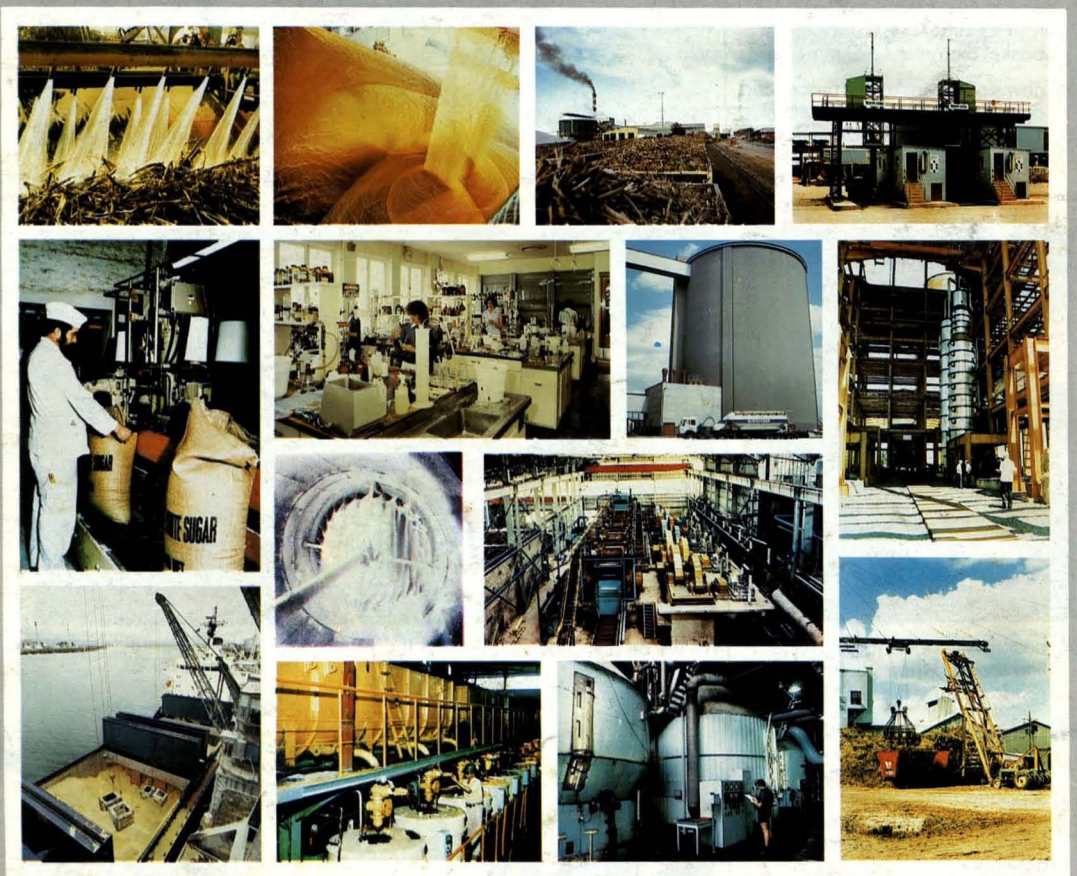
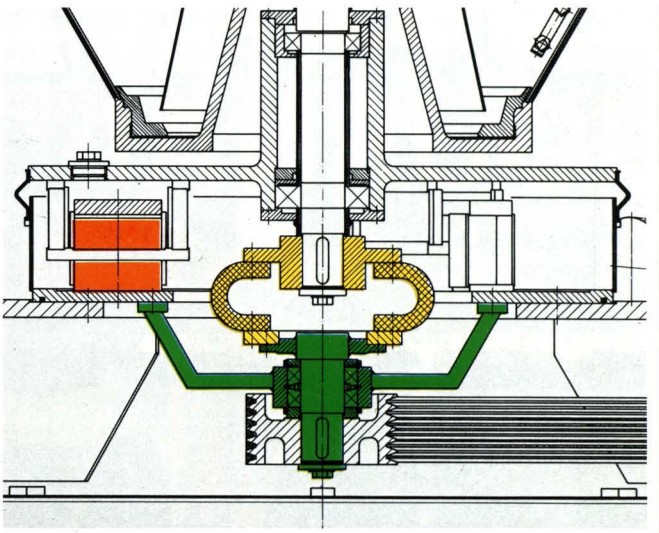
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXVIII/ISSUE No. 1051 JULY 1986

The New K1300
A Supplement to our Range of Centrifugals

The K 1300 centrifugal has been developed to supplement our well-approved series of continuous centrifugals, and already in the 1984 campaign its operation in sugar factories at home and abroad was a great success.



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At home in the world of sugar

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News and views

World sugar prices

Following the spectacular increase in the LDP at the end of March to reach $212.50 on April 1, raw sugar prices fluctuated appreciably during most of the month, reflecting buying interest by a number of countries and also reports of sales at relatively low prices. Then at the end of the month came news of the nuclear accident at Chernobyl in the USSR. Nearness of the reactor installation to the growing area of the Ukraine, coupled with very high initial estimates of the affected beets led to expectations that Soviet sugar import requirements would be markedly higher so that sugar prices on the world market climbed accordingly. It is not yet certain to what extent the crops in the USSR and Scandinavia are affected but a lull in buying in May lent support to the view that the Ukrainian crop was not as badly affected as had been thought.

The LDP, which reached $217.50 on May 1 started to slide, in the absence of bullish news, with the LDP sinking to $171 per tonne. A slight improvement came near the end of the month when there were reports of purchase of 150,000 tonnes of Thai raw sugar by the USSR but, in the absence of confirmation the price sank again to end the month at $170 per tonne.

During the two months, the LDP(W) also fluctuated, largely in line with raw sugar values, but less markedly so that the premium diminished as the raw sugar price rose and vice-versa. As a consquence, from $224 on April 1, the LDP(W) rose to $237 on April 8 but then fluctuated between $216.50 and $229.50 before rising to $230 on May 1. It too started to slide during May and, apart from small rises when a number of white sugar sales were announced, gradually fell to $195.50 at the end of May.

The Asian sugar market

F. O. Licht recently made a survey of net sugar imports in a number of Asian countries[1]. It noted that India's requirements over the past two seasons (before which it was an exporter) had coincided with very low sugar prices, unlike previous occasions when sugar imports were costly and consequently limited. The Indian government has taken measures to encourage domestic production and Licht concludes that India is not likely to be a permanent outlet for large quantities.

Similarly, Pakistan is also taking steps to increase production and, although imports may continue in the medium term, they are likely to fall away once internal problems have been resolved. Bangladesh, too, has been required to import sugar after floods two years in succession and disputes over cane prices, but Licht considers Bangladesh unlikely to remain a large-scale white sugar importer.

The collapse in oil prices and the cost of financing their war make a rise in sugar imports unlikely for both Iran and Iraq. China, on the other hand, is expected to continue to require imports while it increases production capacity because of steady increase in demand. Imports will be governed by foreign exchange restraints, however, and are not likely to rise above current levels. In Japan, sugar consumption is not rising, while domestic production is increasing so that imports have declined. They are expected to stay at their present level, however, because production cannot be expected to increase further, and the threat from sugar substitutes is not as great as in other developed countries.

Licht concludes that the rise in Asian imports was largely supply-induced and must be expected to decline, putting pressure especially on the white sugar market.

Cuban sugar availability for the USSR

Unseasonal rains, following damage to the crop last November by Hurricane Kate, are considered by *Czarnikow Sugar Review*[2] to make it likely that sugar output in the 1985/86 crop will fall to 6.5 million tonnes, raw value. With domestic consumption reported to be running at some 750,000 tonnes per annum, there would be about 5.75 million tonnes available for export from the crop. The slump in oil prices in recent weeks will have a major impact on Cuba's hard currency earnings, however, and is likely to prompt an overall review of export policy as regards preferential versus free market sales.

For the past three years, Cuba has earned more hard currency from the resale of Soviet crude oil which is surplus to her own requirements than from sugar exports. The fall in oil prices, coupled with the improved return in the sugar market, will have not only reversed this but also severely limited Cuba's capability to finance purchases of free market sugar on behalf of the Soviet Union. Talks were to be held in late April on rescheduling of Cuba's foreign debts which have escalated in the past year.

On the other hand, new five-year agreements have been signed between the two countries under which Soviet credit provisions for Cuba during 1986/1990 have been increased by some 50% from the levels of 1981/85. With all these developments, how will the 5.75 million tonnes of potential export be split? On the basis of the proportion of total exports going to the USSR over the past eight years, deliveries of only 2.0 million tonnes would be indicated. However, when total exports fell to 5.76 million tonnes ten years ago, the Soviet share was 3.04 million tonnes. It is Czarnikow's view that shipments will be around 2.75 million tonnes.

Guyana sugar industry contraction[3]

The Guyana government is considering growing less cane and closing one factory because of problems with the sugar industry. Plans were outlined by the Finance Minister when he presented the 1986 budget; he noted that sugar continued to be Guyana's largest net foreign exchange earner but that the recent loss of 10,000 long tons of its US quota had completely changed the marketing outlook for Guyana's sugar and "given rise to the need for consequential adjustments".

The cultivation of sugar cane on

1 *Int. Sugar Rpt.*, 1986, **118**, 155 - 157.
2 1986, (1748), 51 - 52.
3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 203 - 204.

marginal and uneconomical land would be ended and the area under cane reduced from 120,000 acres to 105,000 acres by the end of 1986 and to 90,000 acres by the end of 1987, by which time average sugar production in Guyana should stand at 250,000 tons.

Guyana's sugar production in 1985 amounted to 285,000 tonnes; with domestic requirements of around 35,000 tonnes more than 200,000 tonnes were available for export. Major destinations are the EEC and United States, both at preferential prices. The EEC quota is 171,000 tonnes, raw value, but the US quota was reduced from 30,480 short tons (27,645 tonnes), raw value, in the 1984/85 quota year to 20,592 short tons (18,677 tonnes) for the period December 1, 1985 to December 31, 1986.

Guyana Sugar Corporation would produce energy from bagasse, enter into large-scale dairy farming, increase fish culture and produce feed supplement for cattle from "ensilaged cane and hydrated bagasse in combination with urea and molasses". The corporation would also carry out a feasibility study on producing hydrous alcohol from molasses.

European beet area, 1986

F. O. Licht GmbH have issued a revision of their initial estimate of beet sowings in Europe for the 1986 crop[4]. It shows only slight variations, however, and the total is unchanged at 7,417,000 hectares. The largest change is an increase of 15,000 hectares expected in Spain but smaller increases elsewhere in the EEC raise that total to 1,892,000 ha against 1,871,000 ha earlier forecast and only 8000 less than the revised figure for the 1985/86 area. Figures for the rest of West Europe are unchanged except for a 2000 ha reduction in Austria, balanced by similar increase for Yugoslavia. In East Europe, reductions have been made in the estimate for Albania (1000 ha), Hungary (10,000 ha) and USSR (10,000 ha), exactly balancing the increase in the forecasts for the EEC.

