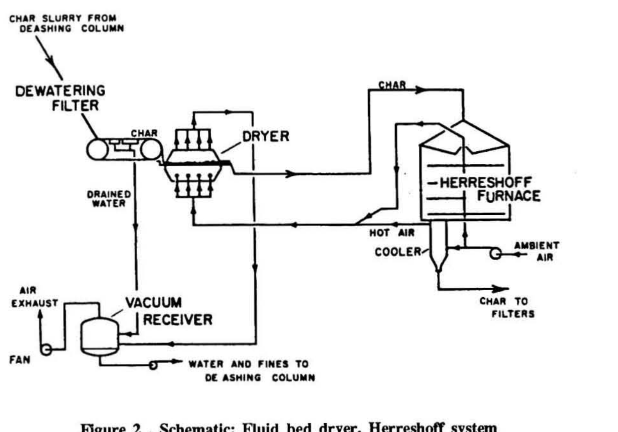


Figure 2 . Schematic: Fluid bed dryer, Herreshoff system

This fluidizing air contains fines released from the fluidized bed. The fines are captured in the wet vacuum receiver and are recycled as a water slurry to the deashing column.

Fluid bed dryers

Each dryer was sized to handle up to 200 short tons per day of adsorbent (bone char and Canesorb mix). Since our char filters hold 56 tons of adsorbent mix, this drying rate would enable us to maintain $3^1/_2$-hour filling times when maximum char burning was required. Filling times in No. 1 House normally average 4 hours.

Pilot-scale testing at Carrier showed that satisfactory fluidization and drying of our adsorbent could be achieved with an average 5-minute residence time at a loading equivalent to a 3-inch bed depth (at rest) in the dryer.

These criteria set limits on the dryer size required since each dryer will feed a continuous blanket of char 3 inches thick. The area of this blanket after 5 minutes will equal the area of one dryer. Calculations (see Appendix I) had shown that two standard Carrier units, each with 80 square feet of fluidizing surface, will maintain a $3^1/_2$-hour fill time.

Description of dryers

Each dryer resembles a large vibrating conveyor with a plenum chamber below the conveyor deck and an enclosing hood above the deck. Four ducts with manual dampers bring hot air into the plenum and four manual dampered ducts connected to a vacuum receiver header draw fluidizing air, moisture and fines from the enclosing hood. Feed adsorbent from the dewatering filters enters at one end and discharges at the other end.

Each unit *is* in fact a vibrating conveyor. If the fluidizing air were turned off, the incoming feed of dump adsorbent would be simply conveyed the length of the deck by a heavy-duty motor driving eccentric weights on three heavy-duty shafts. By adjusting the stroke, frequency and angle of attack of vibratory motion plus adjustment of the weir position at the discharge end, we can control retention time for the adsorbent being conveyed.

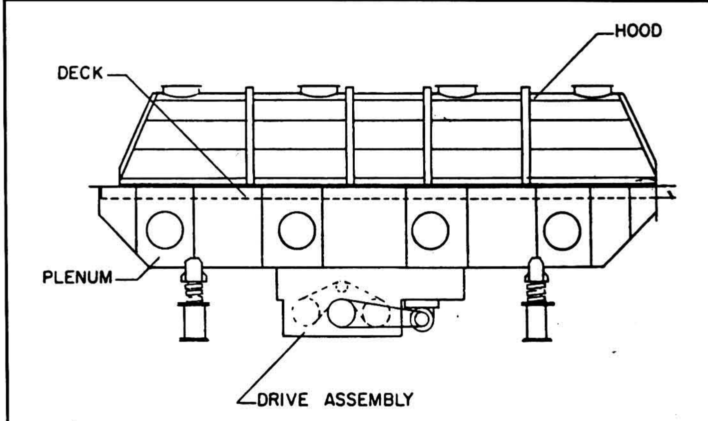


Figure 3. Carrier fluid bed dryer

The conveyor deck, however, makes the unit a dryer as well as a conveyor. The deck is 8 gauge, type 304 stainless steel, perforated with more than 27,000 holes $^1/_8$ inch in diameter and spaced on $^1/_2$ inch by $^3/_4$ inch centres. Drying is accomplished when hot air from the pressurized plenum chamber passes through the holes and into the moving bed of damp char and Canesorb.

At the feed end of each dryer, this upward flow of air causes the adsorbent bed first to expand and causes occasional large blow holes to appear owing to air bubbling through the bed. Midway down the deck, blow holes are smaller but numerous. The last one-quarter to one-third of the deck carries a truly fluidized bed with the adsorbent expanding to 6 to 8 inches above the deck. Dampers on the intake air ducts must be adjusted to avoid excessive fines carry-over in the fluidized section and still provide sufficient air flow to expand the heavy damp adsorbent at the feed end. Incoming air also must be balanced with the induced draft in the dryer hood to avoid blowing some of the fluidized adsorbent out the discharge end of the dryer.

Dryer operation and operation of related equipment

Continuous, smooth operation of the dryers depends on stable operation of all related units. While this is obvious on the face of it, we were nonetheless surprised by the impact of variations we had come to accept as normal in the Herreshoff furnace system.

1. *Deashing column* levels affect feed rates from the column to the two dewatering filters. The water level (hydrostatic head) is constant with continuous overflow at the launder on top of the column. The adsorbent level, however, changes abruptly when a new spent filter begins voiding. High adsorbent levels mean heavy feed rates out of the column. Resulting thick cakes on the dewatering filters carry higher moisture levels. Also, thick cakes can overload the dryers, preventing proper fluidization and reducing drying efficiency. Low adsorbent levels in the column tend to underload the dryers with respect to air flow and this can lead to excessive recycling of air-borne char and char fines.

2. *Dewatering filters* are affected by variations in the char:water volume ratio. These variations cause uneven distribution of adsorbent cake on the dewatering belts. Also, recurring partial blinding of the polypropylene filter cloth causes poor drainage and allows free water to discharge from the dewatering filters into the fluid bed dryers. This has caused char fines to wash through dryer deck holes and to plug the holes.

ISJ Abstracts

Cane sugar manufacture

South African C-massecuites: crystal size distribution and its effect on centrifugal losses

L. M. S. A. Jullienne. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 79 - 82.

The results are summarized of a two-year survey of low-grade massecuite crystal size distribution. The average *C*-massecuite contained very small crystals as a consequence of an endeavour by factories to maximize final molasses exhaustion by producing low-grade massecuites of low purity at high Brix. However, the loss of small crystals through the slots of the centrifugal screens has accounted for most of the molasses purity rise across the centifugals. A serious effort by many factories to increase low-grade crystal size brought about a marked improvement, with a 30% increase to an average of 131 µm and a fall from 35% to 12% in the proportion of small crystals. Nevertheless, the average size is still considered too small, and a minimum mean crystal size of 150 µm is recommended. The elimination of the physical losses in the centrifugal would result in a target purity difference approaching zero at most factories provided the pre-centrifugal exhaustion could be maintained at its present high level. The importance of boiling in producing larger crystals without considerable false grain formation is mentioned.

The use of strain gauges in the measurement of pressure feeder torque and internal chute pressure

A. Wienese and M. J. Reid. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 83 - 87.

During the 1984 crushing season, strain gauges were used to measure cane mill torque, pressure feeder torque and internal chute pressure on diffuser bagasse dewatering mills at three South African factories. The methods and techniques used are described and the relationship of the measurements to mill performance is discussed. A stainless steel diaphram built into the pressure chute and forming part of the lining plate (strain gauges fitted to the diaphragm measuring strain as a direct proportion of pressure) proved successful as a monitor and required no maintenance, the only problem being a zero drift of about 1% attributed to physical wear of the diaphragm. It was found that mill and pressure feeder torque were hardly affected by a change in mill speed, and that only mill torque increased with a rise in hydraulic pressure.

Some conveyor modifications and experiments at Simunye

C. T. Tosio. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 88 - 91.

After two short seasons, the riveted link roller chain on the filter mud conveyor wore out and was replaced with a cheaper round link chain; one central strand replaced two parallel strands, and the steel slats were replaced with narrower polypropylene ones. The chain needed replacing only after three full seasons, and the conveyor proved adequate even with the heaviest load of mud. Maintenance costs were minimal, the slats were much cleaner than a belt and there was no warping due to the mud (as found with belts). A round link chain also proved successful on a modified main bagasse carrier, with relatively little downtime and considerable savings in costs. Details are also given of a block link chain installed on the first two intercarriers in the mill train (normally the most troublesome because of the nature of bagasse at the start of a tandem); although this type of chain is very heavy, it proved extremely reliable with only 2 hours downtime during the entire 1984 season and was to be installed in place of roller chain on all the intercarriers.

Plant trials on chemical cleaning of evaporator heating surfaces at Umfolozi mill

M. A. Getaz. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 96 - 98.

Following successful pilot plant trials conducted by the SMRI, full-scale implementation of the process developed was started in 1983 and continued in 1984. The two-stage treatment involves spraying the evaporator tubes with 25 - 30% w/v NaOH solution at 100 -105°C, and subsequent spraying with 2% w/v sulphamic acid at 70°C. Experiments in practical application of the process are discussed, and details given of the costs of cleaning and of the equipment and plant modifications entailed. Although current costs still favour mechanical cleaning, chemical cleaning can be considerably optimized by regeneration of the solutions and adjustment of the intervals between cleaning, which should reduce the costs to make the process competitive with the mechanical process. Moreover, the general dislike of the mechanical method by workers creates problems in maintenance of adequate supervision and efficiency.

Experiences in evaporator control at Amatikulu

R. G. Montocchio and R. P. Scott. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 99 - 101.

Before the 1984/85 crushing season, the evaporator station at Amatikulu consisted of two Kestner pre-evaporator units operating in parallel and feeding juice to a common separator, from which the juice was treated in two quadruple-effect evaporators operating in parallel. Because of problems associated with feed forward juice flow and hence level control in the evaporator effects, modifications were made to the system, including operation of the two evaporators as one, with juice split between each pair of corresponding effects. Cascade back control was introduced for juice level (which has proved very steady in the 3rd and 4th effects) and a nuclear density meter was installed to monitor the Brix of the combined syrup streams from the final effects; linked to a 3-term PID controller, this has provided very consistent Brix control with a variation of about ± 1°. Since a prerequsite for this is a very steady juice flow control, it is planned to improve the system further by installing a more sophisticated PID controller on the 2nd effects to replace the float-and-torsion level controller.

Characteristics and applications of ejector systems

H. Kirsch. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 108 - 109.

The author introduces the principle of the operation of ejectors to raise vacuum and examines fields of applications of air, steam- and water-driven types. The benefit of multi-stage steam ejectors in providing extremely high compression ratios is discussed, and reference made to the combination of air-driven ejector and liquid ring pump. The advantages and disadvantages of liquid ring pumps and ejectors are given.

Success through planned maintenance at Malelane mill

A. A. Landman. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 110 - 114.

Success achieved at Malelane since 1978/79 in improving mechanical efficiency through the use of a planned maintenance system is discussed. The maintenance organization structure is explained, with details of training, and a brief description is given of the maintenance costing system and of future changes planned for the scheme.

Cooling water – the unseen problems

R. P. Scott. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 115 - 117.

While open and closed circulating cooling water systems are installed at most sugar factories for evaporator and pan condensers, crystallizer cooling, massecuite reheating and liquid ring vacuum pumps, inadequate corrosion control can lead to frequent replacement of pipelines, crystallizer cooling elements and massecuite reheaters. Possible damage that can occur in the systems is discussed with reference to experience at Amatikulu, and determination of the level of expenditure on corrosion control is explained; it is stressed that expenditure should be in accordance with the costs of replacement and the expected life of a given component as if no anti-corrosion treatment were adopted.

Dextran – an overview of the Australian experience

P. C. Atkins and R. J. McCowage. *Proc. 1984 Sugar Processing Research Conf.*, 108 - 140.

Experience in the Australian sugar industry regarding problems caused by dextran is reviewed, covering: (1) factors affecting dextran formation, including cane burning, the delay between burning and harvesting and between harvesting and processing, harvesting conditions and cane billet size and condition; (2) dextran in the factory, including the chemistry and occurrence of dextran; its effects on viscosity, crystallization, clarification and polarimetry; and control (wherein it is pointed out that conventional processing offers little opportunity of relieving the situation once dextran is present, and the best approach is to prevent further formation of dextran, optimize clarification and minimize recycling); and (3) measurement of dextran by the CSR haze method, enzymatic analysis or by the Roberts' copper sulphate method.