US beet area expansion[5]

Beet farmers in the USA have been quick to respond to the high level of support provided by the Farm Bill to domestic growers. Statistics recently released by the US Department of Agriculture indicate that, with returns not yet available for the states of Colorado and Kansas, the planted area is already the highest for five seasons. Moreover, owing to factory closures, only a small area was sown in these two states last season; 56,100 acres were sown in 1984/85 and with factories reopening farmers can certainly be expected to switch back into beet growing again this season.

Dry fructose product

Rumours have been circulating in the sugar trade that Archer Daniels Midland (ADM), a major corn wet miller and producer of high fructose syrup, may offer on the US market up to 250,000 tonnes of dry fructose products at 21.00 cents/lb f.o.b. Decatur[6]. If this were true, it would have significant ramifications for the United States and world sugar markets since, if a dry fructose can be produced and sold profitably at this price and if it can be produced in large enough quantities, the US sugar import quota could be reduced to zero fairly rapidly, and acreage restrictions for cane and beet would be necessary to maintain prices above the loan level.

The fructose is produced by a new drying process to which ADM was said to have purchased the rights; it was developed by Purdue University in conjunction with the US Development Corporation, and uses low drying temperatures and intense sound waves. No licensing agreements have been reached and it was later reported that ADM has looked at the technique but has decided not to invest. Further, the hygroscopic nature of the product remains a barrier towidespread table-top use.

World sugar production, 1986/87

The US Department of Agriculture recently issued its first estimate of sugar production in the 1986/87 sugar season in which it set a total of 100,500,000 tonnes, raw value, against 96,510,000 tonnes in 1985/86, i.e. a rise of 4%. Increases are expected in the Caribbean (840,000 tonnes), South America (680,000 tonnes), North America (260,000 tonnes), the USSR (700,000 tonnes), Africa (60,000 tonnes), the Middle East (210,000 tonnes) and Asia (2,090,000 tonnes), while decreases are expected in Central America (110,000 tonnes), the EEC (640,000 tonnes) and other West Europe (140,000 tonnes). Some of the forecasts are a little surprising (and that for Brazil has been called too high by the I.A.A.) but, if they were accurate, the overall rise in production would hinder a return to a sugar balance and profitable prices.

British Sugar plc ownership

As was to be expected, the fact that a Tate & Lyle acquisition of British Sugar would give the company 94% of the British market for refined sugar was sufficient for the bid to be referred to the Monopolies Commission for study. The announcement of the bid had indicated that it was conditional upon there being no such referral, but no offer had been sent to shareholders in S. & W. Berisford, and no withdrawal of the intention to bid was made; indeed, Tate & Lyle announced that they would cooperate fully with the Commission.

The Hillsdown Holdings bid was also referred to the Commission, which appears to have surprised Hillsdown and, late in May, it was announced that their stake in Berisford had been sold to the Feruzzi Group who now own 23.74% of the company. This is remarkable in view of the Italian company's apparent withdrawal from the scene when it became clear that there was strong opposition to its acquisition of the UK beet sugar industry from farmers and others. The new situation is likely to lead to further investigation by the authorities both in London and Brussels.

Brazilian sugar plan, 1986/87

The long-awaited sugar production plan was released by the Brazilian Sugar and Alcohol Institute at the end of May. It

4 *Int. Sugar Rpt.*, 1986, **118**, 209 - 214.
5 *Czarnikow Sugar Review*, 1986, (1748), 56.
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 274, 310.

is proposed that 8.5 million tonnes, raw value, of sugar will be produced in the next season, or about 200,000 tonnes more than the actual outturn in 1985/86. Further modest increases are proposed for subsequent years, i.e. a 6.8% increase for 1987/88 and a further 8.5% in 1988/89 compared with the 1986/87 level.

Exports are to be set at 2,000,000 tonnes, raw value. This is 200,000 tonnes less than the exports estimated for the 1985/86 sugar year, while domestic consumption is estimated at 5.86 million tonnes. The export figure was originally set at 2.7 million tonnes but 700,000 tonnes of this has been withheld owing to low world market prices. Brazil's sugar industry has great flexibility, as is well known, because of the potential of switching from sugar to alcohol manufacture and, were the price of sugar on the world market to rise appreciably, the export quota could be raised or restored without difficulty, just as it was cut in 1985/86 when prices sank.

Domestic alcohol usage is expected to rise from 10,500 million to 11,430 million litres in 1986/87 and the alcohol production quota allows for this and also an export of 300 million litres.

World sugar production, 1985/86

F. O. Licht GmbH recently published their third estimate of sugar production in the 1985/86 season[7]. This shows a drop to 97.3 million tonnes, raw value, from 101.1 million tonnes in 1984/85 and is close to the total for the second estimate (97.2 million tonnes) No major changes are made, the new figures often being firmer and more accurate levels.

C. Czarnikow Ltd. have also published an updated forecast of production[8] which is, however, on a slightly different basis so that a small discrepancy between its figures and Licht's is not surprising (96.7 million tonnes in 1985/86 and 109.9 million tonnes in 1984/85). Both estimates envisage a fall of about 4 million tonnes in production and thus a reduction in stocks.

Licht note that it is too early to make any precise forecast for the 1986/87 season but consider current indications to be that sugar production may turn out to be close to the 1985/86 level; this contrasts with a substantial increase expected by the U.S.D.A. (see elsewhere in this issue).

World sugar balance, 1985/86

A third estimate of the world sugar balance for the current season was recently published by F. O. Licht GmbH[9] and the figures are shown below.

	1985/86	1984/85
	1000 tonnes, raw value	
Initial stocks	40,308	40,142
Production	97,752	99,967
Imports	27,368	28,464
	165,428	168,573
Consumption	100,062	98,571
Exports	28,047	29,694
Final stocks	37,319	40,308
" "		
% consumption	37.30	40.89

The fall in production has been quite well established, the result of deliberate restrictions in a number of countries and the consequence of bad weather in others. Consumption countries to grow, even if at a lower pace than a decade ago, and inroads made by the HFS and the synthetic sweeteners seem to have reached a plateau. Nevertheless, the patterns of sugar consumption and trade have changed markedly, with greatest growth in countries where price elasticity is high. Licht believes that early indications are for a further improvement in fundamentals and another reduction in stocks. This will, however, depend on the exporters' response to better sugar prices; an increase in production would change the position entirely. Meanwhile the sugar market faces steadily mounting competition from alternative sweeteners.

Licht refers too the views on sugar stocks put forward recently by C. Czarnikow Ltd.[10]; Licht uses I.S.O. data but Czarnikow has considerable reservations as to the reliability of these. They have recently examined all published figures for 1980/84 relating to the same imports/exports as reported by the importers/exporters and have confirmed a consistent non-statistical disappearance of sugar of just under 650,000 tonnes a year. Taking a conservative figure of 500,000 tonnes a year, and using reported and forecast production and consumption figures, Czarnikow calculates that the cumulative stock adjustments are such that, in absolute terms, stocks in 1987 could be very similar to those in existence in 1979 or perhaps even lower. Further, consumption in 1979 was 12 million tonnes lower than that forecast for 1987 so that the position looks to be tighter than in 1979, and it was the low level of stocks then which gave rise to the upward movement in prices in 1980/81.

Indonesian sugar industry rehabilitation[11]

According to a report by the Department of Agriculture, the rehabilitation of Indonesia's 46 older sugar factories on Java is virtually complete. The work cost 120,000 million rupiahs and has increased the daily cane crushing capacity by 10,000 tonnes. Additionally, the country's first cane diffuser was inaugurated in November 1985 at the Kedawung sugar factory.

In the early 1980's the government launched a program to construct 18 new factories. Owing to cut-backs in government revenues only part of the program went forward, while the remaining projects were offered to the private sector which generally showed little interest in them. Five of the new factories (Kuala Muda in North Sumatra, Cinta Manis and Bunga Mayang in South Sumatra, Takalar in South Sulawesi and Subang in Western Java) began operations before 1985, while the Camming sugar factory in South Sulawesi began limited operations last November and Pelaihari factory in South Kalimantan undertook trial operations late in 1985 and should begin production in 1986. Only one other new factory, at Putih Mataram in South Sumatra, is now under consideration.

7 *Int. Sugar Rpt.*, 1986, **118**, 251 - 259.
8 *Czarnikow Sugar Review*, 1986, (1749), 67 - 69.
9 *Int. Sugar Rpt.*, 1986, **118**, 293.
10 *Czzarnikow Sugar Review*, 1986, (1749), 67, 70.
11 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 248.

Product news

New sugar cube drying equipment

Elba Sales, a leading manufacturer of cube sugar machinery, backed by over 25 years of experience, have introduced a new drying system for their type 'r' cubing machine, which is the biggest single unit they have in their range so far.

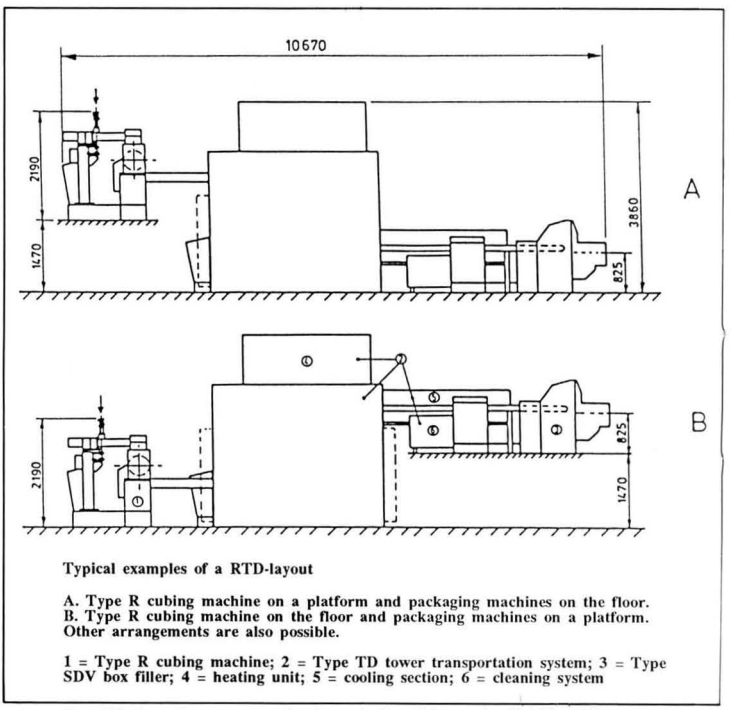
Up to now the machine has been available only with a horizontal drying/cooling tunnel, having a length of about 45 metres. Moreover, the same machine could only be supplied with an electrical drying system based on infra-red heating.

For the new drying system, a so-called tower transportation system is used, as illustrated. With this very compact system it is also possible now to offer a choice of different drying systems, viz.

electrical air heating with a recirculation system whereby air is sucked by means of a ventilator out of the insulated drying chamber, or

the use of steam for the supply of hot air through a heat-exchanger.

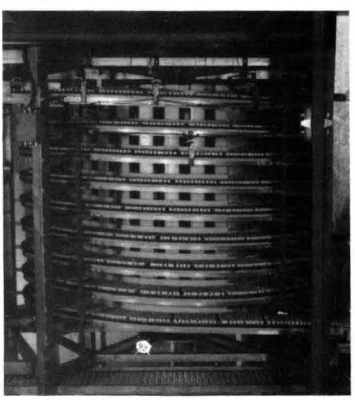
The moisture content in the drying chamber can be controlled and adjusted easily.



Typical examples of a RTD-layout

A. Type R cubing machine on a platform and packaging machines on the floor.
B. Type R cubing machine on the floor and packaging machines on a platform.
Other arrangements are also possible.

1 = Type R cubing machine; 2 = Type TD tower transportation system; 3 = Type SDV box filler; 4 = heating unit; 5 = cooling section; 6 = cleaning system



The endless rotating stainless steel conveyor belt is cleaned by means of a special cleaning system which is part of this new type 'rtd' machine ('td' stands for tower drying).

Also for this 'rtd' machine Elba maintains the principle that the cubes are placed on the conveyor belt immediately after they have been formed and they are not handled or transferred before they are completely dried and cooled.

The moulding section of the 'r' machine may be installed on a platform or at floor level; in other words, the freshly-produced cubes can be transported through the 'td' drying room from top- to floor level or the other way round (see illustrations a and b)

Floorspace saving is only one of the advantages of the newly introduced 'rtd' machine. The cubes manufactured on the 'rtd' machine are perfectly positioned when leaving the drying room for immediate and automatic range packing into 0.5 or 1 kg boxes. The Elba 'sdv' automatic boxfiller can be delivered in order to function in line with the 'r' and 'rtd' cubing machines. Boxforming and closing machines are also part of the Elba range.

The type 'r' machine with horizontal drying/cooling belt and which is successfully producing in many countries of course remains available.

The Elba concept is known for its simplicity and reliability. The manufacture of cubes is not restricted to a particular number of sizes. In principle, any size desired by the customer can be produced on their machines.

Elba sales has designed, engineered and commissioned over 300 plants and machines in over 50 countries to date and is considered a world leader in cube sugar technology. Their range of cubing machinery not only includes fully automatic plants for the production and packaging of sugar cubes with outputs up to 2500 kg/hour, but also small individual units with outputs starting from 80 kg/hour.

Further details: Elba Sales B.V.,
P.O. Box 21,
1270 AA Huizen,
Holland.

Newell Dunford sugar dryer for British Sugar

British Sugar plc have recently

commissioned a new sugar dryer at their Ipswich factory. The unit, which is a combined dryer-cooler, was supplied by Newell Dunford Engineering Ltd., a member of the Firsteel Group. The throughput of the equipment is 45 tonnes per hour and it operates on the evaporative cooling principle, discharging sugar at a temperature of 40°C with a moisture content of 0.02%. The rotary drum has a diameter of 2.69 metres and a length of 12.2 m. It was supplied complete with the Newell Dunford "Remix" wet-type dust collector. Newell Dunford have very extensive experience in the supply of dryers for the sugar industry, having delivered approximately 130 drying installations to sugar factories and refineries in many parts of the world. The dryers are either of the cascade type or the rotary louvre type which gives a very high quality sugar crystal at a rather higher cost.

Further details:
Newell Dunford Engineering Ltd.,
Kingston House, Portsmouth Road,
Surbiton, Surrey KT6 5QH, U.K.

Bugs under microprocessor control

Exciting research into methane and ethanol production from waste products using micro-organisms is taking place at the Biotechnology Centre of Imperial College, London. The Chemap Products Division of Alfa-Laval has supplied fermenters controlled by micro-processors enabling up to twelve critical parameters to be controlled simultaneously.

Further details: Alfa Laval AB,
Tumba,
Sweden.

In gear

A useful directory of gear box and gear manufacturers is available free from BGMA, P.O. Box 121, Sheffield, U.K. Anyone looking for sources of very large industrial gears or speed reduction units will find this booklet exceptionally helpful.

Kent update with microprocessors

Kent's development program is turning out a whole range of new and updated products. Reliability, accuracy and flexibility have all been radically improved by incorporating microprocessor technology. Amongst the new instruments are the P105M – the first circular chart recorder to use microprocessors – and the P100M strip chart recorder which is fully programmable and has an intelligent display. This display is unique and gives constant information in either bar-graph or digital form.

Further details:
Kent Industrial Masurements Ltd.,
Howard Road, Eaton Socon,
St. Neots, Cambs. PE19 3EU, U.K.

Air driven pumps

Flotronic Controls Ltd. have applied for patents on their 710 series pumps. They incorporate a new self-lubricating bearing system which cuts out stalling and ensures infallible starting. The whole assembly can be dismantled by undoing four screws and a nut, making maintenance and cleaning exceptionally fast. The pumps can be driven by any clean compressed air supply.

Further details:
Flotronic Controls Ltd.,
Ricebridge Works, Brighton Road,
Bolney, Sussex, U.K.

Larox filters for the sugar industry

In the sugar industry Larox automatic pressure filters have increased sugar recovery by the high degree of filtration and the effectiveness of the in-machine cake washing. Larox filters use little wash water, meaning that there is less to be evaporated. An additional bonus is that the filter-cake produced by the Larox filter is drier, and is easier to handle and spread as soil enricher. Farmers are claimed to prefer it!

Further details:
Larox Oy.,
P.O. Box 29, SF-53101
Lappeenranta, Finland.

Nils Weibull enters Russian market

Nils Weibull AB. of Sweden has sold its first-ever silo to the USSR: a 50,000-tonne white sugar silo for installation near Kiev. It is part of a factory expansion managed by A/S. De Danske Sukkerfabrikker (DDS) of Denmark. It is also the biggest of 103 Weibull silos built to date.

Weighing/controls group moves ahead

Reorganization of the European Mangood Group of Companies will centralize UK activities at Nottingham. One feature of the rationalisation will be that the previous reliance on imported North American manufactured equipment will disappear. Investment actions have already been taken to ensure that the entire Mangood product range, and future new development, will be totally sourced and manufactured within Europe.

Further details:
Chronos Richardson Ltd.,
Arnside Rd., Bestwood,
Nottingham, UK.

New Rex sideflexing conveyor chain offers 20% longer life

A new thermoplastic sideflexing conveyor chain that offers users 20% longer wear life has been introduced by Rexnord as the Rex Series 879 chain.

The chain is available in tab and bevel design and is moulded from LF acetal resin for low friction and to minimize product damage. It is designed for light- to medium-duty conveyors, runs on Series 880 sprockets and comes in 3.25 inch and 4.5 inch flight widths.

Further Details:
Mechanical Power Divn.,
Rexnord,
P.O. Box 2022,
Milwaukee, WI 53201, USA.

The use of ion chromatography for the analysis of sugar mill products

By E. J. Stewart

(Bundaberg Sugar Experiment Station, Queensland, Australia.)

Introduction

Ash, or inorganic content, has been analysed in sugar mill laboratories for many years using the classical method of incineration in a muffle furnace, usually with the addition of sulphuric acid. Because of the increasing ash levels being encountered in several areas of the industry in Australia[1], and the problems associated with high ash levels when processing such materials, the Bureau of Sugar Experiment Stations (BSES) initiated projects to investigate the reasons for this increase in ash[2-4] and to look for methods to overcome the problem.

It was felt necessary to analyse for the constituents of the ash present, in order to understand the problem more fully, and the projects involved the analyses of a large number of samples. Using classical methods of analysis, this task would be very time-consuming and manpower- and apparatus-intensive. Furthermore, some ionic species, such as sulphate, are difficult to determine in sugar products by classical methods. For example, sample colour or turbidity can interfere with the turbidimetric method of analysis for sulphate, and co-precipitation of barium phosphate can interfere with the barium sulphate gravimetric method. Some initial trials were carried out using classical methods but, because of the number of samples to be handled, a decision was made to purchase a Dionex 2010i ion chromatograph.

Features of the ion chromatograph

The basic layout of the instrument can be seen in Figure 1. It consists of a high pressure pump, an injection valve, a pre-column, a separator column and a suppressor column (the operation of these columns will be discussed later), a conductivity cell and detector, and an integrator.

The system is constructed from special plastic material in order to withstand the corrosive nature of the eluents being handled. Pump pressures of up to 13.7 MPa can be used. The injection valve, which has a capacity of 50 µl, is an air-operated slider valve, the slider being made

from polytetrafluoroethylene. The conductivity cell has a capacity of 1.5 µl and is fitted with two stainless steel electrodes, which are connected to the conductivity detector. From the detector the signal is fed to an integrator which plots the chromatograph on a paper strip and calculates the areas or peak heights. Both a Hewlett Packard 3390 A and a more sophisticated Spectra-Physics 4270, which can be connected to a Waters Associates Wisp 710B automatic sampler, have been used with this system.

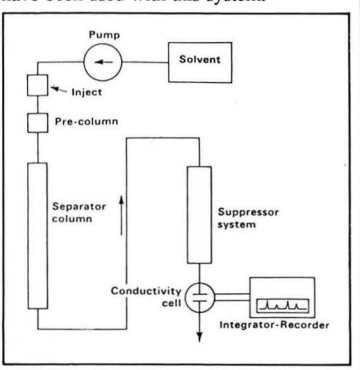


Fig. 1. Basic layout of ion chromatograph

Column operation

(1) Pre-column

This protects the main column from extraneous material such as colorants, and consists of a short (approximately 45 mm) length of main column material.

(2) Separator columns

These separate the various ionic species to be measured. The columns at present in use by BSES are capable of separating anions, monovalent cations, divalent cations, and organic acids. The separator columns act by binding the various species reversibly to the material of the column to an extent determined by the relative affinities of these species for the ion-exchange sites on the column resin. The reversible nature of the process is aided by competition for the sites by species contained in the eluent. For example, the following reactions occur during monovalent cation separation:

$$\text{Resin-}SO_3^- H^+ + Y^+Cl^- \rightleftharpoons \text{Resin-}SO_3^-Y^+ + H^+Cl^-$$

(3) Suppressor columns

These enhance the conductivity of the species to be measured relative to the background conductivity of the eluent. The eluents used in this system are high in conductivity, as will be seen from Table I, and hence the small increase in conductivity caused by the sample would normally be difficult to measure. To overcome this factor suppressor columns are used, the purpose of which is to convert the eluent into a solution of lower conductivity and the sample species into a more conducting form. In the case of anions the sample species are converted into the acid form, and in the case of cations into the alkaline form.