Leuconostoc spp. in sugar cane processing samples

E. B. Lillehoj, M. A. Clarke and W. S. C. Tsang. *Proc. 1984 Sugar Processing Research Conf.*, 141 - 151.

The occurrence and levels of *Leuconostoc* spp. in bagasse and cane juice at various stages of processing are discussed on the basis of two sets of investigations at a Florida factory. While lime addition and heat should inhibit growth of *Leuconostoc* spp., the highest counts were found in limed juice, although it is thought possible that the counts increased prior to liming; whereas *Leuconostoc* spp. can grow at pH 8, they cannot at >65°C, which supports the argument for hot liming where heating precedes lime addition (at the factory in question the juice is limed before heating). The levels of both total bacteria and *Leuconostoc* spp. (56% and 69% of the total) were high in 1st expressed juice and relatively low in last expressed juice (in which the *Leuconostoc* component represented 32% and 31% of the total); however, much of the last expressed juice was imbibition water containing no sucrose. Higher levels in mixed juice exceeded those in 1st expressed juice, and the *Leuconostoc* spp. in the second set of measurements represented 80% of the total bacteria count. Screened juice contained fewer bacteria than the other juices prior to screening, but the *Leuconostoc* spp. constituted 80% and 57% of the total bacteria, with the area behind the screens appearing to be the most frequent source of *Leuconostoc* contamination in the factory, with rapid formation of masses of slimy material. Juice from the rotary vacuum filters had low counts of total bacteria and *Leuconostoc* spp.; while bacteria were thought to settle out in the clarifiers and to remain in the mud in the filters, relatively low counts suggested that the temperatures in clarification were sufficiently high to kill most of the organisms. The levels of total bacteria and especially *Leuconostoc* spp. were surprisingly low in bagasse. The possibility of controlling *Leuconostoc* spp. by growing non-slime forming *Lactobacillus* spp. to compete for the available carbohydrate is suggested; while the latter bacteria produce lactic acid, this is considered less of a problem than dextran.

Operation Clean Cane

G. Dewey. *S. African Sugar J.*, 1986, **70**, 201 - 203.

A campaign was launched to reduce the amount of sand and other extraneous matter entering the Dalton factory of Union Cooperative Ltd. with the cane. The sand was estimated to have cost the factory an extra R250,000 in 1981 in wear of boiler tubes, cane preparation equipment and pumps as well as in the additional fuel requirement. The main source of the trouble was infield loading. As a result of the campaign, ash % cane fell from 2.36% in 1981/82 (the worst in South Africa) to 0.77% in 1985/86 (compared with an industry average of 1.42% in 1985/86), while the cane:sugar ratio was decreased from 9.46 to 7.85 in 1985/86, compared with an industry average of 8.88. Comparison is made with average cane:sugar ratios in Australia in 1955/84.

Mill observations at Portvale factory

O. A. Hinds. *Proc 3rd Ann. Conf. Barbados Sugar Tech. Assoc.*, 1985, 4 pp.

The author emphasizes the empirical nature of adjusting cane mills, using trash plate setting as an example. Causes of mill chokes are then listed, including change in the physical property of the cane blanket, excessive roller polishing, poor drainage and mill adjustment, and intercarrier problems. Chokes at the 1st mill at Portvale were eliminated by installing a Fletcher & Stewart Polymex forced feeder driven by a separate variable-speed hydraulic drive (as against the mill engine used to power the feeder initially); apart from trouble-free operation, very low wear of the mill rollers and trash plate was the most significant benefit derived from the feeder and roller surface treatment by arcing. Subsequent arcing of rollers on Nos. 3 and 4 mills also reduced wear by comparison with rollers provided with conventional chevron grooving, although further data were considered necessary to substantiate the advantages of roller treatment.

The importance of measuring devices in factory control

M. F. Armstrong. *Proc 3rd Ann. Conf. Barbados Sugar Tech. Assoc.*, 1985, 5 pp.

Although the Innes formula has been used for many years to calculate imbibition % cane, when used to check the performance of a vortex meter installed together with a Fischer & Porter digital indicator/recorder at Carrington factory it gave, in most weeks, an average value that was lower than the measured value by up to 9.36 units (the calculated values being higher than the measured ones by 1.31 and 2.03 units in only two cases). Had corrections been made for fibre % cane in the formula, the differences would have been greater, as demonstrated by values for Carrington and two other factories in 1985. The formula takes the form: imbibition % cane = 86.57 (B_1/B_m) – 83.74, where B_1 = weighted weekly average Brix of 1st expressed juice and B_m = weighted weekly average Brix of mixed juice; it is suggested that one of several factors possibly contributing to the difference between measured and predicted imbibition is the apparent change in the relationship between B_1 and B_m since the original work was carried out by Innes in 1957.

Unbalanced voltage — latent killer of induction motors

S. B. Carrington. *Proc 3rd Ann. Conf. Barbados Sugar Tech. Assoc.*, 1985, 4 pp.

Possible causes of unbalanced voltage in a normal 3-phase circuit and the adverse effects even a small imbalance of only 2% can have on the performance of an induction motor through a considerable rise in winding temperature and noticeable current imbalance are discussed.

Design of imbibition water mixed juice heat exchanger

S. K. Bhojraj and R. Iyer. *Indian Sugar*, 1986, **36**, 7 - 16.

Design calculations are given for a multipass shell-and-tube heat exchanger intended for mixed juice heating from 35° to 49°C using condensate at 90°C; the discharge water from the heater is used for imbibition.

Measures for saving bagasse in sugar factories

N. A. Ramaiah. *Bharatiya Sugar*, 1986, **11**, (7), 9 - 11, 13.

Measures for reducing bagasse consumption as fuel in order to increase the amount available as raw material for paper production include those aimed at decreasing steam consumption and bagasse drying to 38 - 40% moisture content. The various aspects are discussed.

Sugar cane: composition and quality aspects affecting sugar manufacture

D. P. Kulkarni. *Bharatiya Sugar*, 1986, **11**, (7), 15, 17, 19 - 20.

After a brief description of the sugar manufacturing process, the author discusses the effect of process conditions on cane constituents, examines the components of cane and looks at the effect of various groups of impurities (including those in extraneous matter) on sugar recovery.

Use of a microprocessor-based control system in the sugar industry

M. L. Agiwal, A. K. Saxena and P. Arora. *Bharatiya Sugar*, 1986, **11**, (7), 25 - 30.

Information is provided on a Micon P-200 microprocessor-based multi-loop system for automatic control of two boilers at Mawana sugar factory, with details of its performance and a list of benefits, including a 2% improvement in efficiency to 69% and an associated reduction in bagasse consumption.

Bagasse as fuel

P. K. Shewale. *Sugar Scene*, 1986, **4**, (8), 12 - 13.

The fuel properties of bagasse are discussed and details given of its typical composition, ash constituents and calorific value. The effects of furnace type, cane preparation and bagasse moisture content on its behaviour as a fuel are examined, and the problem of fly ash control is considered.

Beet sugar manufacture

Optimization of energy management at Lovosice sugar factory

P. Hoffman. *Listy Cukr.*, 1986, **102**, 155 - 161 *(Czech)*.

Details are given of the modifications (carried out in two stages in successive campaigns) to the energy scheme at Lovosice, whereby the fuel consumption was reduced from 5.18% to 4.08% on beet. The major changes included installation of a battery of compressors at the 1st evaporator effect, waste heat recovery from condensate and modifications to the vapour bleeding arrangements. Diagrams are presented of the old and new schemes.

Experiences with drum-type beet slicers at Warburg

H. van Malland. Zuckerind., 1986, 111, 636 - 637 (German).

The performances of Maguin drum-type beet slicers and of a disc slicer were compared at Warburg sugar factory. Results favoured the Maguin machines; a modification of the drive control allowed the drum to move forwards and backwards during cleaning or inspection, thus considerably simplifying and accelerating the procedures. Other modifications are also noted. The quality of the cossettes was so good that the diffuser capacity was raised from 3200 to 3500 tonnes/day at a draft of 108% and losses of 0.35%. With a 10% rise in factory slice, the average dry solids content of pressed pulp rose from 30% to 32.4% to coincide with the operation of the Maguin slicers.

Putsch drum-type beet slicers

R. Hies. *Zuckerind.*, 1986, **111**, 637 - 641 *(German)*.

A detailed illustrated description is given of the Putsch TSM 2000-40-600 drum-type slicer which has a rated capacity of 4500 tonnes/day.

Investigation of industrial factors decreasing sugar crystal colour

G. Mantovani, G. Vaccari, G. Sgualdino, D. Aquilano and M. Rubbo. *Zuckerind.*, 1986, **111**, 643 - 655.

See *I.S.J.*, 1987, **89**, 38A.

Investigation of the pressure of sugar in silos. I. Symmetrical discharge and effect of the filling method

M. Kaminski. *Zuckerind.*, 1986, **111**, 649 - 655 *(German)*.

Investigations are reported on the effect of sugar pressure during storage in silos; for the experiments, three models were constructed differing in their diameters but all having a height of 1015 mm. Results showed how sugar differs considerably from other materials in regard to pressure. During discharge, the pressure is low and is governed by the ratio between height and diameter. The value and distribution of the horizontal pressure can be reduced by adapting the method used to fill the silo, the lowest value of the horizontal filling and discharge pressure occurring after feeding the sugar around the perimeter of the circular silo.

Crystallizer automation

A. F. Kravchuk and I. A. Dan'ko. *Obz. Inf. TsNII Inf. i Tekhn.-Ekon. Issled. Pishch. Prom., Sakhar. Prom.*, 1986, (4), 20 pp; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (14), Abs. 14 R498.

Descriptions are given of Soviet and other systems and means of automation for horizontal and vertical crystallizers and ancillary equipment. Results from appraisal of the systems are reported with the aim of deciding on the direction in which to develop and create schemes.

Checking the pH in preliming

V. V. Pyshnyak. *Sakhar. Prom.*, 1986, (7), 18 - 19 *(Russian)*.

From calculation of the mean difference in predefecation juice pH between the values at 20°C and 60°C, i.e. the temperature at which pH is normally measured and the process temperature, a correction factor has been obtained for calculating the pH at any given temperature and thus contributing to preliming pH control.

Intensification of massecuite boiling in batch vacuum pans

S. M. Petrov, A. R. Sapronov, V. I. Tuzhilkin and V. M. Fursov. *Sakhar. Prom.*, 1986, (7), 19 - 23 *(Russian)*.

A frusto-conical swirler chamber located immediately above the central downtake in a low-grade pan with its upper end at the maximum massecuite level reduced the boiling time by 6 - 13%, increased the average crystal size by 10 - 20%, raised the crystal content by 1 - 5% and reduced particle size distribution by 7 - 8% by comparison with an unstirred pan. The massecuite flow is broken up as it passes from the top of the heating tubes into the swirler via openings in the side wall and follows a downward spiral path to the downtake.

Effectiveness of longitudinal mixing of the solid phase in mass transfer vessels with vibratory means

A. L. Ignatenkov and P. P. Loboda. *Sakhar. Prom.*, 1986, (7), 23 - 25 *(Russian)*.

For investigations of mixing of crushed beet and other solids with sugar solution as liquid phase, a 1 metre high unit was provided with plates at regular intervals, and jet sprays at the plates used to impart pulsatory flow under continuous counter-current conditions. The effects obtained were contrasted with conditions in a conventional tower or scroll diffuser, and the mixing efficiency found to be such as to allow a considerable reduction in length of a vessel in order to achieve target results.

The application of A2-PKB condensers as vacuum-condensing plant in sugar factories

S. Z. Zozulya, E. I. Kotenko, M. S. Stafiichuk and A. I. Khomenko. *Sakhar.*

Prom., 1986, (7), 27 - 31 *(Russian).*

The use of the title barometric condensers in sugar factories is discussed and a calculation made of the number of sections in a spray-type cooling tower to meet the condenser requirements.

Results of tests on a flume-wash water clarifier

A. P. Parkhomets, Yu. V. Raskin and V. D. Novoseletskii. *Sakhar. Prom.*, 1986, (7), 31 - 33 *(Russian).*

Tests are reported on a vertical clarifier used to treat flume-wash water at a rated hourly clear water output of at least 90 m^3. The waste water enters at the top and is distributed to the settling chamber by a rotary valve which closes the entry to the distribution pipes once per rotation, thus allowing mud to accumulate and act as a filter bed for subsequent water; hence the speed of rotation of the valve governs the degree of mud thickening. A mixture of milk-of-lime and iron sulphate (100 - 140 mg/litre) at pH 10.5 was an effective flocculant, giving up to 88% purification.

New pump sets

N. K. Rzhebaeva, N. A. Kravtsova, A. V. Knapovskii and S. K. Loktev. *Sakhar. Prom.*, 1986, (7), 36 - 38 *(Russian).*

Information is given on the Soviet ANS-series cantilevered pump for liquid transfer in sugar factories; built to the international standard ISO 2858-75, it is recommended in place of the SOT-series pump which is bulky and difficult to service.

The effect of certain chemical agents on the coefficient of sucrose diffusion from beet tissue and tissue resistance to slicing

J. Kubiak. *Gaz. Cukr.*, 1986, **94,** 1 - 4.

Investigations of the effects of aqueous solutions of disinfectants at varying concentrations showed that 0.03% formalin gave the highest diffusion coefficients which, however, fell sharply with a greater concentration. A reduction in the coefficient occurred in the presence of 0.03% hydrogen peroxide, but a concentration of 0.05 - 0.1% caused it to rise. An average 30% fall in the coefficient was caused by 0.01% trichloroacetic acid, and a reduction was also caused by 0.01% - 0.08% calcium hydroxide, although the value increased at >0.08%. The greatest increase in the resistance to slicing was given by 0.01% trichloroacetic acid, but increases in concentration caused no further noticeable change; 0.01 - 0.1% formalin and $Ca(OH)_2$ caused only slight increase in the slicing resistance.

Investigations on vibrations in machines with rotary components

J. Kruszynski. *Gaz. Cukr.*, 1986, **94,** 5 - 7 *(Polish).*

A brief historical account is given of research in Poland on vibrations in rotary machines such as electric motors, fans, centrifugals and turbogenerators, followed by an examination of the numerous possible causes of design, technological and operational origin, and methods and equipment for machine testing.