Figure 2 shows the reactions occuring in an anion hollow fibre suppressor. The sample and the eluent pass through the hollow fibre and the suppressant liquid

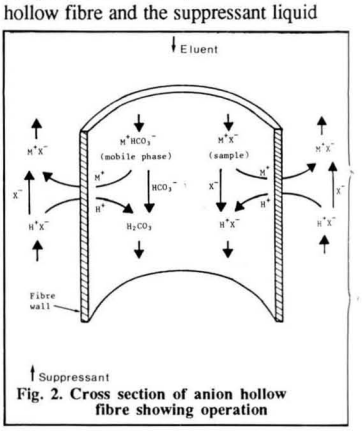


Fig. 2. Cross section of anion hollow fibre showing operation

1 Kirby: *Proc. Queensland Soc. Sugar Cane Tech.*, 1975, **42**, 263 - 269.
2 Kirby & Kingston: *ibid.*, 1978, **45**, 133 - 138.
3 Kingston & Kirby: *Proc. Australian Soc. Sugar Cane Tech.*, 1979, 61 - 69.
4 Kingston: *ibid.*, 1982, 11 - 17.

Table I. Column details

Type of column	Species separated	Eluent	Suppressant	Run time, min
Anion (AS4)	*O.A., Cl^-, PO_4^{---}, NO_3^- SO_4^{--}, $C_2O_4^{--}$	0.0026M $NaHCO_3$ +0.0023M Na_2CO_3	0.025M H_2SO_4	10
Monovalent cations (CS1)	Na^+, NH_4^+, K^+, Li^+	0.005M HCl	0.025M K_2CO_3	20
Divalent cations (CS1)	Ca^{++}, Mg^{++}	0.0025M HCl + 0.0025M *m*-phenylenediamine dihydrochloride [$C_6H_4(NH_2)_2$,2HCl]	0.020M Tetra-methylammonium hydroxide	12
Organic acids	**Aconitic, lactic, acetic and citric acids	0.001M HCl to 0.1M HCl	Suppressor column in Ag^+ form	20

* O.A. = Organic acids (mainly acetic and lactic acids)
** Several other peaks are present but are as yet unidentified

passes outside the fibre, in the opposite direction. As shown in Figure 2, the hydrogen ions and other cationic species are able to pass through the membrane wall, but it is impermeable to anions. This suppression of the eluent and increase in conductivity of the sample species allows the system to have greater sensitivity, and gives it the ability to detect lower concentrations in the sample.

Other ion chromatograph systems are available which do not employ a suppressor system, but the eluents used in these are less conducting (e.g. organic acids), and electronic suppression is generally employed.

Table I shows the species that have been separated on each type of column from samples of sugar mill process streams. The table also shows the eluents and suppressants used for each type of column. An anion chromatogram is shown in Figure 3.

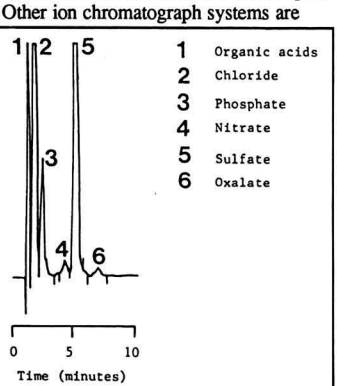


Fig. 3. Anion chromatogram of mixed juice using a Dionex 2010i system (HPLC-AS4 separator column; carbonate/bicarbonate eluent; hollow fibre suppressor; flow rate 2 ml/min; conductimetric detector of 30 microsiemens full-scale)

Column cleaning and maintenance

As with all HPLC and IC columns, cleanliness is of prime importance. All eluents, suppressants and other solutions used in the ion chromatograph are made with double-distilled, deionized water, filtered through a 0.2 μm membrane filter. The columns need regular cleaning to remove ions that remain on the resin e.g. the monovalent cation column needs washing with M HCl to remove the divalent cations Ca^{++} and Mg^{++} and the transition metals.

The anion column needs washing with 0.1 M sodium tartrate to remove any cation contamination. This is usually followed with a short wash with M HCl and a further wash with 5% acetonitrile to remove any organic contamination. The column is then flushed with 0.1M Na_2CO_3 and put back into service. These clean-up procedures need to be carried out on a regular basis if accurate results are to be obtained.

Operating conditions

Typical operating conditions for the ion chromatograph were as follows:

Flow rate : 2.0 ml/min

Column and detector temperature : ambient (usually 20 - 23°C)

Detector sensitivity : 30 μS/cm f.s.d.

Detector output : 1000 mV

System back-pressures were of the order of 6.9 MPa for the anion column and 3.4 MPa for the cation columns at a flow rate of 2.0 ml/min.

When the ion chromatograph was being used in the manual mode, at least six ml of sample was flushed through the injection loop to wash it thoroughly and to avoid contamination from the previous sample.

Calibration

This was achieved by using external standards made up each day from standard stock solutions of 1000 mg/kg concentration. The standard was injected and the integrator response factors were computed. These were then stored in the integrator for the computation of unknown concentrations.

Table II. Linearity checks*

Ionic species	Range mg/kg	R^2	slope peak height count/ unit concentration ± standard error	Intercept peak height count ± standard error	Sy (Standard error of estimate) peak height count	n	Level of significance
Cl^-	0 - 18	0.999	$385 \times 10^3 \pm 47 \times 10^2$	$-41 \times 10^3 \pm 48 \times 10^3$	94×10^3	11	better than 1%
PO_4^{---}	0 - 4	0.998	2295 ± 60	- 182 ± 120	180	5	better than 1%
NO_3^-	0 - 4	0.999	2470 ± 50	171 ± 110	170	6	better than 1%
SO_4^{--}	0 - 20	0.999	$106 \times 10^2 \pm 140$	$-26 \times 10^2 \pm 16 \times 10^2$	24×10^2	6	better than 1%
K^+	0 - 40	1.000	1820 ± 8	116 ± 220	240	4	better than 1%
Ca^{++} (30 µS FS)	0 - 12	0.999	$7 \times 10^3 \pm 100$	- 610 ± 710	1050	7	better than 1%
Ca^{++} (10 µS FS)	0 - 12	0.999	$20 \times 10^3 \pm 270$	- 940 ± 1830	3140	8	better than 1%
Mg^{++} (30 µS FS)	0 - 12	0.999	$16 \times 10^3 \pm 160$	- 1210 ± 1080	1840	8	better than 1%
Mg^{++} (10 µS FS)	0 - 12	1.000	$49 \times 10^3 \pm 400$	$-5 \times 10^3 \pm 2730$	4670	8	better than 1%

* Cl^- and SO_4^{--} were run on an HP 3390A while PO_4^{---}, NO_3^-, K^+, Ca^{++} and Mg^{++} were run on an SP 4270 integrator

Evaluation of chromatograms

At the end of each sample the chromatogram was automatically evaluated using the standard response factors. Dilution factors were then applied manually, or they could be stored in the integrator and applied automatically. The results were printed as mg/kg of each ion present in the mixture. All results were calculated on peak height basis.

Experimental results

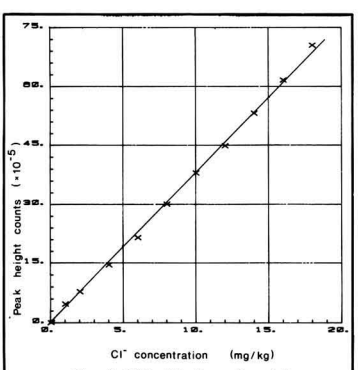


Fig. 4. Chloride linearity plot

Linearity

Linearity checks have been carried out on a number of ionic species. The details of these tests are shown in Table II while Figures 4 and 5 show the plots for Cl^- and K^+ ions. As may be seen, the linearities are good.

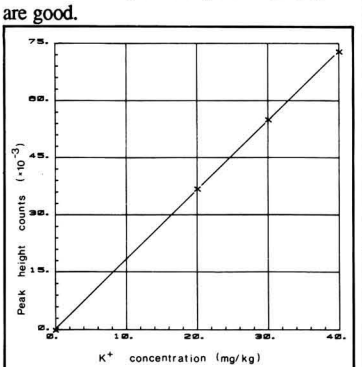


Fig. 5. Potassium linearity plot

Table III (a and b) illustrates a series of repeatability tests carried out on K^+, Cl^- and SO_4^{--} ions. The results show that an acceptable standard of repeatability can be obtained.

Table III (a). Repeatability for K^+ analysis

Sample	Day I mg/kg K^+	Day II mg/kg K^+
1	1012	1006 and 1017
2	965	961
3	940	956
4	988	974

Recovery

There is no guaranteed method against which the accuracy of the ion chromatograph results can be assessed in the presence of a complex mixture of materials such as final molasses. However there are methods which may be inherently accurate in simple mixtures. Therefore a reliance has been placed on recovery experiments for any quantitative evaluations of the method. Accordingly known amounts of the cations and anions were added to a final molasses of known composition (final molasses being the most complex sample from a sugar mill) and recovery of the amounts added was calculated from the initial and final analyses. The results are given in Tables

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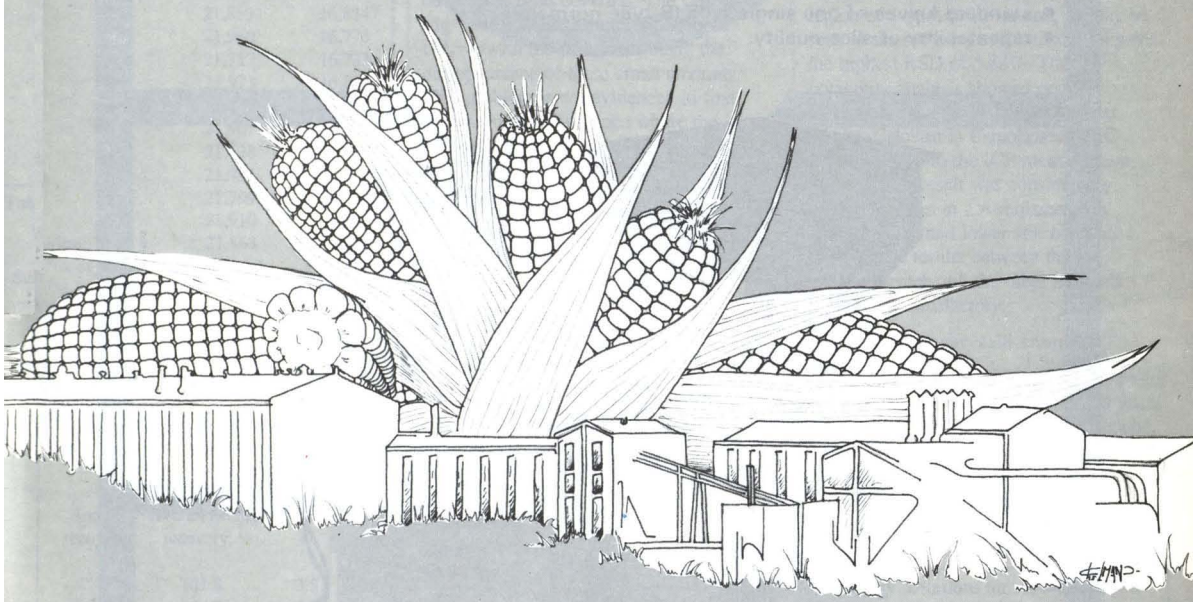

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Table III (b). Repeatability for Cl^- and SO_4^{--} on the same sample

Sub-sample	Cl^- (mg/kg)	SO_4^{--} (mg/kg)
1	21,869	16,834
2	21,960	16,773
3	21,717	16,733
4	21,973	16,827
5	21,877	16,981
6	21,901	16,838
7	21,638	16,537
8	21,993	17,153
9	21,799	16,764
10	21,910	16,833
Mean, $\bar{x}$	21,863	16,827
No. of samples, n	10	10
Std. error of mean, $S\bar{x}$	36	51
95% confidence limits of the mean	182	114

VI to XIII in Appendix I, and are summarized in Table IV.