Studies on the suitability and application of fibres for filtration in the sugar industry

G. Romel, J. Slupecka, A. Moraczewski and G. Pigulowska. *Gaz. Cukr.*, 1986, **94,** 8 - 9 *(Polish).*

In tests on synthetic fibre cloths for carbonatation juice filtration, all the cloths satisfied filtration requirements and had a longer service life than PT-45/150 stylon fibre used hitherto in the Polish sugar industry, but I/PE 5213 polyester fibre gave the best results: lower average sugar losses in filter cake, a smaller amount of HCl needed for cloth regeneration and a lower purchase price.

Operation of vertical crystallizers on C-massecuite at Garbów sugar factory

M. Nurzynski. *Gaz. Cukr.*, 1986, **94,** 10 - 12 *(Polish).*

The operation of a battery of three vertical crystallizers is discussed, including the automatic cooling system used, low-grade massecuite fluidity and molasses exhaustion. By comparison with the previous crystallizer station, the new system has reduced molasses purity and yield and increased sugar output on beet.

A suggestion for a method of carrying out building work in buildings subject to the effect of sugar dust

K. Zielinski, B. Zgola and A. Wrezel. *Gaz. Cukr.*, 1986, **94,** 25 - 26 *(Polish).*

Details are given of the various measures used in the reconstruction of the packaging house of the Szamotuly sugar factory to counter the effects of sugar found in the reinforced concrete floors and in the grouting between the wall bricks. The building was 90 years old, and it has been found that the presence of as little as 0.1 - 0.2% sugar by weight in cement reacts sufficiently with the CaO to prevent setting.

Evaluation of the exposure of workers to vibrations occurring at work stations in sugar factories

A. Tulodziecki. *Gaz. Cukr.*, 1986, **94,** 27 - 30 *(Polish).*

The effects of vibrations at increasing amplitude on the human body are discussed and measurements of the vibrations emanating from specific pieces of equipment in a sugar factory reported in which the worst conditions were found in the sugar screening rooms, while those in the vicinity of centrifugals were still well above comfort level; only slight transgression of the comfort limit was found in the turbine room (particularly in the control cabin). Details are given of the methods and equipment used in the investigations.

Selected technico-production problems at Malbork sugar factory

K. Wasinska. *Gaz. Cukr.*, 1986, **94**, 31 - 32 *(Polish).*

Modifications introduced at Malbork during 1983/84 and particularly during 1984/85 included changes to the lime dosing and carbonatation mud recycling to preliming, the use of Antiprex scale inhibitor in the evaporator, replacement of one type of polyester filter cloth for another in the vacuum filters, installation of an entrainment separator in the 1st evaporator effect, introduction of a special limestone crushing system and replacement of control valves with adjustable-speed pumps for juice flow control from the diffuser to the filter-thickeners. As a result of the modifications, sugar colour in 1984/85 averaged 0.55°St as against 0.75 - 0.84° St in the preceding five campaigns.

Juice filtration in a filter-press with carbonatation mud pressing

E. Wylupek, W. Czuk, M. Pitrowski and S. Godzisz. *Gaz. Cukr.*, 1986, **94**, 32 - 34 *(Polish).*

A description is presented of the Soviet FPAKM-15 automatic filter press as tested at Klemensów sugar factory, and some performance data are given for treatment of diluted muds from vacuum filters and for filtration and pressing of 1st carbonatation mud in which filter cake losses averaged 1.81%. Reference is also made to the performance of a Czechoslovakian filter press at Hodonin where filter cake losses were 0.4 - 0.6%, which compares with 0.14% (0.007% on beet) achieved with a Hoesch filter-press. The higher losses in the Polish factory were attributed to an inadequate pressure (0.2 MPa) at which sweetening-off water was applied.

Possibilities of treating sugar factory waste water together with domestic sewage and effluent from other industrial plants

B. Zalicka. *Gaz. Cukr.*, 1986, **94**, 43 - 45 *(Polish).*

A brief summary is presented of experience in a number of countries in treatment of sugar factory effluent together with domestic sewage, and details are given of investigations conducted in Poland in 1976/77 and in 1981/82 when anaerobic treatment was used for a mixture of sugar factory waste water, domestic sewage and effluent from a citric acid plant; results showed 85% reduction in COD to 500 - 800 mg/dm^3 and 90% reduction in BOD$_5$ to 100 - 300 mg/dm^3 for the waste from the sugar factory and citric acid plant, respectively, and 90% and 95% reduction, respectively, to 200 mg/dm^3 and 50 mg/dm^3 for the domestic sewage.

The effluent of greatest pollution from a sugar factory in the light of investigations conducted by the Sugar Industry Institute

E. Glabski. *Gaz. Cukr.*, 1986, **94**, 45 - 46 *(Polish).*

The relative pollution load of sugar factory wastes is discussed and ranges of COD and BOD$_5$ given for the various sources. The most contaminated effluents include flume water, mud settled out of flume water and carbonatation mud, while water from laundering of filter cloths and from other factory washing facilities are also very polluted; highly concentrated waste also emanated from deliming stations and particularly resin columns used for decolorization of remelt liquor, as well as run-off from stored beet pulp. The low-contamination group included domestic sewage, condenser water, condensate, water from washers and gas pumps and cooling water for pumps and compressors.

Possibilities of artificial biological treatment of sugar factory effluent - rate and efficiency of processes

B. Polec. *Gaz. Cukr.*, 1986, **94**, 46 - 48 *(Polish).*

Equipment and methods for waste water treatment by aerobic and/or anaerobic means in various countries are surveyed with the aid of tabulated data showing typical characteristics of the various effluents and results obtained in their treatment.

Strike sequence control

H. Merensky. *Proc. 59th Ann., Congr. S. African Sugar Tech. Assoc.*, 1985, 102 - 107.

See Assenmacher *et al.*: *I.S.J.*, 1987, **89**, 27A.

Fixing the temperature measuring point in sugar beet piles

P. V. Schmidt, E. Manzke and B. Senge. *Lebensmittelind.*, 1986, **33**, 177 - 178 *(German).*

Investigations at East German sugar factories over a number of years have demonstrated the variations in beet pile temperatures. Since measurement of the temperature is essential where forced ventilation is used, it is necessary to know the average temperature in the pile and to know the deviations from this at different points. The question of the number of measuring points and where they should be in the pile is discussed on the basis of the investigations and some recommendations are made.

Stones - the factory and the grower

M. Branch and R. Palmer. *British Sugar Beet Review*, 1986, **54**, (3), 3 - 7.

The problems created by stones and other extraneous matter that accompany beet delivered to the factory are discussed and the various means used at British Sugar factories to separate the material from beet are described. A map indicates the proportion of beet deliveries represented by stones in the different areas of the UK, ranging from <0.2% to >0.5% by weight. The damage inflicted on beet knives is demonstrated by a table showing that the total cost of knife replacement in the 1985/86 campaign was over £207,000. The disposal of the material represents another cost item, and a number of recommendations are made on how to solve the problem.

Starch based sweeteners

Studies of the isomerization of D-glucose to D-fructose using Maxazyme GI immobilized isomerase

L. Slominska. *Acta Aliment. Pol.*, 1985, **11**, (1), 133 - 139; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (12), Abs. 12 R502.

A study was made under laboratory conditions of the effect of the form of substrate (glucose solution, corn or potato starch hydrolysate of 93 and 96.4 DE, respectively, and containing 5 and 19 ppm Ca^{++} ions) on the kinetics of glucose conversion to fructose using immobilized glucose isomerase at a substrate concentration of 45°Bx, a temperature of 60 - 70°C, pH 7.5 - 7.7, Mg^{++} ion concentration of 3×10^{-3}M, SO_2 at 100 ppm and 45% glucose conversion with top feeding of the syrup in the column. It was found that the initial process rate is independent of the form of substrate, while the action of the isomerase is affected by the degree of syrup demineralization. The presence of trace quantities of Ca^{++} ions reduces the initial process rate by 10%. Holding the enzyme for half-an-hour at 75 - 80°C necessitates reducing the rate of syrup feed by 5 - 6%; at 90°C, the reduction must be 13%.

Uniform particle size and shape key to flow with agglomerated dextrose

D. D. Duxbury. *Food Process.* (USA), 1985, **46**, (12), 70 - 71; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (12), Abs. 12 R503.

A method of agglomerating glucose that gives a uniform particle size has been developed. After treatment, the glucose particles have an oval shape and measure 0.15 - 1.2 mm, mainly 0.18 - 0.60 mm. The agglomerated glucose is suitable for dosing since it has an elevated flowability.

Introduction of a single-stage glucose crystallization process at Verkhnedneprovsk starch syrup combine

N. G. Gulyuk, L.S. Khvorova, E. G. Bondar', V. Ya. Sarapuka and V. G. Shornikov. *Sakhar. Prom.*, 1986, (7), 48 - 50 *(Russian)*.

Details are given of a one-massecuite scheme for manufacture of crystal glucose from starch hydrolysate, in which the syrup was exhausted from 95% to 75% DE during 90 - 107 hours' crystallization. Average crystal content in the massecuite was about 50%.

Preparative chromatographic separation of glucose-fructose mixtures: effect of the method used to fill the column with cation exchange resin and to load it with the mixture to be separated

Yu. E. Kuptsevich, I. D. Stal'naya, L. A. Nakhapetyan, A. Ya. Pronin and O. G. Larionov. *Sakhar. Prom.*, 1986, (7), 53 - 58 *(Russian)*.

Investigations of large-scale preparative chromatography for glucose separation from fructose showed that best results were obtained when fine-particle sulphonic cation exchange resin of narrow particle size range was loaded in a moist state (without any free water) in small portions, and when the mixture load was 8% bed volume at 40% dry solids content.

Immobilization of xylose isomerase and trial production of high-fructose corn syrup

M. J. Chun and B. S. Lim. *J. Korean Agr. Chem. Soc.*, 1983, **26**, (4), 222 - 230; through *Food Sci. Tech. Abs.*, 1985, **17**, Abs. 5 L2.

A process was developed for immobilizing xylose isomerase from *Streptomyces griseolys*. Porous resins, e.g. Amberlite IRA 93, were effective for immobilization; optimal immobilization conditions for this resin were pH 7 and 55°C, yielding material with an activity of 80.6% and a half-life > 24 days at 65°C. The optimal temperature was slightly lower for the immobilized than for the free enzyme, with a wider range (60 - 70°C), while optimal pH approached 8.0 - 8.3. Trial production of HFS from 50°Bx purified glucose syrup on a pilot scale showed that 1 litre of immobilized xylose isomerase would be able to produce 293 litres of 75°Bx HFS during its half-life of 30 days.

Calculation of the iron content in crystal glucose using a calculated coefficient

N. A. Listunova. *Sakhar. Prom.*, 1986, (8), 53 - 54 *(Russian)*.

According to a standard Soviet method, the iron content in glucose is determined from the intensity of colour of a ferrosulphosalicylic complex formed; the optical density is measured and the iron content read off a calibration curve. However, application of a coefficient K (the ratio of the iron content in a standard solution to its optical density), which is the arithmetical mean of the sum of values found for each concentration of dilute solution, eliminates the need for construction of the calibration curve while giving exactly the same result as the original method.

Comparison of enzymic saccharification of starch and cellulose from technological and economic aspects

K. Réczey, E. László and J. Holló. *Starch/Stärke*, 1986, **38**, 306 - 310.

While enzymatic saccharification of starch has been used on an industrial scale for many years, enzymatic saccharification of cellulose has only been conducted on a pilot plant scale; enzymatic saccharification of the lignin-encrusted cellulosic substance is particularly difficult. Pretreatment of starch by liquefaction is most frequently conducted in the presence of thermostable alpha-amylase in a jet cooker, whereas the most economical method of lignocellulose pretreatment appears to be steam explosion, but the lack of liquefaction means that the subsequent saccharification occurs in a heterogeneous phase. Energy consumption and costs are lower for starch than lignocellulose saccharification.

Sugar refining

The Australian sugar industry

B. M. Munro. *Paper presented to 45th Ann. Meeting Sugar Ind. Technol.*, 1986, 11 pp.

A short survey is presented of the Australian sugar industry, including the processes used and products made at the six CSR refineries (including that in New Zealand). The function of the Sugar Board, the role of CSR Ltd. as contractor to the Queensland government, domestic market policies and the fall in domestic sugar consumption are other aspects discussed.

Quantification of the effects of different raw sugar impurities on filtration rates in carbonatation refineries

P. Hidi and R. J. McCowage. *Proc. 1984 Sugar Processing Research Conf.*, 186 - 208.

Studies, involving small-scale affination and carbonatation procedures, were aimed at reliable simulation of refinery filtration. Details are given of the procedures and of the carbonatation equipment, and the effects of soluble impurities, soluble phosphate, soluble silicates, aluminium salts, magnesium compounds, starch, dextran, gums, colloidal inorganic compounds and coarse insoluble impurities determined in terms of their filtration impeding activities (fia), where fia = –log (filtrability/100). Results showed that soluble phosphate had by far the highest fia (0.96 per 100 ppm) of all the impurities tested, followed by soluble Mg present at >150 ppm (0.46), soluble silicate and colloidal inorganic material (0.45), soluble Al (0.40), gums (0.19), cane starch (0.13), dextran at 4,000,000 - 50,000,000 molecular weight, soluble Mg present at up to 100 ppm (0.04), and soluble starch and coarse insoluble material (0.02).

Observations on filtration impedance in raw sugar

J. A. Devereux and M. A. Clarke. *Proc. 1984 Sugar Processing Research Conf.*, 209 - 230.

The effects of soluble and insoluble non-sucrose components in washed raw sugars on filtration were studied using a Walton filter cell at normal process temperatures and these effects expressed in terms of a filtration impedence factor (the slope of a straight line of time/filtrate volume *vs.* filtrate volume). Details are given of the filtration and analytical procedures used, and results given for polysaccharides, dextrans (including those of low molecular weight), amino-N and suspended solids. Results showed that the suspended solids content was the best indicator of filtration impedance at operating and room temperatures. Among the soluble solids, the total polysaccharides had an effect which increased with temperature rise (dextran remaining the most significant polysaccharide to affect filtration); the correlation was consistent throughout the entire temperature range. Low M.W. dextrans also contributed to filtration impedance. Starch had two effects: the well-known decrease in filtration efficiency as soluble starch gelatinizes, and a marked impedance caused by ungelatinized starch granules measuring less than 2 μm in diameter.

Refining research in South Africa

Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1985/86, 8 - 9.

The effect of mechanical circulation in refined pans on sugar quality at Noodsberg: Investigations to establish whether the installation of massecuite stirrers in the refinery pans had produced any change in the residence time needed for adequate conditioning of the sugar showed that use of the stirrers reduced the conglomerate count in the sugar leaving the dryer before the conditioning silo from 91% to 63% as well as the moisture content; as a result of the improvement, the time required for conditioning was cut from 60 to 20 hours.

Conditioning of refined sugar using silica gel: Because of a lack of conditioning capacity, unconditioned sugar is packed in 1-tonne bags (consisting of a reusable polypropylene bag and a disposable polyethylene inner lining) currently used for export of refined sugar; importers have complained that the sugar has arrived wet and sticky or caked hard. Investigations on the use of silica gel sachets for moisture absorption (25 kg gel being used per tonne of sugar) showed a definite decrease in sugar moisture after 3 weeks of storage by comparison with the control in which moisture was found to migrate from the centre towards the periphery of the bag. Caking tests were negative, indicating effective conditioning of the sugar. Further tests to establish the minimum quantity of silica gel that would satisfactorily condition refined sugar showed that where a 1-kg sachet was used, a very small amount of soft caking occurred as against lumps formed in the control; the other samples, treated with up to 4 kg silica gel per tonne, were free-flowing.

Caking of refined sugar in 25 kg paper bags: The effects of initial sugar quality (moisture content, temperature, etc.) at packing, the material used for packing and warehouse conditions on the keeping quality (particularly lump formation) of refined sugar in various types of bag were investigated for sugar from four refineries stored at two sites, Bloemfontein and Durban, characterized by low and high humidity, respectively. Sugar packed at a higher initial moisture content (0.065%) became moist in 4-ply polyethylene-lined bags (which are virtually impermeable to moisture) and remained moist throughout the trials at Durban, whereas at Bloemfontein it eventually dried out, indicating some movement of water vapour through the valve closure or the polyethylene itself. Sugar of 0.015% moisture content in the same bags remained free-flowing. It was concluded that humidity conditions in the warehouse play a very important role where sugar is packed in bags made of a moisture-permeable material, while the initial moisture content of the sugar is an important factor in the caking potential of sugar packed in moisture-impermeable bags.

Laboratory studies

Sucrose crystal habit in a refinery

P. G. Morel du Boil. *Proc. 59th Ann. Congr. S. African Sugar Tech. Assoc.*, 1985, 33 - 38.

Increasing concentrations of molasses caused increasing degrees of crystal elongation when pure sucrose solutions were spiked with refinery molasses under laboratory conditions. Fractionation of the molasses using ethanolic precipitation coupled with carbon column chromatography caused no significant loss of *c*-axis elongating properties. Addition of the individual fractions to sucrose solutions indicated that the major habit modifiers were in the fraction containing low M.W. oligomers; this fraction also had the greatest rate-retarding effect. It was also demonstrated that standard dextrans, isomalto-oligosaccharides, malto-oligosaccharides and an oligosaccharide preparation from sucrose (probably mainly 6- and neo-kestose) did not induce significant *c*-axis elongation under similar conditions and at similar concentrations. Hydrolysis of this fraction with yeast invertase completely removed the habit-modifying properties, implying that fructose-based oligomers were probably responsible for the elongation in the refinery, with polysaccharide components making minimal contribution.

Sensory analysis of brown sugars and its correlation with chemical measurements

M. A. Godshall, C. H. Vinnett and V. Chew. *Proc. 1984 Sugar Processing Research Conf.*, 22 - 52.

A study of brown sugars, rated for 13 flavour attributes, showed that much information could be obtained by sensory evaluation that correlates with chemical composition (volatiles, acetic acid, titratable acidity, colour, phenol, iron, Cl^-, ash, amino-N, glucose, fructose and sucrose). Turbinado sugars differed markedly from the other brown sugars in having much lower concentrations of all constituents tested except amino-N, which was higher; amorphous sugars also contained more amino-N than the other sugars, but their chemical composition was more similar to that of the other brown sugars. The best predictors of light brown sugar flavour rating were amino-N and Cl^-, low contents of each being desirable for a good flavour.

Recent observations on starch and sugar cane products

F. W. Parrish, W. R. Goynes, E. J. Roberts and M. A. Clarke. *Proc. 1984 Sugar Processing Research Conf.*, 53 - 59.

Microscopic examination of starch granules in samples of five raw sugars is reported. The 50°Bx solutions were centrifuged at 14,000 rpm for 20 minutes and the solid residues washed twice with water; each wash was followed by 10 min centrifuging at 14,000 rpm. Polarized light microscopy with a camera attachment was used; the starch granules were detected by staining with 0.1M iodine in 10% KI, and the gelatinization temperature (T_g) of the granules was determined in water and sucrose solution on a hot stage attachment. Two sizes of granules were observed: larger ones averaging 5 µm which had T_g values in line with those of other starches containing about 20% amylose, viz. 58 - 106°C in 0 - 70°Bx sucrose solution, and smaller granules measuring an average of 1 µm which did not gelatinize in water or 15°Bx sucrose solution when heated to boiling point nor did they stain with iodine. Possible reasons for the presence of two sizes are suggested.

A glucan from sugar cane

E. J. Roberts, M. A. Clarke, M. A. Godshall and F. W. Parrish. *Proc. 1984 Sugar Processing Research Conf.*, 60 - 71.

Details are given of the procedure used in separation of indigenous sugar cane polysaccharide (ISP) from fresh cane juice, purification of the ISP, isolation from it of a glucan and its subsequent analysis. The glucan had a specific rotation $[\alpha]_D^{20}$ of +120° and, on acid hydrolysis,yielded about 98% glucose; it gave a red-purple colour with iodine, similar to that of amylopectin, and showed very slight birefringence under polarized light, but no Maltese cross pattern as found with starch granules. GLC showed that the glucan was predominantly α-(1-4) linked with some α-(1-6) linkages and 11 - 13% of terminal groups. It was found to produce only very slight increase in viscosity when added to water, raw sugar syrup or refined sugar liquor, but formed no floc. Possible structures of the glucan based on treatment with pullulanase and isoamylase are indicated. The structure of the glucan is similar to that of amylopectin and glycogen, but its degree of branching (as shown by the percentage of terminal branches) is greater and its molecular weight lower. It might be a phytoglycogen, although it was readily soluble in water and gave a clear solution as against the milky phytoglycogen extracted from corn and animals.

Performance characteristics of the CTI apparent purity laboratory analysis system

J. Kysilka and S. E. Bichsel. *Proc. 1984 Sugar Processing Research Conf.*, 72 - 91.

A description is given of the apparent purity system developed by Crystal Tek International, a division of American Crystal Sugar Co., which embodies a CTI-501 dark solution optico-electronic polarimeter provided with an infra-red emitting diode as light source and measuring at 875 nm, a CTI-601 reflection refractometer and a CTI-1001 Tek Mate 16-bit microcomputer which permits easy adaptibility to on-line monitoring. There is no need for lead clarification. Comparison of results with those given by a standard automatic polarimeter and the Karl Fischer method showed no significant difference in precision and accuracy at the 99% confidence level.

Changes in juice composition of sugar cane as affected by post-freeze deterioration in Louisiana

B. L. Legendre, W. S. C. Tsang and M. A. Clarke. *Proc. 1984 Sugar Processing Research Conf.*, 92 - 107.

Measurement of changes in Brix, apparent sucrose, appa-rent purity, titratable acidity, pH and dextran content of juice from eight varieties of cane revealed significant pre-freeze differences in the first four parameters while differences were sometimes found in all the parameters after a sharp frost (–10.6°C). A more detailed analysis of juice from three varieties showed similarity between pol readings and sucrose as determined by HPLC, even when the dextran content was excessive. The haze method gave dextran values 3 -20 times greater than those given by Roberts' copper method in severely deteriorated juice. While glucose remained essentially constant throughout the sampling period, the level of fructose rose as sucrose was consumed by the apparent action of *Leuconostoc mesenteroides*, so that fructose content may be used as a measure of deterioration. It is considered possible that resistance to deterioration by frost is related to resistance to *L. mesenteroides*.

Laboratory filtrability test methods

N. Nenadkevich. *Proc. 1984 Sugar Processing Research Conf.*, 162 - 175.

The procedure used in determination of washed raw sugar filtrability by means of the Johns-Mansville bomb filter and the Walton filter (also made by Johns-Manville) are described. The latter filter is a pressure leaf unit complete with pump, ancillary piping and valves, all mounted on a portable stand. The bomb filter used was a new unit built to the design specifications of an older unit; after checks and a number of adjustments had been made, the new filter gave results in satisfactory agreement with the older unit for 30 raw sugar samples. The filtration rate of samples adjusted to pH 8 were an average of 15% slower than those for samples of unadjusted pH in the range 5.8 - 6.6. The effect on turbidity of filtration with four grades of kieselguhr was also investigated and the results tabulated, showed that turbidity generally rose with flow rate. Comparison between the Walton filter and the bomb filter showed excellent agreement in filtration rates, with a correlation coefficient of 0.972, but the bomb filter is considered preferable in that it needs almost no maintenance and would seem to have a long life; it can be located in many areas that are far from optimum whereas the other filter requires more of an analytical or laboratory setting.

Sugar liquor clarification using diatomite filter aid

C. W. Cain. *Proc. 1984 Sugar Processing Research Conf.*, 176 - 185.

A study is reported on determination of the particle size distribution of filterable solids in various washed raw sugars and on interaction between the particles and filter aid. The samples were screened to remove particles measuring > 20 µm, and the particles that passed through the screen then dispersed in electrolyte followed by particle sizing using a Coulter counter with a 19 µm aperture. The total filterable solids were determined by dissolving 2 g of sugar in 100 ml distilled water and filtering through a pre-washed and -weighed Millipore membrane of 0.22 µm, after which the membrane was throughly washed, dried and weighed. Combination of the two sets of data gave the particle size distribution. Results for typical filter aids demonstrated the increase in particle removal with increased cake thickness and decrease in flow; the major mechanism for particle removal is mechanical screening; as liquid flows through layer after layer of filter aid, the effect of the smaller pores becomes predominant. Sedimentation also contributes to the removal, but at high flow rates its role is very small because of viscous drag on the very small particles; however, at low flow rates, these particles may settle in the large pores of the filter aid and restrict flow. Graphs illustrate the difficulty of filtering liquor that has not been carbonatated or phosphatated to agglomerate the extremely fine particles; this was demonstrated by deviation of raw sugar filtration curves from the theoretical, which assumes the formation of an incompressible filter cake of constant permeability through its depth, whereas the tests showed a decrease in permeability as a function of flow rate. This function suggests that better information could be obtained from tests at constant pressure where the volume of filtrate was measured under limiting flow rate conditions rather than between given time intervals.

Current applications of HPLC in sugar analysis

W. S. C. Tsang and M. A. Clarke. *Proc. 1984 Sugar Processing Research Conf.*, 316 - 330.

The literature on HPLC application in sugar cane and sugar processing research is reviewed, and methods are described for rapid analysis of organic acids (particularly aconitic and lactic acid), identification of uronic acids as a contribution to polysaccharide analysis and of the component sugars of polysaccharides, analysis of difructose dianhydrides and measurement of aspartame artificial sweetener and its degradation products.

Choice of cation exchanger for chromatographic separation of molasses components

R. F. Kambarova, N. B. Kazakova, G. A. Chikin, I. P. Shamritskaya and S. G. Boryakov. *Izv. Vuzov, Pishch. Tekh.*, 1986, (3), 24 - 26 *(Russian)*.

The sucrose adsorptive properties were determined of a number of sulphonic cation exchange resins suitable for chromatographic separation of molasses constituents as in the Finnsugar process. Because of the complex composition of molasses, a model solution was used containing 40% sucrose and 3% NaCl. Results are tabulated and discussed. It was found that gel-type resins of medium cross-linkage containing 4 - 6% DVB and of restricted granulometric composition had the greatest selectivity to sucrose whereas macroporous resins were not selective.