Table IV. Recovery of cations and anions in final molasses

Ion recovered	Overall average recovery, %	RSD, %	No. of samples
Cl^-	101.8	3.5	12
SO_4^{--}	104.7	3.8	11
NO_3^-	97.4	-	2
PO_4^{---}	96.0	-	1
Ca^{++}	102.2	3.7	9
Mg^{++}	102.6	2.3	8
Na^+	99.4	5.9	9
K^+	101.6	2.3	13

The average recoveries obtained indicate that the method is essentially quantitative and has adequate accuracy for the analysis of these ions. The recovery data showed the most scatter for Na^+ but, as this element is one of the minor constituents of ash in sugar products, this is no great problem. Results for PO_4^{---} are of passing interest only, as final molasses and any sample after the clarification process will contain relatively low amounts of phosphate. This analysis is also compounded by the problem of the dilution required to keep the chloride level on scale on the integrator and to avoid overloading of the column. In this situation the phosphate peak is very small. The accuracy of the phosphate analysis below one ppm is also affected to some extent because Ca^{++} and Mg^{++} can attach themselves to the surface sulphonated substrate between gaps in the outer latex bead covering. The Ca^{++} and Mg^{++} can scavenge small amounts of PO_4^{---} with the end effect being the disappearance of these small amounts. This problem is not evidenced in first expressed or mixed juice where the amount of PO_4^{---} after final dilution is generally greater than 3 ppm.

Comparisons with other methods

It was decided to compare the results of the ion chromatograph with those obtained by other means. The Soils Laboratory of the BSES has these instruments available and samples of final molasses and *A*-molasses were forwarded to this laboratory. Calcium and magnesium were analysed by either a Varian AA 120 atomic absorption spectrometer (AAS) or an inductively-coupled Labtest Plasmascan 710 plasma spectrometer (ICP). To suppress interference from other elements strontium chloride was added to the samples when analysing for calcium and magnesium on the AAS. It was added at the rate of 1500 mg/l of Sr^{++} in the flame. The sodium and potassium were analysed on a Corning Model 400 flame photometer (FP) with interference filters and the chloride analysis was carried out on a Corning Solid State 476126 Cl^- ion-selective electrode. Chloride was also measured by the $AgNO_3$ titration method with detection of the end-point using a silver electrode to measure the sharp increase in the current at the end-point.

The results of the comparisons are set out in Table XIV of Appendix II. The results for magnesium by the three methods available (IC, ICP and AAS) are in good agreement. Chloride by IC and $AgNO_3$ titrations are in agreement but the result from the initial run with the ion selective electrode was quite different. A second analysis by ion selective electrode was performed after cleaning and refilling the reference electrode and the results of this were in better agreement for the *C*-molasses and the *A*-molasses than those obtained previously.

The results for sodium are in reasonable agreement. The IC results are lower than that obtained on the FP but the levels of sodium in the final dilution are in the region of 1 ppm or lower and, as may be seen in the recovery section, sodium gave the highest RSD of 5.88%. The potassium analysis showed good agreement with the flame photometer results. Calcium in *C*-molasses by IC agreed well with the ICP measurement, but the AAS result was considerably lower. Calcium in a *A*-molasses was lower by ICP and lower still by AAS. Overall, the results between the ion chromatograph and the other methods tested were satisfactory.

Analysis of sugar mill samples

The ion chromatograph has been used for the analysis of mixed juice, clarified juice, syrup, *A*-, *B*- and *C*-sugars, *C*-massecuite, and *A*-, *B*- and *C*-molasses. The samples were prepared by dilution and filtration through a 0.2 µm membrane filter. Examples of the dilution used for the inorganic species are shown in Table V.

Table V. Dilutions for various samples

Sample type	Anions	Monovalent cations, g/500ml	Divalent cations,
First expressed juice	7.5	12.5	5.0
Mixed juice	7.5	12.5	5.0
Clarified juice	7.5	10.0	4.0
Syrup	2.0	15.0	2.5
A-molasses	0.4	0.6	0.5
B-molasses	0.35	0.5	0.4
C-molasses	0.25 - 0.3	0.3	0.3
C-massecuite	0.3	0.4	0.35
A-sugar	10.0 - 12.5	15.0	5.0
B-sugar	10.0 - 12.5	15.0	5.0
C-sugar	5.0 - 7.5	5.0	2.5

Conclusions

The experience to date with this apparatus has shown it to offer a rapid and accurate means of analysis for inorganic anions and cations and organic acids. Provision of this facility has enabled the number of analyses necessary to carry out

a meaningful ash investigation to be performed in a reasonable time-span using only one analyst. This program would not have been possible using classical methods, with facilities previously available.

Analysis using this equipment can be completed in between ten and twenty minutes for each column run, as indicated in Table I. The instrument has been successfully connected to an automatic sampler and samples can be prepared during normal working hours for overnight running.

The ion chromatograph represents a further step forward in the search for instruments which provide accurate specific analytical results, and which can be programmed to operate with minimum of attention from an analyst. This equipment, coupled with the HPLC described in an earlier paper[5], provides a powerful analytical system for investigational work.

5 Abeydeera: *ibid.*, 1983, 171 - 186.

Appendix I

Table VI. Recovery of chloride added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
13.17	15.17	2.00	100.0
13.63	17.66	4.00	100.8
13.55	19.63	6.00	101.3
13.42	15.48	2.00	103.0
14.36	16.51	2.00	107.5
13.96	20.45	6.00	108.2
13.61	19.57	6.00	99.3
13.60	15.52	2.00	96.0
13.27	21.47	8.00	102.5
13.63	17.81	4.00	104.5
13.46	15.47	2.00	100.5
13.35	17.27	4.00	98.0

Overall ave. recovery, % ± S.D. 101.8 ± 3.6
RSD (%) 3.5

Table VII. Recovery of sulphate added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
9.95	12.03	2.00	104.0
9.54	13.57	4.00	100.8
10.12	12.33	2.00	110.5
10.05	16.29	6.00	104.0
9.70	11.84	2.00	107.0
9.95	14.10	4.00	103.8
10.03	18.22	8.00	102.4
9.94	14.04	4.00	102.5
10.12	17.98	8.00	98.3
10.15	12.38	2.00	111.5
10.99	15.25	4.00	106.5

Overall ave. recovery, % ± S.D. 104.7 ± 4.0
RSD (%) 3.8

Table VIII. Recovery of nitrate added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
0.08	2.04	2.00	98.0
0.14	2.56	2.50	96.8

Table IX. Recovery of phosphate added to final molases

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
0*	1.92	2.00	96.0

* Not detectable

Table X. Recovery of sodium added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
0.98	5.65	5.00	93.4
1.14	11.62	10.00	104.8
0.99	5.64	5.00	93.0
1.14	16.19	15.00	100.3
1.28	5.90	5.00	92.4
0.84	6.34	5.00	110.0
1.31	6.31	5.00	100.0
1.77	11.69	10.00	99.2
1.31	6.39	5.00	101.6

Overall ave. recovery, % ± SD 99.4 ± 5.9
RSD (%) 5.9

Table XI. Recovery of potassium added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
25.67	30.69	5.00	100.4
25.67	35.88	10.00	102.1
25.66	40.73	15.00	100.5
25.86	30.91	5.00	101.0
25.16	30.07	5.00	98.2
25.69	36.28	10.00	105.9
24.38	29.52	5.00	102.8
24.38	34.41	10.00	100.3
25.01	29.91	5.00	98.0
24.38	40.18	15.00	105.3
25.01	35.20	10.00	101.9
24.77	34.94	10.00	101.7
24.77	37.56	12.50	102.3

Overall ave. recovery, % ± SD 101.6 ± 2.3
RSD (%) 2.3

Table XII. Recovery of calcium added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
4.58	8.75	4.00	104.3
5.34	6.34	1.00	100.0
5.20	7.22	2.00	101.0
5.34	6.35	1.00	101.0
4.68	10.68	6.00	100.0
5.01	8.91	4.00	97.5
5.89	6.99	1.00	110.0
4.71	12.72	8.00	100.1
5.27	9.49	4.00	105.5

Overall ave. recovery, % ± S.D. 102.2 ± 3.8
RSD (%) 3.7

Table XIII. Recovery of magnesium added to final molasses

Initial concentration	Measured concentration	Added	Recovery, %
mg/kg			
4.23	8.35	4.00	103.0
4.69	5.74	1.00	105.0
4.51	8.60	4.00	102.3
4.59	6.54	2.00	97.4
4.61	8.80	4.00	104.8
4.51	6.59	2.00	104.0
4.21	10.36	6.00	102.5
4.25	12.39	8.00	101.8

Overall ave. recovery, % ± S.D. 102.6 ± 2.4
RSD (%) 2.3

ISJ Abstracts

Cane sugar manufacture

Trends in the Louisiana sugar industry

H. S. Birkett. *Sugar J.*, 1985, **47,** (12), 14 - 19.

Trends in the Louisiana sugar industry during 1970/84 are reviewed with the aid of graphs, covering the total sugar production, average cane and sugar yields, number of factories in operation, average crushing rate, lost time % total operating time, pol extraction, final molasses and syrup purities, average sugar pol and gas consumption.

Microbial sugar losses

D. F. Day. *Sugar Bull.*, 1985, **63,** (18), 6.

Reference is made to the work of Mackrory *et al.* on microbial losses in cane mills and diffusers[1]. While factories in South Africa showed lactic acid levels in the range 380 - 600 ppm on mixed juice Brix, measurements at a Louisiana factory showed 1500 ppm lactic acid on mixed juice Brix, from which a daily loss of about 1170 lb of sugar is calculated for a crushing rate of 4000 tcd.

Improving low-grade sugar crystallization

R. S. Patterson. *Sugar J.*, 1985, **48,** (1), 10 - 12.

See *I.S.J.*, 1985, **87,** 123A.