By-products

Continuous ethanol production in an immobilized whole-cell fermenter using untreated sugar cane bagasse as carrier

I. H. S. Cheung, M. Gishen, P. Ghosh and N. B. Pamment. *Appl. Microbiology and Biotechnol.*, 1986, **23**, (6), 413 - 416; through *S.I.A.*, 1986, **48**, Abs. 86-1119.

Saccharomyces cerevisiae was immobilized by absorption on sieved air-dried bagasse in a packed-bed reactor. Complete conversion of glucose to ethanol was obtained at a dilution rate of 0.19/hr. Continuous ethanol production was maintained for up to 57 days. Reactor productivity increased with increasing packing density of the bagasse. Plugging resulted in fluctuations in productivity between days 9 and 26; increasing the average column temperature from 30 - 33°C to 33 - 36°C alleviated plugging and restored performance over a short period, but after 8 - 10 days led to a decrease in ethanol production. Advantages of bagasse as support material include negligible cost, ready availability and the capacity to support a high yeast population.

Evaluation of sugar cane bagasse and rice straw as process substrates for the production of ethyl alcohol

D. B. Rivers, G. M. Zanin and G. H. Emert. *Proc. Arkansas Acad. Sci.*, 1984, **38**, 95 - 96; through *S.I.A.*, 1986, **48**, Abs. 86-1120.

Bagasse was submitted to simultaneous saccharification fermentation by *Trichoderma reesei* and *Candida brassicae*. Conversion to ethanol was negligible if the bagasse was in the native state, and it was not increased by previous ball milling. Pretreatment of the bagasse with 0.5N NaOH at 60°C for 24 hours increased the conversion to 67% of theoretical.

Preparation of enriched molasses

L. G. Belostotskii, V. E. Skryplev, A. A. Savun, T. A. Vdovina and N. V. Raskina. *Sakhar. Prom.*, 1986, (7), 33 - 35 *(Russian).*

A description is given of a plant for adding orthophosphoric acid, ammoniacal water, trace elements and vitamins to beet molasses for use as animal fodder.

Equal distribution of components in enriched (beet) pulp

M. G. Parfenopulo and N. B. Karaulov. *Sakhar. Prom.*, 1986, (7), 35 - 36 *(Russian).*

A scheme is described which is proposed for production of animal fodder comprising 73% dried pulp of 11 - 12% moisture content, 19% molasses, 5% urea and 3% diammonium phosphate plus trace additives.

Fermentable sugars from starches and cellulosic materials

M. R. Ladisch. *Proc. 1984 Sugar Processing Research Conf.*, 152 - 161.

Research on fermentable sugars production from biomass materials, including agricultural residues (particularly corn), grains, beans, wood and sugar cane crop waste, e.g. bagasse, is described. Details are given of biomass composition and its processing by acid or enzymatic hydrolysis to yield fermentable sugars for subsequent use in alcohol manufacture, and the costs of producing glucose from biomass and from starch are compared.

The potential for by-products in the Barbados sugar industry

C. K. Laurie. *Proc. 3rd Ann. Conf. Barbados Sugar Tech. Assoc.*, 1985, 7 pp.

A survey is presented of the potential uses of: (1) bagasse as fuel, in pelleted form, to provide extra electricity for sale and as poultry litter and mushroom beds, animal fodder and in building blocks formed from a 6:1 bagasse:slaked lime mixture encased in concrete; (2) molasses as raw material for fuel alcohol production (rum manufacture being on the decline because of competition from other producers) and as animal fodder; the potential for CO_2 as the major by-product from molasses fermentation is also mentioned; (3) filter cake as source of wax (the production costs of which may be more favourable than some 30 years ago in view of the rise in the price of petroleum products), as fertilizer and as a medium for the intensive production of earthworms for use as a high-protein animal feed; and (4) bagasse ash for possible use in special cements.

The utilization of sugar cane tops as a preserved animal feed

J. Zelzer. *Proc. 3rd Ann. Conf. Barbados Sugar Tech. Assoc.*, 1985, 5 pp.

Feeding trials with sheep and cattle indicated the benefits in weight gain of cane top silage supplemented with 8 - 10% molasses. However, a number of problems were encountered in the silage-making program, and some recommendations are made.

Determination of volatile fatty acids in molasses

L. Prochazka, F. Kravnicka and A. Stechova. *Kvasny Prum.*, 1986, **32**, (2), 33 - 36; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (16), Abs. 16 R399.

Results are given of the determination in molasses of volatile fatty acids (VFA) which inhibit the fermentation process. The VFA were determined in aqueous distillate by capillary isotachophoresis. It was found that the VFA content in molasses from Czechoslovakian sugar factories, with the exception of acetic acid, was 5 - 10 times greater than values in the literature for molasses from other countries. It is noted that the VFA content in Czechoslovakian molasses has risen from 0.77% to 1.02% over the last five years. Particular attention is drawn to the formic acid content, which is approx. 0.1% higher than in molasses from other countries.

3. *Herreshoff furnace* operations will run without interruption for hours, but whenever adsorbent feed to the coolers stops the temperature of the air leaving the coolers drops sharply, by as much as 250°F. At these times, the fluid bed dryers stop drying and become conveyors, discharging damp char to the furnace storage bin.

Most pervasive of these problems is variable feed through the dryers due to continual change in the adsorbent level in the deashing column.

Results

From the start of operations, the dryers have done an effective job utilizing waste heat to partially dry the adsorbent mix before Herreshoff storage. Most of the problems, some still not under control, were caused by other parts of the systems, not by the dryers themselves.

Energy savings began early in 1984 when both dryers went on-stream. During the two years that followed, we monitored performance by frequent, brief test intervals when moisture samples were collected and concurrent operating levels were measured and recorded.

Important variables

Effective fluid bed drying depends (1) on an adequate air supply and (2) the highest practical temperature.

Air flow to each of the two dryers ranged from 11,000 to 14,000 c.f.m., with a combined total flow of 25,000 to 26,000 c.f.m. Dampers on the forced draft fan were adjusted to deliver only the volume of air to the Herreshoff coolers that could be used efficiently by the dryers. By slightly reducing flows to the coolers in this way, we raised the temperature of discharge air. Since the char coolers had excess capacity, this did not compromise their primary function of cooling Herreshoff char.

Air temperatures ranged between 240°F and 420°F during test runs. Flow of air from the forced draft fan to the coolers is reasonably uniform, so these temperature variations were due to brief downtimes which stopped char flow through the furnace or to fluctuations in flow of hot char through the coolers.

Table II. Effect of initial level on moisture removed

Moisture entering dryer %	Air to dryer Flow, c.f.m.	Air to dryer Temperature, °F	Moisture removed lb/hr	Energy saved, therms/hr
23.5	12,000	345	2000	23.6
19.0	12,000	330	1600	18.9

Average results, 4 hour fill time runs only

We expected 19 to 20% moisture in the char from the shortened dewatering filters, only slightly higher than moisture from the original full length filters. The actual average during test runs was a fraction above this range. Individual moisture results for char entering dryers ranged from 17% to 25%. This variation was due almost entirely to swings in the rate of char flow from the deashing column to the filters.

Table II shows that dryers functioned creditably with either high entering moistures or low entering moistures. We removed more water in the higher moisture tests and apparently saved more energy. But credit cannot be taken for removing moisture that enters above the 19% moisture level since moisture to the furnace averaged no higher than 19% before modification of the dewatering filters. It is encouraging, however, that the dryers can function effectively even at high moisture levels and high char feed rates.

Energy available in waste hot air

To evaluate performance of the dryers, consider first the energy available for drying. Bone char leaves the bottom hearth of the furnace and enters the coolers at an average temperature of 1075°F. Ambient air from the forced draft fan reduces this adsorbent temperature to 140°F. This is a transfer of heat from the regenerated adsorbent to the cooling air equivalent to 55 therms/hour (Appendix II). Except for heat lost in the transfer, this may be considered the maximum heat available for drying.

Energy utilized in test operations

We measured energy savings, as we have seen, by intermittent data logging and sampling to measure moisture removal. Table III shows average test results.

The bottom row of the tabulation represents 17 separate tests, all at a filling time of about 4 hours. Average moisture removal in these tests was 1800 lb/hr per dryer. For both dryers operating, this is equivalent to energy savings of 42 therms/hour. The overall average for all data sets in Table III is close to 40 therms/hr. This is about 70% of 55 therms/hour, the calculated energy available in hot air from the Herreshoff coolers.

Actual energy savings in continuous operation

Actual savings in natural gas consumption were disappointing initially. Instead of achieving savings equivalent to 40 therms/hr, as projected by our tests, fuel utilization results for the Herreshoff furnace showed a reduction of only 1.2 therms/ton of char regenerated. This is 17 therms/hour, less

Table III. Test results: Averages at several rates for a single dryer

Char rate (dry), lb/hr	Equiv. fill time, hr	Air to dryer Flow, c.f.m.	Air to dryer Temp., °F	Moisture % Entering	Moisture % Leaving	Moisture removed, lb/hr	Energy saved, therms/hr
9,500	5.9	12,300	285	20.1	9.5	1360	16
10,500	5.3	12,500	313	21.8	9.8	1777	21
11,700	4.8	12,300	292	19.8	11.8	1399	17
12,600	4.4	12,100	323	21.0	11.8	1620	19
13,500	4.2	12,100	338	20.4	10.1	1923	23
14,400	3.9	12,000	343	20.8	12.0	1799	21

than half the energy savings found during test runs. The comparative results shown in Figure 4 were for 16 weeks operation in mid-1983 and for a similar interval in mid-1984 after the dryers went in service.

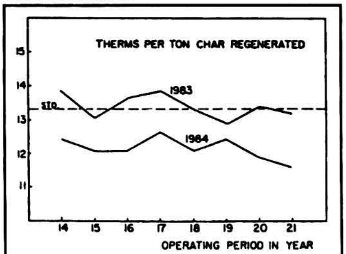


Figure 4. Energy consumption: Modest initial improvement

Since these initial gas consumption comparisons were made, however, we have steadily improved the consistency of furnace operation. This substantially improved the continuity of hot air feed to the dryers, and this is reflected in gas consumption results shown in Table IV.

Table IV. Herreshoff furnace gas consumption, annual results

Year	Natural gas consumption Total	Reduction Therms/ char filter	Reduction Therms/ hr*
1983	837	–	–
1984	697	140	33
1985	652	185	43
1986 to date	624	213	50

* Therms/hr based on 4.3 hr annual average fill time

Results for the start-up year of 1984, when averaged for the whole year, were almost twice as good as the 17 therms/hr savings in the monitored 16 week comparison. Average reduction in gas consumption in 1984 was 33 therms/hour.

In 1985, daily operations were more like test operations when fluidizing air temperatures almost always were kept in a practical range for drying. As a result, the 1985 annual average energy saving was 43 therms/hour, similar to savings reported for test runs.

Our higher energy savings in 1986 to date – 50 therms/hour – are due, we believe, to use of centre shaft cooling air. This is a source of waste heat not used until late in 1985. Since an additional fan is required to utilize this waste air stream, we have yet to evaluate the cost/benefit trade-off.

Adsorbent losses

Are we losing adsorbent through attrition in fluidized bed drying? It is too early to give assurance that we are not, but operating results to date are encouraging. We have not had a specific gravity separator to remove heavy particles since 1980. Accumulating heavy particles, we believe, jeopardize softer particles, in our adsorbent mix. On the other hand, we have in the past two years replaced vibrating conveyors and bucket elevators with hydraulic transport. This should provide some benefits in gentler handling. Also, we have achieved better control of oxygen in the furnace which should reduce granular carbon losses through combustion. All of these changes tend to obscure any possible damaging effect due to fluidization. Nevertheless, we believe fluid bed losses were negligible because adsorbent make-up in No. 1 House is down while inventory remains at normal levels. Canesorb make-up in 1985 was 3.1% (of the Canesorb inventory) per cycle, the lowest annual make-up to date. At the same time, the Canesorb fraction of the inventory is at its highest level. Loss through attrition clearly has not been a recent problem in No. 1 House.

Conclusion

By providing 160 square feet of continuous fluid bed drying capacity, we have made it possible to utilize the waste heat in hot air from our Herreshoff air-cooled char coolers. Formerly this hot air was discarded by exhausting it to atmosphere. Now we use it as the fluidizing medium in fluidized-bed drying conveyors to partially dry char. This removes some of the moisture which otherwise would have to be evaporated in the furnace. We have found that:

1. Good fluid bed performance depends on uniform feed rate and uniform moisture to the dryers and to a steady flow of hot, fluidizing air.

2. Natural gas consumption was reduced by 43 therms per hour in 1985, the first full year that the dryers were in service.

3. Fluidizing has not caused increased adsorbent loss through attrition.

At current natural gas prices, annual savings are about $80,000 per year from reduced gas consumption.

Acknowledgement

The authors wish to acknowledge the work of Brian Trudel of Carrier Vibrating Equipment Incorporated in developing some of the test data reported in this paper.