The belt filter press in the sugar industry

J. Lauria. *Sugar y Azúcar*, 1985, **80,** (6), 43 - 46.

The advantages of a belt filter press, in which two endless open-mesh screens pass through a system of pressing rolls, in conjunction with conventional rotary vacuum filters for clarification mud treatment are discussed; they include: increased sugar recovery without any extra water consumption, a reduction in the BOD going to the mud ponds and in the quantity of mud for disposal, a decrease in cake moisture content and simplification of vacuum filter operation. Belt filter presses have been used for three seasons at Clewiston sugar factory. Tests conducted by Parkson Corp. have shown that the belt filter press is also suitable for recovering sugar from bagacillo. Mention is also made of its application to carbonatation mud treatment in the beet sugar industry.

Louisiana tests new main carrier chain

Anon. *Sugar y Azúcar*, 1985, **80,** (6), 53 - 54.

An illustrated account is given of a new Link-Belt chain used on the main cane carrier at a Louisiana sugar factory, and mention is made of other Link-Belt power transmission components as used e.g. for bagasse conveying.

Two ways to de-ash sugar cane products

R. A. Johnson. *BSES Bull.*, 1985, (11), 18 - 19.

Two demineralization techniques are outlined, viz. ion exchange and electrodialysis; emphasis is placed on the importance of removing K and Ca by these methods, and it is stressed that adoption of either system depends on economic factors.

Farm practices affect the sugar process

G. Leonard. *BSES Bull.*, 1985, (11), 22 - 23.

It is briefly shown how farmers can reduce raw sugar colour by ensuring that nitrogen is not applied in excessive quantities and by minimizing the amount of extraneous matter accompanying cane to the factory. The author also indicates sources of colour that occur during cane processing and raw sugar storage.

Clarification of syrup by flotation for improving sugar quality

J. F. Tong, Y. C. Hsiao and C. H. Chen. *Taiwan Sugar*, 1985, **32,** (3), 8 - 11.

Details are given of the phosflotation system introduced at three Taiwan sugar factories and tested at Towliu, using a flotation clarifier of special design intended to give maximum mud compression, reduce dead space and provide a good syrup flow pattern. The feed at 60 - 65°Bx enters at the bottom of the vessel through a V-type divergent channel and flows along a channel formed by a double-layer jacket before overflowing through a draw-off pipe. A V-type collector collects scum at the top of the clarifier. Before clarification, phosphoric acid, at 50 - 200 ppm on solids, is added to the syrup and the pH adjusted to 6 - 7 with milk-of-lime; after aeration by centrifugal pump, the syrup is heated to 85°C by injecting live steam directly into a static mixture, after which 10 - 15 ppm flocculant is added and the syrup held in a reaction chamber for about 30 seconds before entering the clarifier. Turbidity and colour removal data are given, and a significant colour reduction shown for syrup in both a plantation white sugar factory and a remelt refinery section by comparison with conventional processing without phosflotation.

Cane sugar mills, preparation of raw juice

S. Cecek. *Czechoslovak Heavy Ind.*, 1985, (11), 13 - 17.

Cane reception and milling are outlined, and details given of Skoda 3- and 5- roller mills and turbine drives (together with their gearing).

The merits of electric welding on a mill roller surface

C. J. Lu and W. H. Tsai. *Taiwan Sugar*, 1985, **32,** (4), 7 - 9.

Details are given of two types of electric rod used for cane mill roller surface treatment by a special welding procedure at Chiali sugar factory. Tabulated values demonstrate the fall in the number of cases of slippage over the years with only 0.85 slippage per 10,000 tonnes of cane at a crushing rate of 2540 tcd in 1984/85.

1 *I.S.J.*, 1985, **87,** 79A.

Beet sugar manufacture

Methods for increasing the efficiency of sugar solution purification

V. A. Loseva. *Obz. Inf. TsNII Inf. i Tekhno-ekon. Issled. Pishch. Prom., Sakhar. Prom.*, 1985, **5**, 28 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (16), Abs. 16 R415.

Methods for purification of sugar solutions developed at Voronezh Technological Institute are discussed. They incorporate preliminary coagulation of non-sugars with 1N H_2SO_4 solution, sulphitation or carbonatation, introduction of certain salts, treatment with live steam, precarbonatation and introduction of polyacrylamide flocculant, and the use of powdered filter-aids. Schemes are worked out and the features of the proposed methods compared with conventional purification. Recommendations are made on improving the filtration rate using powdered filter-aids.

Coagulation and aggregation of colloids in preliming

D. V. Ozerov, A. R. Sapronov and A. M. Gavrilov. *Sakhar. Prom.*, 1985, (8), 4 - 27 (*Russian*).

Changes in the structure of colloids in raw juice were studied on the basis of juice optical density as a function of temperature. Addition of carbonatation mud to juice at 40 - 45°C before the onset of structural changes (when they were still unaffected by juice pH) was followed by gradual addition of calcium hydroxide to pH 11 - 11.4 (optimum for colloid coagulation); the lime salts concentration fell with increase in coagulation, both in the presence and absence of calcium carbonate, while juice clarity also rose. The fall in Ca content was of a stepped character, the first noticeable decrease occurring after flocculation of the coagulated particles, while the second marked reduction took place with gradual disappearance of the exchange reactions in the aggregates, at which point the sucrose concentration rose; this confirmed the participation of Ca-sucrose complexes (unstable mono- and disaccharates) that differed from other mono- and disaccharates in that they contained a larger proportion of Ca. These complexes disintegrated after colloid coagulation, the sucrose passing into solution and the Ca being adsorbed by the mud.

The effect of voltage of an electric field and of temperature on sugar diffusivity in beet

A. B. Matvienko, M. P. Kupchik, L. G. Vorona and I. M. Katrokha. *Sakhar. Prom.*, 1985, (8), 27 - 29 (*Russian*).

The effect of field voltage and temperature on the diffusivity of sugar was determined in experiments using an electric diffuser with ion exchange membranes separating the extraction chamber from the electrode chambers through which a 0.4% NaCl solution was passed at 25 - 75°C and a voltage of 0 - 100 V/m applied. Results showed that diffusivity rose with increased voltage and fell with reduction in temperature (regardless of the electric field which, however, did increase the temperature effect).

Optimum design of vapour heaters for process products in sugar factories

V. V. Maiorov, I. Yu. Veniaminov and V. S. Romanov. *Sakhar Prom.*, 1985, (8), 32 - 36 (*Russian*).

An algorithm is presented for calculation of the design parameters of economically optimum heaters for juice, syrup and water, using reheat steam and assuming a product flow rate of at least 2 m/sec.

Modification of the transport system in tower diffusers

B. A. Melent'ev. *Sakhar. Prom.*, 1985, (8), 48 (*Russian*).

The flights in a conventional Soviet tower diffuser have a cross-sectional area and angle of slope which are constant over their entire length, and the interval between them over the height of the central shaft is identical; as a result, the diffuser efficiency suffers to a certain extent - the juice-cossettes mixture undergoes changes in its physico-mechanical properties as it progresses up the diffuser, and the uniform cross-sectional area of the flights and their fixed centre of gravity may cause them to bend when overloaded, possibly causing damage if they come into contact with the side baffles. In a modified system, the flight is given a special profile in which the cross-sectional area and angle of slope are no longer constant, while the pitch between adjacent rows of flights and radius of curvature of the baffles also vary over the height of the diffuser. Operation of the system at a number of factories has permitted increased throughput, has given pulp losses no higher than the norm and has reduced electricity consumption by the diffuser drive.

Avoid losses - keep down costs - produce quality

W. C. von Kessel. *Die Zuckerrübe*, 1985, **34**, 204 - 207 (*German*).

Minimization of beet losses in harvesting, storage and transport is discussed. Causes of storage losses indicated include respiration, injury, inefficient topping (leaving extraneous matter on the beet) and frost. Advice is given on frost protection of beet clamps.

The problems of sugar factory maintenance

H. Lührs, H. Francke, F. Jens and J. Bierett. *Zuckerind.*, 1985, **110**, 771 - 785 (*German*).

A symposium presented at the General Assembly of the German Sugar Technologists Association in 1985 deals with the problems of sugar factory maintenance, including: the difficulties associated with worker motivation and the high costs of maintenance; how the costs can be optimized by careful preparation of the work, gathering of information on faults and their analysis, comparative costing and a well-organized materials economy; measures adopted at Süddeutsche Zucker-AG for systematic fault assessment and for servicing and maintenance work based on work schemes and set targets; and work facilities and the

effects of factory layout (multi- or single-storey plants) and location of the workshops and stores on maintenance costs. Examples are presented which demonstrate how costs can be considerably reduced by planned maintenance.

Energy savings through modification of the carbonatation process

W. Lekawski and K. Urbaniec. *Zuckerind.*, 1985, **110,** 810 - 813.

Under the most favourable conditions, the steam consumption in 1st and 2nd carbonatation is at least 2.2% on beet. Energy losses result from heat and mass transfer between the juice and gas and are affected by the CO_2 content of the gas, its degree of utilization, juice temperature and amount of lime added. Two suggested methods for reducing these losses are described: (1) heating and moistening the gas with ammoniacal condensate, and (2) carrying out 2nd carbonatation under pressure. In (1), the gas is passed through a packed column provided with Raschig rings in which it is wetted by condensate at 75°C and 25% on beet in 1st carbonatation and at 95°C and 5% on beet in 2nd carbonatation. In (2), maximum energy economy is obtained at a pressure of 2 - 3 bar. The overall effect of both measures is a two-thirds reduction in steam, equivalent to 1.6 - 2.6% on beet. Mention is made of factory altitude above sea level in connexion with pressure carbonatation and of the possible use of boiler flue gas containing 12 - 14% CO_2.

The importance of sulphitation and methods of conducting it

M. Friml and R. Stengl. *Listy Cukr.*, 1985, **101,** 193 - 197 (*Czech*).

A discussion of juice and diffusion water sulphitation includes a general examination of the role of sulphitation and of major factors influencing its effectiveness, a brief summary of SO_2 properties and their determination, means of producing SO_2 (particularly by sulphur burning as practised in Czechoslovakian sugar factories), and a brief mention of sulphitation vessels. 26 references are given to the literature.

Baling in valve bags - a way to rational conveyor bagging of crystal sugar

J. Pribyl. *Listy Cukr.*, 1985, **101,** 198 - 203 (*Czech*).

A description is given of an automatic line for bagging sugar in 50-kg multi-wall paper valve bags and storing these on pallets. A two- or three-nozzle bag filler/weigher supplied by Bates Maschinenvertriebs Ges.m.b.H. of Austria and a Strapex machine of Swiss origin that binds the filled bags together in 6-layer stacks with polypropylene tapes on the pallets are two pieces of equipment given particular mention.