Appendix I. Calculation for sizing fluid bed dryers

1 3.5 hr fill time requires 11,000 ft^3 char per day

2 Each dryer handles 5500 ft^3 per day.

3 At 5 min retention, each dryer handles $5500 \times 5/(24 \times 60) = 19.1$ ft^3

4 For a 3-inch cake (0.25 ft), dryer surface required to handle 19.1 ft^3 in 5 minutes is: $19.1/0.25 = 76.4$ ft^2

5 A standard 4 ft × 20 ft dryer was chosen to provide 80 ft^2 of surface

Appendix II. Theoretical maximum energy savings

Char regeneration rate	400 ft^3/hr
Char bulk density	70 lb/ft^3
Specific heat of char (600°F)	0.21 B.Th.U/lb/°F
Temperature of char:	
Entering coolers	1076 °F
Leaving coolers	140°F

$400 \times 70 \times 0.21 \times 936/100000 = 55$ therms/hr

Developments in sugar manufacture at Sezela sugar factory, 1959 to 1984

By S. North-Coombes
(C. G. Smith Sugar Limited, Durban, South Africa)

Introduction

Between 1959 and 1984 the South African sugar industry more than doubled its production to a record level of 2,370,040 tonnes. This was achieved by a process of expansion which started in the 1960's and which included both the building of new factories as well as modernizing and expanding existing plants. It has recently involved increasing the capacity of the CG Smith Sugar Limited's Sezela factory to 450 t.c.h., and the commissioning of the new 600 t.c.h. Felixton factory by Tongaat-Hulett Sugar Ltd. The technical progress of the industry can be followed by studying the evolution of a typical South African sugar factory such as Sezela, within the context of the industry's development. This paper will attempt to show that trends in cane quality and factory performance at Sezela over the period under review are typical of what has been achieved in the sugar industry, generally.

During the period under review, the manufacturing processes used at Sezela have undergone major changes:

(a) Extraction of juice by straight milling has been replaced by diffusion.
(b) Clarification by juice sulphitation has been replaced by simple defecation.
(c) Changes have also been made in evaporator design following the introduction of diffusion and a bagasse-based by-product plant producing furfural and furfuryl alcohol. A refinery which had operated for 24 years has been closed to make room for increasing the capacity of the factory as well as to save bagasse for the furfural plant, which underwent a major expansion in 1981 - 82.
(d) The boiling process has been modified to produce very high pol sugar (99.3 pol) and continuous pans as well as continuous crystallizers and centrifugals have been installed.
(e) Steam engines were replaced by more efficient high pressure steam driven turbines and electric motors.
(f) Modern high pressure large capacity steam boilers, both coal and bagasse fired, replaced the small fire-tube units.
(g) High efficiency turbo-alternator sets were introduced to supply electric power.

S. North-Coombes

(h) Automation and process control were gradually introduced and are an integral part of plant development.

These changes are highlighted under the appropriate sections, and plant capacities are given in an appendix.

The Sezela Factory

Sezela was built in 1914 to cope with increasing land development and cane supply[1]. It is situated on the south coast of Natal and forms part of a group of six sugar factories of CG Smith Sugar Ltd. It achieved a South African record production of 266,740 tonnes of sugar for the 1984/85 season. Its growth followed the industrial trend and was accomplished in three phases, namely the first expansion (1965-1966) to take advantage of an increasing export market and the lifting of sugar quotas; a second expansion (1975 - 1976) to cope with cane becoming available after the closure of an adjacent mill, and the final expansion (1981-1984) to meet a projected increase in cane supply. This last project was necessary as an exhaustive study had revealed that the capacity requirements of 365 t.c.h. in 1982/83 would rise to a projected 450 t.c.h. in 1990 or earlier.

Cane supply

Until the mid 1970's cane was transported from fields to factory by an elaborate tramway/railway system. Sezela had the longest tramline system in the South African industry, covering 200 km and using 38 locomotives. This was gradually replaced by road transport which was more economical and enabled hilly land to be developed. About 75% of cane delivered to the factory is loose cane transported in Hilo type "spiller" vehicles while the remainder of the cane is delivered in 4-tonne bundles by lorry or tractor-drawn road transport. Deliveries are on a continuous basis during the whole week while a constant cane supply is assured by stock-piling in transfer-zones in the fields.

Cane quality

The quality of the cane processed over the last twenty-five years has gradually deteriorated. Although fibre content has remained fairly unchanged for the industry, it has increased at Sezela; whereas, in contrast, sucrose content has fallen both for Sezela and the industry, as shown in Figure 1.

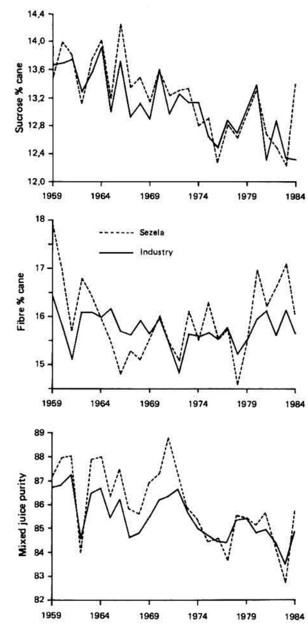


Fig. 1. Sucrose % cane, fibre % cane and mixed juice purity[2]

The purity of mixed juice has also declined markedly, resulting in an increase in the amount of non-sucrose entering the boiling house.

1 Anon: *S. African Sugar Year Book*, 1959/60, 30, 218 - 219.
2 Data obtained from: *Proc. S. African Sugar Tech. Assoc., Reviews of milling seasons*: 1959 to 1984.

Juice extraction

At the begining of 1959, the extraction plant at Sezela comprised two separate milling tandems, each made up of a shredder, followed by five three-roller mills driven by horizontal steam engines. During the first expansion of 1965-1966 one milling train (McNeil) installed in 1914, was retained and the second was replaced by a new and modern Walkers milling tandem. New steam turbine drives were installed on the shredder and each of the heavy-duty five-roller pressure-fed Walker mills, to replace the outdated horizontal engines. Until the second major expansion (1975-76) cane was processed by the 5-mill Walker tandem operating at 250 t.c.h. Following the introduction of diffusion in the early 1960's and its development at other factories, including the Company's own plant at Pongola, a bagasse-type diffuser was installed at Sezela in 1976. It operated in parallel with the Walker mill train and processed an additional 90 to 100 t.c.h. after the closure of the Renishaw mill. The hourly throughput of 150 to 165 t.c.h. in 1959 thus rose to 247 t.c.h. in 1966 and to 340 t.c.h. in 1976. The move from pure milling to bagasse-diffusion was determined by:

- the closure of Renishaw mill which made available a complete cane preparation line together with two mills complete with drives – this was ideal for de-watering duties;
- installation and maintenance costs which were much lower than for a milling train; and
- higher sucrose extraction which could be achieved.

The extraction obtained with bagasse diffusion was 97.0 for the first season of operation compared with 95.2 for the Walkers mill. During the period between 1976 and 1980 great strides were made in the development of cane diffusion[3]. Although these diffusers were a few circulating stages longer than bagasse diffusers there was no need for a pre-extraction mill.

Their adoption at the other factories in the Company and in the industry greatly influenced the decision to install cane diffusion at Sezela during the final expansion of 1981-84. The hourly throughput rose to 422 t.c.h. in 1984 and the extraction to 97.2%. Figure 2 illustrates the changes in extraction and hourly throughput over the 25-year period.

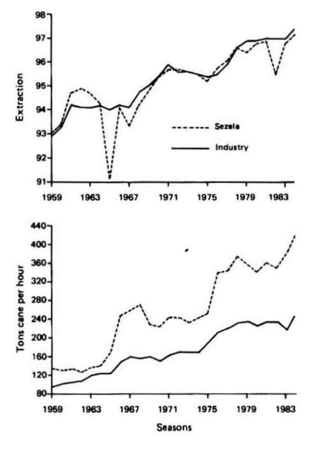


Fig. 2. Extraction and throughput for Sezela and the industry[2]

Present extraction plant design

There are two parallel cane preparation lines each feeding one diffuser. Rubber belts are used as conveyors for shredded cane. They are simple in design and are less maintenance-intensive than conventional slat cane carriers. On each preparation line cane is fed through a set of leveller knives with a clearance of 1 m from the belt and then through a set of heavy duty knives[4] contra-rotating against an anvil plate. The knifed cane is then fed to a "Smith-designed" shredder.

The diffusers stand in the open on either side of a building which houses the de-watering mills and accommodates a workshop. All cane, bagasse carriers and extraction equipment are monitored and controlled from the main panel in a dedicated control room overlooking the cane yard, diffusers and mills. The cane diffusers are of BMA design and are capable of handling 250 tonnes cane per hour each. They are of the moving bed-type, fitted with two sets of lifting screws and 12 pumping stages. Press water is returned untreated before the second set of lifting screws about a third of the length of the diffuser from the discharge end.

Each diffuser is followed by two de-watering mills, retained from the Walker mill train installed during the first

3 Lamusse: *Sugar Technol. Reviews*, 1979/80, 7, 197 - 253.

4 Lionnet: *Proc. S. African Sugar Tech. Assoc.*, 1984, 58, 39 - 41.

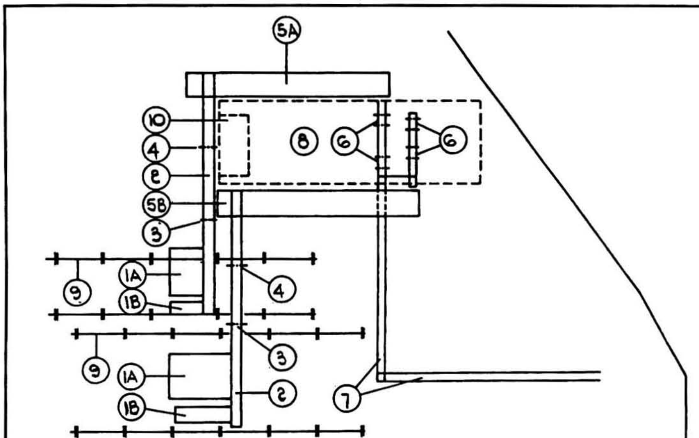


Fig. 3. Cane yard and extraction plant layout. Key: (1) Feeder tables; (2) Cane carrier; (3) Cane knives; (4) Shredders; (5) Diffusers; (6) Dewatering mills; (7) Bagasse conveyors; (8) Mill services building; (9) Crane gantries; (10) Control room

expansion in 1965. They have been arranged for parallel operation at 125 tons cane per hour each and had their speed reduced from 3.0 to 1.6 rpm by the installation of an additional high speed gearbox. Because of uncertainity as to the behaviour of diffuser bagasse of high moisture content (78%) and at high temperatures (80°C), Sezela installed a sixth underfeeder roller on these mills to improve feeding, thus converting them to six roller units.

Evolution of the manufacturing process

Clarification and filtration

Until the early 1960's clarification by juice sulphitation was common throughout the industry. This process was replaced in 1966 by lime defecation, and today hot liming using lime saccharate is practised. Settling of juice is done in three fast-flow trayless SRI clarifiers of Australian design, modified to reduce the retention time of muds and ensure better displacement of juice at the lower levels. This was necessary following a 50% reduction in mud volumes with cane diffusion. With milling, muds of about 9% solids were drawn off and, in order to obtain the same consistency with diffusion, draw-off of muds had to be delayed for long periods to allow compacting. These delays caused purity drops of some 5.0 points between mixed juice and filtrate which increased undetermined losses.

Research work at the Sugar Milling Research Institute, however, showed that muds with solids content of below 4% improved filtration and reduced losses in filter cake[4]. This, in combination with steam injection to maintain a high temperature of muds (80°C) in transit to the filters, has reduced the purity drop below 1.5 points. The influence of diffusion on filtration compared with milling is shown as follows

	Filter cake % cane	Loss in cake % pol in cane	Filter area m²/tch
Milling (1973)	5.28	0.28	0.86
Cane diffusion (1984)	1.45	0.16	0.18-0.26

Evaporation

The evaporator evolved from quadruple effect operation in the early 1960's to quintuple effect evaporation following the 1965-66 expansion. Maximum steam economy was required to supply the needs of the back-end refinery, and those of the furfural plant which was commissioned in 1974. The final expansion of the sugar factory in 1981-84 also coincided with a major expansion of the chemical (furfural) plant. This called for the supply of additional bagasse and high pressure steam to supply the bagasse digesters. In order to meet these new requirements the final evaporator design involved maximum bleeding of first and second vapours and the introduction of mechanical vapour recompression (MVR), discussed briefly in the section on Energy.

In order to provide the large heating surface required for MVR and vapour bleeding duties as well as to reduce the retention time of juice at high temperatures, kestner-type long-tube vessels were installed in the first effect, and semi-kestner vessels in the second effect. The kestners have tubes 7 m long and 50 mm o.d. while the semi-kestners use identical tubes 3.5 m long.

Boiling

Raw sugar of 98.5 pol used to be produced in Natal until about 1966. The universal single-magma 3-boiling system was used which resulted in the production of a mixture of first and second sugars of notoriously poor filtrability, with high ash and starch levels. In order to improve the refining properties of South African raws, the boiling process was modified. It is now based on the well-known effect of purification by recrystallization and produces very high pol (VHP) sugar of 99.3 pol[5,6]. *C*-sugar is completely melted and returned to syrup. *B*-sugar is made into a magma with water or clear juice to a purity of 90 and used as a footing for *A*-massecuites. Any excess *B*-sugar is also melted and returned to syrup. VHP sugar is produced from *A*-massecuites only, thus obviating a mixture of two sugars of varying crystal size and purity. VHP sugar is produced to meet stringent specifications, as follows:–

Pol	99.3°S (min.)
Moisture	0.18% (max.)