Simulation models of sugar factory manufacturing schemes. III. Model of a mixed factory

B. Kopriva, J. Gebler and R. Stengl. *Listy Cukr.*, 1985, **101,** 204 - 215 (*Czech*).

A mathematical model is presented of white sugar manufacture in a "mixed" factory, i.e. which manufactures white sugar from its own beet and from raw sugar brought in from elsewhere. Computer programs are given as well as a sample print-out showing a materials balance. Because of computer capacity limitations, the overall scheme has had to be divided into two sub-systems for low-grade sugar crystallization, and the sub-system described in this article concerns *C*-sugar melting. Because of the high complexity of the overall process, with its very large number of interactions, it was considered advisable to introduce standard input values of given parameters for the basic manufacturing processes and to work out self-regulating functions for the other processes. The need to process the input data is particularly governed by the quantity of raw sugar used from other factories.

Danish microprocessor controller for the pan floor

G. R. Møller. *Sugar y Azúcar*, 1985, **80,** (7), 33 - 35.

A microprocessor-based pan boiling controller is described which is designed for continuous use with a batch pan and installed adjacent to it. It measures the syrup and massecuite levels for automatic charging, tightening and change of feed supply, vacuum and steam feed, controls supersaturation on the basis of conductivity, regulates the absolute pressure in the pan, steam supply throughout the strike and massecuite temperature as well as all secondary functions during starting and stopping of the boiling cycle, and measures power consumption of a massecuite stirrer (where applicable). Details are given of display and keyboard, hardware, pushbuttons, back-up, etc. For purposes of optimization or central supervision, the equipment is provided with means for transmitting all the process and operational data to and receiving data from a supervisory host computer.

The effect of SHF heat treatment of vegetable raw material in the extraction process

V. A. Shulika, M. P. Kupchik, Ya. F. Trachevskaya and N. G. Fishchuk. *Prom. Teplotekhn.*, 1985, **7,** (2), 49 - 51; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (17), Abs. 17 R437.

The effect of a super high frequency field (of 3000 - 30,000 MHz) on the heat treatment of vegetable raw material was investigated. It was found that sugar extraction from beet cossettes treated in a SHF field accelerated markedly while the process temperature fell and the quality of the extract improved. The data obtained may be used for comparison with other methods of treating vegetable material.

Method for intensifying the beet pulp pressing process

V. G. Belik *et al. Obz. Inf. TsNII Inf. i Tekhn.-Ekon. Issled. Pishch. Prom., Sakhar. Prom.*, 1985, (7), 23 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (17), Abs. 17 R445.

A survey is presented of beet pulp screw

presses used in Soviet and other sugar factories. Various methods of intensifying the process so as to raise the degree of pressing to at least 25% dry solids are examined, as well as new unconventional methods of intense pressing in a thin layer and thermal pressing.

Investigation of drying of a film of sugar solution

V. A. Mikhnenko and I. N. Fiklistov. *Rpt. Lvov Polytechn. Inst.*, 1984, 11 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (17), Abs. 17 R453.

A study was made of the behaviour of films of sugar solutions during intensive drying by natural convection in air. A special experimental method was developed involving continuous determination of moisture removal from the film of solution applied to a sugar substrate on a plate. During the process, glass-like films of sugar were able to form on the crystals and subsequently crystallized with removal of free moisture during prolonged storage. The shape of the curve of fluidized bed kinetics during the second phase of white sugar drying was attributed to the formation of glass-like inclusions and to release of moisture from "dried" sugar during subsquent protracted storage.

From the technical institute to industry

R. B. Lozinskii and S. A. Kolmychok. *Sakhar. Prom.*, 1985, (9), 14 - 16 (*Russian*).

Outlines are given of projects undertaken by students at the Krasnodar Sugar Industry Technical Institute for their diplomas. The work concerned specific sugar factories and included a new design for a beet flume water separator, replacement of dry feeding of beets with fluming, substitution of special tangential nozzles for conventional spray nozzles in order to improve filter cake sweetening-off, and a raw juice heater modification.

Crystallization schemes

T. P. Matvienko, Yu. D. Kot and V. A. Shestakovskii. *Sakhar. Prom.*, 1985, (9), 27 - 31 (*Russian*).

Three 2- and three 3-massecuite schemes (all involving low-grade sugar affination) that have been used as normal practice or tested in Soviet sugar factories are assessed; constants are: beet pol, thick juice Brix and purity, molasses dry solids and purity, losses prior to the boiling house, and sugar yield. Three criteria are used for evaluation of: (1) the weighted mean boiling time, allowing for the adverse effect of non-sugars on the crystallization rate; (2) sugar quality (Gibbs' equation being given for calculation of the quantity of matter adsorbed on crystal surfaces); and (3) operational stability. Results showed that (1) was lowest in a 2-boiling scheme with intermediate massecuite curing in the centrifugals, but that the system lacked stability and a steady rhythm where batch boiling and spinning were used, while the boiling process was too complex. Of the 3-massecuite schemes, the best in terms of factor (1) involved low-grade boiling on a *B* crystal footing; its operational stability ensured good quality sugar and a high degree of molasses exhaustion. Use of combined *A*-massecuite washing with syrup and water increased crystal yield by comparison with conventional water washing and reduced fuel consumption.

Secondary sugar crystallization of *A*-massecuite by cooling

V. I. Tuzhilkin *et al. Sakhar. Prom.*, 1985, (9), 31 - 33 (*Russian*).

In 2-massecuite boiling, the purity of the run-offs is so high that low-grade massecuite exhaustion in horizontal crystallizers is inadequate. However, the purity of run-offs used for *B*-massecuite boiling can be reduced by supplementary cooling of *A*-massecuite in a vertical crystallizer, and laboratory and factory-scale trials of the scheme are reported. The factory experiments showed that a 6 - 8°C reduction in temperature during 60 - 70 minutes' cooling gave a 1.8% decrease in mother liquor purity and raised the crystal yield by 2.6% without any secondary nucleation. Purging was not difficult and white sugar colour was practically the same as with the normal scheme.

The advisability of ageing 2nd carbonatation juice

V. A. Golybin and Yu. I. Zelepukin. *Sakhar. Prom.*, 1985, (9), 33 - 35 (*Russian*).

Ageing 2nd carbonatation juice in special stirred vessels reduces the lime salts content and supersaturation and causes secondary crystallization of $CaCO_3$ on the surface of the mud particles. Investigations showed that supplementary liming before 2nd carbonatation improved the effects of ageing (in terms of colour and lime salts); without it, colour increased with the time of ageing. The lime salts content reached a minimum after 20 minutes' ageing, and the optimum temperature was 83 - 85°C (above which there was accelerated non-sugars decomposition and associated increase in colour and undetermined losses). Intensive mixing during ageing was inadvisable in view of its adverse effect on carbonate crystallization.

The effect of granulometry on white sugar quality during storage

A. I. Belyaev and A. A. Slavyanskii. *Sakhar. Prom.*, 1985, (9), 38 - 42 (*Russian*).

While samples of white sugar from 10 Soviet factories conformed to the official standard on size range, marked differences were found between the samples as regards M.A. and C.V. Examination of samples from three of the factories showed that fractions measuring 0.63 - 0.80 and 0.8 - 1.0 mm corresponded to minima in crystal size *vs.* colour curves; the colour rose on each side of the minima, particularly at >1.0 mm and <0.315 mm. Increase in crystal uniformity gave an even lustre, good friability, reduced turbidity and hygroscopicity and improved storage properties. A method is briefly described for determining the content and size of insoluble particles in sugar solution. Results showed that 70 - 80% of the total insolubles involved particles measuring 5 - 25 μm and that the content was minimum in the size range 0.63 - 1.00 mm; crystal

fractions stored in bags under heated conditions exhibited colour increase with time, but the 0.63 - 1.00 mm crystals were least affected and are recommended for storage.

Artificial biological treatment of sugar factory effluents

A. P. Parkhomets, N. A. Savdun and S. A. Mikhailik. *Sakhar. Prom.*, 1985, (9), 42 - 45 (*Russian*).

Details are given of the performance of the activated sludge/oxygenation system used at Glodyana to treat a mixture of factory effluent and domestic sewage. At a throughput of 190 - 200 m^3/hr, BOD was reduced by 97 - 98% and COD by 94 - 95%; more than 55% of the saponin was oxidized, the ammonia content was reduced by up to 53% and nitrite and nitrate levels decreased to trace quantities. The treated water was clear and odourless. The BOD:N:P ratio was maintained at 100:5:1 by adding superphosphate and ammonium sulphate. Details are given of various operational parameters and of the activated sludge, including the species of organism in it.

Ways of reducing heat losses in the carbonatation station

O. V. Moroz, A. A. Lipets and D. M. Korilkevich. *Sakhar. Prom.*, 1985, (9), 45 - 47 (*Russian*).

A carbonatation scheme is described in which, by comparison with the conventional process, heat losses caused by evaporation in the 1st and 2nd carbonatation vessels are reduced and a steam loss of 0.85 - 1.7% on beet eliminated by omitting recycling of unfiltered 1st carbonatation juice. The raw juice is heated to 50 - 55°C before pre-carbonatation, and juice treated in the 1st (warm) stage of fractional liming is heated to 85°C before the 2nd (hot) stage; before settling, 1st carbonatation and 2nd carbonatation juices are heated to 80 - 85°C and 95°C, respectively. For a factory of 3000 tonnes/day beet slice, the heat losses in 1st and 2nd carbonatation alone (allowing for heat loss in pre-carbonatation in the new scheme) are cut by 60%.

Protection of sugar factory equipment against corrosion failures

G. M. Vysokova, P. A. Shelist and N. P. Romenskii. *Sakhar. Prom.*, 1985, (9), 47 - 51 (*Russian*).

Recommendations are made on the use of suitable metals and application of protective coatings to prevent damage caused by corrosion.

A method of raw juice purification with pre-coagulation of non-sugars by means of certain salts, pre-carbonatation and addition of polyacrylamide flocculant

V. A. Loseva and R. P. Lisitskaya. *Rpt. Voronezh Technol. Inst.*, 1985, 6pp; through *Ref. Zhurn. AN SSSR (Khim.)*, (18), Abs. 18 R434.

In investigations of the possibility of raising raw juice purification efficiency, ammonium sulphate, sodium sulphate and sodium suphite were used in optimum quantities for pre-coagulation of non-sugars. A suitable scheme based on this was developed, and the optimum quantity of lime for pre-carbonatation established. The most suitable point at which to add polyacrylamide and its optimum concentration were also determined. The proposed method raised 2nd carbonatation juice quality and increased purification efficiency by 5 - 10% compared with conventional treatment.

The behaviour of albumins during raw juice purification using certain salts, pre-carbonatation and addition of flocculant

V. A. Loseva and R. P. Lisitskaya. *Rpt. Voronezh Technol. Inst.*, 1985, 6 pp; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (18), Abs. 18 R435.