5 Van Hengel: *S. African Sugar Milling Qtly. Bull.*, 1962, **23**, 28 - 34.

6 Alexander: *South African Sugar Year Book*, 1971/72, **43**, 65 - 66.

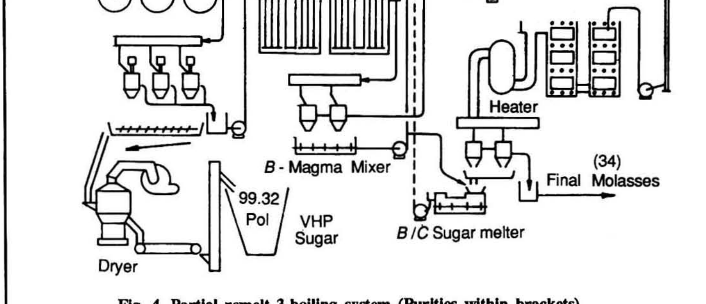


Fig. 4. Partial remelt 3-boiling system (Purities within brackets)

Conductivity
ash 0.20% (max.)
Starch 150 ppm (max.)
Specific grain size 0.65-0.75 mm
Mean aperture 0.7-0.8 mm
Fines (through 600 µm)30% (max.)
ICUMSA colour
(420 mm) 1350 (max.)

Drying of sugar is done using two automatically-controlled fluidized bed dryers of 50 tonnes capacity. They have replaced rotary louvre type dryers and were chosen on the basis of lower capital and maintenance costs and are well suited to automation. The level of starch is generally controlled by the use of the commercial high temperature tolerant enzyme amylase, which is dosed in the evaporator juice line between the third and fourth effects.

Introduction of continuous pans

Development and expansion over the 25-year period had resulted at Sezela in a conventional pan station consisting of batch pans situated at upper factory level. The second expansion of 1975-1976 saw the installation of four additional large 85 m³ pans to produce *A*- and *C*-massecuites while four 42 m³ pans installed in previous years were dedicated to *B*-boilings. During the final expansion (1981-84) the additional pan capacity required was partly provided by the installation of a 90 m³ Fives-Cail-Babcock (FCB) continuous pan for *C*-boiling (1981), while the existing pans were reallocated to boil *A* and *B* -massecuites. The reasons for the installation of a continuous *C*-pan were:

• to tie in with continuous crystallizers and centrifugals installed in previous years,
• to benefit from experience acquired at the Company's Gledhow mill where an identical pan was installed in 1978 for similar reasons, and
• continuous pans were well adapted to automation, requiring minimum supervision while their steam demand was more regular.

To complete the *C*-station capacity requirements, a second 90 m³ continuous Sugar Research Institute (SRI) pan was installed in 1984. Whereas the FCB pan is fitted with horizontal stainless steel tubes stacked in a nest to provide the heating surface, the SRI pan has a "floating" calandria with mild steel welded vertical tubes. The FCB pan has 12 control loops to the SRI's 7 and the massecuite path is shorter in the SRI pan which consists of 3 distinct sections with separations between them.

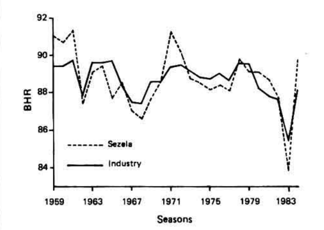


Fig. 5. Boiling house recovery from 1959 to 1984[2]

Both pans have performed well with a slightly better grain distribution and exhaustion in the SRI pan. Figure 5 shows the boiling house recovery from 1959 to 1984. The severe dip in the case of Sezela is mainly due to the effect of a very severe drought as well as the poor performance of the new *C*-crystallizer station (see below). Figure 5 also shows that the boiling house recovery seems to follow a trend similar to that of the mixed juice purity (See Figure 1). Continuous pans are now used on *B*-massecuite at Felixton and Illovo and on *A*-massecuite at Felixton and Maidstone.

Crystallizers

All three massecuites are water-cooled before curing. *A*-crystallizers are connected together in series to provide continuous operation. They are conventional horizontal units formerly part of the *A*- and *B*-stations, now regrouped. Crystallizers for *B*- and *C*-massecuites are of the vertical type. *B*-crystallizers are fitted with vertical rotating cooling elements of an earlier design with 7 m long and 50 mm o.d. finned tubes. The drives consists of constant torque hydraulic motors of 7.5 kW each. For *C*-massecuite, six vertical crystallizers, each of 100 m³, are arranged in three groups of two units in series. When they were first installed (1983) they were fitted with vertical rotating cooling elements made of 100 mm vertical tubes. These proved to be very inefficient with poor plug flow and insufficient cooling, resulting in high molasses losses. The vertical elements were replaced the following year with static horizontal water-cooling tubes arranged in stacks. Rotating arms are provided between the rows of tubes and assist the flow of massecuite. These modifications have proved very successful.

Vertical crystallizers have the main advantage of standing on their own foundations, no steel supporting structure being necessary. They stand in the open at Sezela, no building being provided, and occupy less ground space than horizontal units. In all, 14 vertical units totalling 916 m³ are installed for *B*- and *C*-massecuites. Figure 6 shows the general improvement in final molasses purity and the molasses % cane. Whereas the molasses purity has declined the quantity of molasses shows a gradual increase.

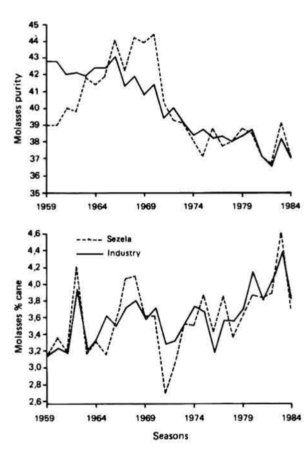


Fig. 6. Final molasses purity and molasses % cane for Sezela and the industry[2]

Curing

Curing of *A*-massecuite is done in modern batch type centrifugals while for *B*- and *C*-massecuites continuous machines have replaced batch-type units. The introduction of continuous centrifugals has allowed the handling of *C*-massecuites of lower purity and has greatly contributed to reducing the loss in final molasses. It has permitted a substantial saving in labour, and has reduced maintenance costs greatly. Final molasses is cooled down to below 45°C in a plate heat exchanger before storage.

Steam and power

In the early 1960's steam at a pressure of 1.2 MPa was raised in six 18 tonnes steam/hr water-tube boilers, equipped with bagasse spreaders and dumping grates. During the first expansion of 1965 two additional boilers, each of 57 tonnes/hr at 2.1 MPa were installed, both units being equipped with spreader strokers and travelling grates. In 1979 the small boilers of the 1960's were discarded and replaced by a large modern 146 tonnes/hr unit to cope with the additional steam demand required by the bagasse-based furfural factory. In the final expansion of 1981-84 a second large capacity 130 tonnes/hr boiler was installed to meet the increasing steam demand of the factory and to supply additional steam to the expanding furfural plant. Whereas the larger boiler is fired on bagasse/residue mixture only, the other three units are designed to be fired on coal and /or bagasse/residue mixture; residue being the bagasse waste returned from the furfural plant. All four boilers are fitted with suspension firing equipment and are equipped with wet flue-gas scrubbers, to comply with regulations. These require that the grit level should not exceed 400 mg per Nm^2 at 0°C and 12% CO_2. The sugar factory produces its own power by means of three turbo-alternator sets with a design capacity of 16.8 MW.

Chemical factory, energy and vapour recompression

The chemical (furfural) plant and sugar factory are mutually dependent. Sezela provides energy to the chemical plant in the form of bagasse and high pressure steam. The chemical factory returns steam at exhaust pressure, and also bagasse residual waste. This waste is mixed with bagasse and used to fire the boilers. The residue is of a moisture content of about 52%, some 2 points above normal bagasse, but the mixture burns well. The total steam requirements for the whole complex could at times exceed the supply available from natural fibrous fuel, especially below 15% fibre on cane. Vapour recompression was introduced to minimize the burning of supplementary fuel by utilizing a small margin of let-down to allow the balancing of exhaust steam demand and availability. The MVR installation consists of two 50 tonnes per hour centrifugal-type compressors driven by steam turbines and operating between the first vapour and exhaust steam ranges.

Effluent treatment and water recycling

All effluents from the sugar factory, chemical plant and village complex are treated in a two stage aerobic activated sludge system followed by a settling and maturation pond. Clear water from the treatment plant is returned as make-up to the cooling water system of the sugar factory. The overflow from this system is pumped to the flue-gas scrubbers. The smuts laden water is pumped to a settling dam 2 km away from the factory. From this dam overflow returns to the scrubbers by means of a 400 mm-bore polypropylene line.

Automation and control

With the increase in throughput and the introduction of modern equipment, labour intensive operations have gradually given way to the use of automatic control. In the final expansion of Sezela the major sections of the plant are operated from strategically situated control rooms where skilled personnel operate the instrument panels. Great use is made of two-way portable radios amongst the operating staff, supervisors and managers.

Discussion

During the period under review Sezela Factory has undergone many changes in plant equipment and technology to satisfy the needs of industrial expansion; these have resulted in:

(a) An improvement in cane handling and preparation.
(b) A dramatic increase in extraction by the gradual evolution of the extraction plant from milling to bagasse diffusion and then to cane diffusion at the full throughput of 450 t.c.h.
(c) Great improvement in steam and fuel economy by the introduction of kestners, semi-kestners and installation of mechanical vapour recompression.
(d) Modifications to the boiling process to produce only VHP sugar with better refining properties.
(e) The introduction of continuous *C*-pans and vertical *C*-crystallizers and the use of water-cooled continuous crystallizers for all massecuites.
(f) The use of continuous centrifugals on intermediate and low-purity *C*-massecuites which resulted in lower final molasses purity.
(g) The supply of bagasse and steam for the production of furfural.
(h) The installation of a very modern boiler house incorporating high efficiency boilers designed to fire on bagasse and furfural residue mixture and/or coal and the installation of wet scrubbers on flue-gases to meet regulations.
(i) Greater use of plant automation and process control.
(j) The treatment of all effluents and the recycling of treated water to feed the cooling water tower and the wet scrubbers as well as to convey smuts to a distant settling dam, thus greatly reducing transport costs.

Having listed the major plant and technological changes it is of interest in conclusion to review the results obtained at Sezela and for the industry in terms of extraction, boiling house recovery and overall recovery. Figure 7 illustrates the changes in performance.

It is evident that extraction has played a major role in helping the overall recovery to increase by about 1% for the industrial average and by approximately 0.4 % at Sezela. B.H.R. on the other hand shows a marked decline of some 1.5% for both Sezela and the industry. This is cause for concern,

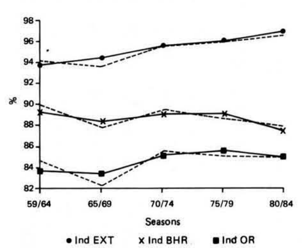


Fig. 7. Extraction, boiling house recovery and overall recovery for Sezela and the industry[2]

especially when considering the high cost involved in modern installations as well as the application of top technology. Although higher levels of extraction will reduce the purity of mixed juice to process, the deterioration in cane quality should not be ignored (see Fig. 1.) Any future significant improvement of boiling house recovery and therefore overall recovery will largely depend on a higher purity of cane delivered to the feeder tables of our factories.

Summary

Developments in sugar technology at the Sezela factory over the past twenty-five years are discussed. During that period Sezela underwent three major expansions and changes at this factory generally mirror those that took place throughout the industry. Generall trends in cane quality and performance of both Sezela and the industry are compared. Main changes relating to process and equipment are discussed as well as the influence of a bagasse-based furfural factory on the steam balance and energy requirements. The treatment of effluent, water and smuts disposal are briefly described.

Appendix

Equipment and power used for raw sugar production at Sezela

	No. 1 Line	No. 2 Line
Extraction plant		
Total installed power kW/tfh	164	150
Cane preparation kW/tfh	100	91
Dewatering mills; Total roller volume m^3/tfh	0.37	0.34
Diffusers: Screen area m^2/tch	2.22	2.06
Clarification and evaporation		
Juice heaters: Heating surface m^2/tch		8.7
Clarifiers (Trayless): m^3/tch		1.0
Evaporators: Heating surface: m^2/tch		59.6
Boiling house		
Vacuum pan volumes m^3/tch		*A* 0.70
		B 0.40
		C 0.60*
Crystallizer volumes, m^3/tch		*A* 1.77
		B 1.88
		C 1.58
Centrifugals		
Batch type: *A*-mc: D^3H/tch**		34.3
Continuous:*B*-mc: W^2 V/tch**		170.0
C-mc: W^2 V/tch**		291.9
Steam and power generation		
Electricity***kW/tch		44.3
Boilers: Maximum Continuous Rating: tons steam/tch		0.82

* This includes 0.42 m^3/tch for capacity of 2 continuous pans.
** Empirical values used in South Africa to compare centrifugal capacities,
D = Basket diameter (batch types)
H = Basket height (batch types)
W = Speed of rotation (continuous types)
V = Volume of cone formed by basket (continuous types)
*** Electricity generated by steam driven generators 16.75 MW installed capacity.

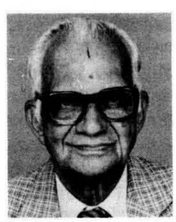
PROCESSING

Steam-aided imbibition

A new process for reducing pol and moisture in bagasse

By K. S. G. Doss

One of the important factors which influence efficiency of the extraction of sugar from cane during milling is the efficient contact of added water or juice with bagasse. The real difficulty in achieving intimate contact is caused by the air present in the bagasse between the fibres and to some extent within the fibre itself.



K. S. G. Doss

Entry of the water is hindered by these air bubbles and this is normally alleviated by the use of integral imbibition, whereby the bagasse is made to emerge from between the rollers directly into water or juice. Large amounts of imbibition water are required for carrying this out effectively. Another method is to have recirculation of the juice from every mill; this is a compromise in the counter-current extraction which should be avoided if possible.

In steam-aided imbibition (the SAI process), steam is injected along with the imbibition water or juice at the emergence point of the bagasse. This produces an atmosphere of steam near the emerging bagasse. As the bagasse expands steam enters the mass and condenses, also drawing in water or juice which is thus brought into intimate contact with the whole of the bagasse. The sugar in bagasse then diffuses into the water or juice since the latter is very close to the fibres. The extraction of sugar thereby becomes very efficient.

In this process the bagasse may be heated up to even 100°C. This produces a tendency of the bagasse to slip, thereby lowering the capacity of the mills. However, since roughening of the mill roller shells by welding was first introduced in Australia, it has become a common practice practically all over the world, so that there is nowadays no difficulty in the mills handling hot bagasse. In fact, hot imbibition is invariably used by the factories where welding of the roller shells is practised.

The temperature of the bagasse can be brought down by having a suitable arrangement for blowing air through the bed of bagasse as it moves on the carrier. This not only brings down its temperature, but effectively reduces the moisture content of the bagasse. To reduce the moisture content from 50% to less than 45% would be easy and would largely compensate for the steam employed in carrying out the imbibition.

If steam-aided imbibition were practised on all mills an additional advantage would be that microbial destruction of the sugar would be largely eliminated. If the amount of steam needed were about 20% on fibre, the amount of imbibition water could be lowered correspondingly. It may not be necessary to use more than 140% water on fibre.

The steam can be introduced through a 1-inch pipe having 0.25-inch holes at 3-inch centres. The steam jets would be directed near the point of the emergence of the bagasse. Since the steam is much lighter than air it has a tendency to rise quickly and spread all over the mill house. It is therefore essential to have a canopy to contain the steam so as to minimize its loss. If a canopy is not used a good proportion of steam would be wasted.

Instead of adding water and steam separately one can use superheated water (as used in a centrifugal) at the penultimate mill. In the case of the earlier mills, a steam ejector can be used to transfer water or juice from mill to mill. Preliminary trials of the process in a few South Indian factories have given very encouraging results.

Seminar on cane sugar by-products and diversification

The 1987 Inter-American Sugar Cane Seminar will again be contemplating the by-products of the cane sugar industry, and sugar cane as plant source of energy. This was decided by the Technical Organizing Committee in its first meeting, considering the request by most of the participants to the 1986 Seminar. However, the topics have been broadened in order to accept papers dealing with the uses of sugar, and other aspects tending to defend the noxious propaganda to which sugar has been subjected, mainly in the developed countries.

The date for the 1987 Seminar has been set for September 23, 24 and 25, again at the James L. Knight/University of Miami Convention Center. The headquarters hotel will also be the Dupont Plaza, located just about half a block from the Convention Center. The event, as usual, will be sponsored by Inter-American Transport Equipment Company and the City of Miami, with co-sponsors: Florida International University, Louisiana State University, Nicholls State University, The Organization of American States, the Texas Agricultural Experiment Station of Texas A&M University, the University of Georgia, the Everglades Research and Education Center of the University of Florida , the USDA Sugarcane Field Station at Canal Point, the US Sugarcane Field Laboratory at Houma, Louisiana, and Diario Las Américas, Miami, Florida.

The Technical Organizing Committee has released the customary Green Brochure with a Pre-Registration sheet attached to it, for those interested in attending the 1987 Inter-American Sugar Cane Seminar.

Abstracts of papers or conferences for this Seminar will be accepted until August 1, and authors are urged to send manuscripts with slide illustrations, avoiding as much as possible the use of acetates. For further information on this event, please contact Inter-American Sugar Cane Seminars, 3690 N.W. 62nd Street, Miami, Florida 33147, U.S.A.; Telephone +1-305-633-0351; Telex: 153665 SIASUCAS.

Facts and figures

Peru sugar production, 1986[1]

Sugar production in Peru in the calendar year 1986 totalled 600,209 tonnes, tel quel, down 17.4% from the 726,792 tonnes produced in 1985, according to the Ministry of Agriculture. The cane harvested was 50,334 hectares, down 5.3% from the year before, and the quantity of cane crushed amounted to 6,273,000 tonnes, down 14.4%.

Switzerland sugar production, 1986/87[2]

Aarberg and Frauenfeld sugar factories sliced a total of 762,294 tonnes of beet in the 1986/87 campaign to produce 118,607 tonnes of white sugar.

1 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 83.
2 *Zuckerind.*, 1987, **112**, 80.

Facts and figures

International sugar cane technology conference in Réunion

ARTAS, the Agricultural and Sugar Technologists Association of Réunion, is to hold its third international Congress from the 19th to the 24th October 1987 on Réunion Island in the Indian Ocean. An invitation is extended to all those interested. Additional information may be obtained from the Secretary, ARTAS, c/o C.E.R.F., La Bretagne, P.O. Box 315, Sainte-Clotilde, Réunion (Telex number 916138 RE).

Mauritius sugar crop, 1986[1]

Harvesting of the 1986 sugar crop in Mauritius started on June 16 and ended on December 15, 1986. The 19 sugar factories crushed 6,024,962 tonnes of cane, yielding 706,839 tonnes of sugar, tel quel (748,472 tonnes, raw value). Average cane yield per hectare was 77.5 tonnes and average sugar extraction was 11.73% on cane. The 1986 crop was the second highest in the history of Mauritius although the area harvested was 3343 hectares smaller than in 1976. Sugar yield per hectare, at 9.1 tonnes, was the highest on record. Weather conditions during both the growing and maturation season were very favourable.

New Australian cane milling record[2]

Australia's largest sugar factory, Victoria Mill, at Ingham, Queensland, processed a record 1.85 million tonnes of cane during the 1986 crushing season, beating its own previous peak of 1.81 million tonnes in 1982. The sugar content of the crop was low, however, at 12.77%, more than half a unit below the 5-year average, so that the 244,000 tonnes of sugar produced fell short of the factory's previous best. With prospects of a slight increase in cane area through reassignments, good weather could allow the possibility of a 2-million tonne crush in 1987.

Sugar industry diversification[3]

Perhaps one of the most important activities of GEPLACEA in 1986 was the preparation of the Project for the Diversification of the Sugar Industry which was scheduled to begin in early 1987. It is expected that this project, financed by the United Nations Development Program (UNDP), will provide guidelines for systematic development of diversification of the agro-industry, thus reducing dependence on a single product.

Jamaica sugar production, 1986[4]

Jamaica's sugar output in 1986 amounted to 200,287 tonnes, tel quel, down 6420 tonnes from the year before, according to the Sugar Industry Authority. The decrease was due to unfavourable weather conditions and to a 5325 acres smaller crop area, although the industry performed satisfactorily, given that the weather had affected the sugar content and brought a premature end to milling by some factories. The cane:sugar ratio was 10.91 against the 1985 figure of 10.81.

Mexico self-sufficiency in sugar[5]

With a 1986/87 crop forecast at 3,800,000 tonnes, a new record for the sugar industry, Mexico will have reached its goal of self-sufficiency and will open up new possibilities for exports. This is reported in a statement by Azúcar S.A., the national sugar company, which also mentioned that 187,000 million pesos are to be invested in the sugar industry over the next five years. Production of sugar was 2,890,000 tonnes in 1982/83 and rose to 3,045,200 the following season, reaching 3.7 million tonnes in 1985/86. The report also stated that sugar sold in Mexico is the cheapest in the world but retail prices will be raised in line with inflation so that the sugar industry can be profitable without a need for subsidies. Further, surplus production will only be exported when world prices are at a level sufficient to obtain adequate earnings.

Dominican Republic sugar factory closure plans denied[6]

Earlier reports[7] had claimed that the Consejo Estatal del Azúcar (CEA) was to close some of its sugar factories following cuts in the US supply quotas. The CEA Vice President, speaking briefly to reporters, recently stated that "the government has no plans to close any of its twelve factories".

Brazil sugar exports, 1986[8]

	1986	1985
	tonnes, raw value	
Algeria	227,748	257,512
Bangladesh	14,291	0
Bulgaria	14,291	0
Canada	0	21,000
Chile	5,466	7,577
EEC	2,725	29,500
Egypt	119,264	211,572
Ghana	0	32,478
India	308,950	247,624
Iran	196,603	102,847
Iraq	340,534	229,298
Jordan	41,139	25,333
Kenya	47,351	29,198
Madagascar	0	3,431
Morocco	28,000	108,000
New Zealand	0	19,000
Nigeria	134,835	353,541
Pakistan	147,045	0
Peru	54,997	0
Portugal	0*	51,624
Saudi Arabia	0	12,342
Somalia	61,615	0
Sri Lanka	42,786	53,482
Surinam	1,082	1,083
Sweden	0	22,800
Syria	0	12,991
Tunisia	23,991	67,991
Turkey	15,049	0
Uganda	16,207	0
US	140,365	359,693
USSR	567,800	335,148
Venezuela	0	13,641
Total	2,554,438	2,608,706

* included under EEC

Pakistan sugar factories close[9]

The five sugar factories in the North West Frontier Province have had to close because of lack of cane supplies. The cane price fixed by the government for sale to the factories is not attractive to farmers who are using their cane to produce gur which gives a very good return. The factory owners have sought government action to force growers to supply cane at the fixed price but, in the absence of such measures, they may be obliged to raise their payment for cane above the set price in order to secure supplies for restarting the factories which incur huge losses when idle.

New Rumanian sugar factories[10]

In addition to the four sugar factories opened in 1986[11], a further six factories are in construction. All the new plants are small, with a slicing capacity of 1000 tonnes/day each. The new factories will bring the slice for the whole Rumania industry to 75,000 tonnes/day, for which beet supplies are available.

Zaire sugar factory expansion[12]

Sugar production at the Kiliba sugar complex in the Kivu region of Zaire is to be raised from 12,000 tonnes in 1986 to 28,000 tonnes in 1990 by enlargement of the cane area and re-equipping the factory. Of the cost, most ($16.7 million) will come from the African Development Bank, while the balance ($7.5 million) will be granted by the Banque de Développement des Etats des Grands-Lacs and by the state.

1 *Mauritius Sugar News Bull.*, 1986, (12).
2 *Australian Canegrower*, 1987, **9**, (1), 10.
3 *GEPLACEA Bull.*, 1987, **4**, (1), Edit.-1.
4 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 36.
5 *GEPLACEA Bull.*, 1987, **4**, (1), Sugar Inf. 3 - 4.
6 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 36.
7 *I.S.J.*, 1986, **88**, 159.
8 *I. S. O. Stat. Bull.*, 1987, **46**, (2), 7.
9 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 38 - 39.
10 *Zuckerind.*, 1987, **112**, 81.
11 *I.S.J.*, 1986, **88**, 100.
12 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 83.

PERSONAL NOTES

We regret to report the death in early April of the late **Harold E. C. Powers** at the age of 90. He was formerly Chief Chemist of Tate & Lyle Ltd.'s Thames refinery at Silvertown in London and was very well known not only in international sugar circles but also in the wider field of science as a consequence of his studies on crystallization, especially of sugar. He was one of the first to use time-lapse cinemicrography to record the development of sugar crystals and was able to demonstrate some of the remarkable phenomena which take place in the manufacture of our commodity. He was also noted for having introduced the M.A./C.V. concept whereby the size and variation in sizes of a large number of crystals could be expressed by two numbers — a system which is in wide use throughout the world. He was very active in ICUMSA up to and even after his retirement and retained his interest in sugar and science up to the time of his death.

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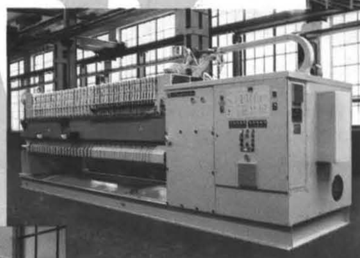

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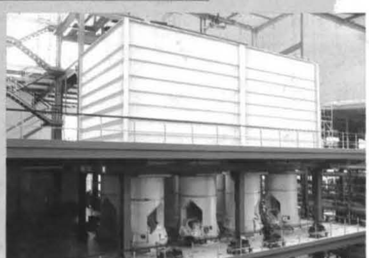

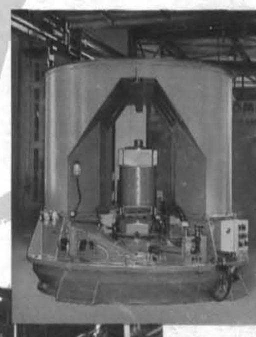

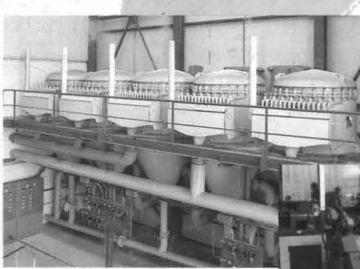

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