In an investigation of the behaviour of albumins in the scheme described in the preceding abstract, the effects of the ammonium sulphate, sodium sulphate and sodium sulphite on the content of albumins and their degradation products were determined in raw, prelimed, limed and 2nd carbonatation juice. Results showed that the salts reduced the content by 10 - 17% in preliming and by 8 - 16% in main liming by comparison with conventional treatment.

Effect of temperature and sucrose concentration on CaO solubility in aqueous sugar solution

V. A. Loseva, I. S. Naumchenko and V. M. Perelygin. *Rpt. Voronezh Technol. Inst.*, 1985, 7 pp; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (18), Abs. 18 R436.

The solubility of CaO added to water and sugar solution in a special glass vessel provided with a continuous mixing system fell with temperature rise; but addition of $Ca(OH)_2$, KOH and MgO individually as electrolytes increased solubility of the lime in the sugar solution, even when the electrolyte dose was very small (0.00133 - 0.02014% on CaO by weight), and thus increased non-sugars removal. Solubility fell with increase in the dosage rate above 0.02014%.

Development of a method for calculating massecuite movement water

A. I. Gromkovskii and N. V. Sorokina. *Rpt. Voronezh Technol. Inst.*, 1985, 6 pp; through *Ref. Zhurn. AN SSSR* (Khim.), 1985, (18), Abs. 18 R438.

A method for calculating movement water proposed for practical use has been checked by factory tests and against data in the literature. It requires knowledge of standard molasses parameters (as determined over 10-day periods) as well as the Brix and sugar content of supersaturated mother liquor. Strict attention to the calculated amount of water will ensure that the supersaturation coefficient does not fall below 1, while crystallization efficiency will rise and the molasses purity will be some 0.8% lower than under conventional conditions. The method of calculation has proved reliable.

Sugar refining

Analysis of boiling house performance during raw sugar processing

R. Ts. Mishchuk and V. A. Shul'ga. *Sakhar. Prom.*, 1985, (8), 30 - 31 (*Russian*).

A mathematical model is presented for determining the relationship between any two variables in the boiling house when cane raw sugar is refined. The method is applied to the dependence of molasses yield on the quality of purified raw sugar remelt as well as *A*- and *B*-run-offs. While molasses yield rose in proportion to a fall in remelt purity, the latter fall was a function of the amount of *A*-run-off recycled to purification; hence, the greater the amount recycled, the lower was the molasses yield.

Automatic stabilization of the concentration of raw sugar remelt

Z. S. Voloshin, N. S. Matsipura and L. S. Alekseeva. *Sakhar. Prom.*, 1985, (8), 41 - 42 (*Russian*).

A brief account is given of experience at Gorodeya sugar factory in the preparation of raw sugar remelt of constant Brix in two parallel automatically controlled lines. The Brix is kept constant at 54 - 56°, and fuel consumption is 0.1% less on raw sugar by comparison with manual control using a refractometer.

Predictive power control system for a sugar refinery by demand controller

H. Ota, T. Asahina and T. Hiki. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1985, **34**, 21 - 25 (*Japanese*).

The demand controller installed at Nissin Sugar Mfg. Co. Ltd. in 1979 continuously monitors power consumption, predicts the maximum demand and gives an audible warning when the predicted value exceeds the target value. When load control is necessary, the system automatically interrupts and releases the loads in accordance with the preset control formula. The controller has permitted cuts and shifts in peaks, has facilitated power control in the case of peak loading and has reduced from 4800 to 4600 kW per year the amount of electricity needed to be bought from the utility, giving a substantial monetary saving.

Application of pure carbon dioxide to carbonatation in a sugar refinery

I. Takahashi, S. Sugihara and N. Sekine. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1985, **34**, 24 - 25 (*Japanese*).

In a pilot plant test in which pure CO_2 replaced boiler flue gas for liquor carbonatation, a new tubular mixer to accelerate the reaction between the CO_2 and $Ca(OH)_2$ was installed in the pipeline between the raw liquor tank and the carbonatated liquor receiver. The CO_2 was blown into limed liquor just before it entered the mixer; the liquor was recirculated until its pH had fallen from 11.2 to 7.0, which required 9.5 moles of CO_2 per mole of $Ca(OH)_2$. This was no lower than the consumption using the conventional method, however, and the quality of the treated liquor was inferior to that with conventional carbonatation.

The future of raw sugar quality

M. A. Clarke. *Sugar y Azúcar*, 1985, **80**, (9), 32 - 34, 37, 40, 44 - 45, 48 - 50.

The question of raw sugar quality (pol, colour, ash, invert, moisture, dextran, turbidity and storage properties) is discussed in regard to refining and the effects of quality of changes in the export and domestic markets and of developments in manufacturing processes to meet market requirements. The situations in South Africa (with development of Very High Pol sugar) and the USA (as a major raw sugar importer and with increasing replacement of refined sugar by fructose syrups) are examined, and the point made that the demand for increased export sugar quality can only rise. Processes for manufacture of white sugar and/or higher quality raw sugar for refining are surveyed under five categories: (1) raw sugar for export + raw sugar to be processed in a refinery attached to the factory; (2) sulphitation white sugar + raw sugar for export; (3) sulphitation white sugar + remelt for the refinery section; (4) direct white sugar manufacture; and (5) raw sugar clean-up processes for small-scale refined sugar manufacture.

Deep bed filtration in the sugar industry

N. Coote. *Paper presented to British Soc. Sugar Cane Tech.*, 1985, 5 pp.

Deep bed filtration (DBF) is commonly used for solids removal from drinking water and swimming pools; the filter generally takes the form of a cylindrical tank containing a support grid or gravel layer on top of which is the filter medium, typically sand and anthracite. The water is fed at the top and flows down through the medium, which is of carefully selected particle size and layered so that solid impurity particles are trapped without blinding of the surface and with minimal breakthrough into the filtrate stream. Backwashing (preferably with some of the filtrate) is used to fluidize the bed and flush the trapped particles out of the top of the filter, after which the bed is re-established with correct layering. The technique has been successfully applied to melt liquors after phosphatation, as well as corn syrups clarified by the Taloflote process, so as to prevent fouling of e.g. granular carbon by residual suspended solids. The bed is so layered that larger particles are on top and get smaller towards the base. Because no filter aid is used, there is no filter cake to sweeten-off and no risk of filter aid leakage into downstream processing. By comparison with conventional filtration, DBF of large volumes of liquor, e.g. >22 m^3/hr in a filter 1.8 m in diameter, is possible and the filter can be fully automated, including the backwash cycle - the need for cleaning is established simply by sensing the pressure drop across the bed. However, DBF is less effective than normal filtration at removing very small particles (≤5 μm), so that it is best suited to liquors of higher turbidity than normally filtered liquors.

Laboratory studies

Hydrodynamic resistance in sugar crystal settling

A. I. Gromkovskii and N. V. Sorokina. *Izv. Vuzov, Pishch. Tekh.*, 1985, (2), 96 - 98 (*Russian*).

Crystal movement relative to the mother liquor plays a significant role in crystallization, and relative to the heating medium in drying. Calculation of the settling velocity requires knowledge of the coefficient of crystal shape ϕ and of the coefficient of hindered settling λ; ϕ represents the ratio of the settling velocity of a sucrose crystal ω to that of the spherical particle in an infinite space ω_o. From experimental determination of ω and calculation of ω_o based on Reynolds' number (= Archimedes' number/18), a value of 0.813 was found for ϕ which was in good agreement with values obtained by other authors. Similarly, tests were conducted on artificial massecuite of known crystal content to establish values of ω_c (velocity of hindered settling); again, values were calculated of Reynolds' number in terms of Archimedes' number and a maximum difference of $\pm$ 10% found between experimental and calculated values. The coefficient λ is given by $\omega_c/\omega_o\phi$ or by $e^{a + b \ln x}$, where e = base of the natural logarithm, x = massecuite crystal content, and a and b are coefficients found by paired correlation to have values of -0.2450 and -0.4019, respectively.

Electrical retention of colouring matter in sugar manufacture

L. D. Bobrovnik, V. N. Rudenko, V. V. Mank and M. P. Kupchik. *Sakhar. Prom.*, 1985, (7), 29 - 31 (*Russian*).

The decolorizing efficiency of a laboratory ion exchange membrane unit was determined; stainless steel electrodes were used in the anode and cathode cells on each side of the sample cell (containing solutions of colouring matter obtained by methods that are described). Results showed that for each colorant group, separation increased with voltage; at an electric field strength of 20 V/cm, the colour retention was 28.6% in the case of caramelin, 40.0% for caramelen, 51.8% for a mixture of caramelen and caramelan, 83% for melanoidins and 84% for reducing sugar alkaline degradation products. The differences in separation efficiency were a function of the zeta-potential, values of which are given for each group at pH 4 - 6.

High performance liquid chromatography of sugars on copper(II)-modified silica gel

J. L. Leonard, F. Guyon and P. Fabiani. *Chromatographia*, 1984, **18,** (11), 600 - 602; through *Anal. Abs.*, 1985, **47,** Abs. 8D83.

Partisil 5 silica gel is shaken with aqueous 0.1M Cu(II)-1M NH_3 for 5 minutes, filtered off and dried at 100°C for 12 hours before being packed into a HPLC column (20 cm × 4.8 mm). A mobile phase of aqueous 75% acetonitrile containing 2mM Cu(II) and 1.5M NH_3 is used for separation of, e.g., fructose and glucose. Detection at 254 nm against a mobile phase-reagent blank gives detection limits of 8 and 12 nmol in the sample for fructose and glucose, respectively.

Modification of sucrose crystal faces

G. Mantovani. *Listy Cukr.*, 1985, **101,** 188 - 191 (*Czech*).

As part of a lecture delivered at the Slovak Technical University in Bratislava, the author discusses the effects of raffinose, KCl and dextran on sucrose crystal habit modifications as determined in experimental work conducted by himself and other authors. Single crystals grown on a plastic thread under quiescent conditions and weighing from a few grams to about 2 kg have shown the characteristic deformations associated with the presence of the impurities, but not all the crystals have exhibited the needle formation caused by dextran under factory conditions, and it is suggested that dextran may not be the only factor involved. The theory of Hartman & Perdok on the growth morphology of the sucrose crystal is explained, particularly the formation of the F, S and K surfaces and the significance of the role played by energy bonds and periodic bond chains; diagrams of crystals exhibiting the various characteristics are described. The growth of twin crystals is briefly discussed, and mention made of the three types noted in the literature.

Surface tension of sucrose solutions. II. Interference of impurities on the action of surfactants. General expression for the calculation of surface tension

R. Gonzáles Q. and M. Derivet Z. *ATAC*, 1984, (4), 15 - 21 (*Spanish*).

The action of three surfactants, in doses of 100, 300 and 500 ppm and between 60° and 100°C on cane juices at 20° and 60°Bx has been examined. The action of the surfactants are analysed comparatively on the juices and on pure sucrose solution. The effect of two of the impurities in the cane juice - dextran and cane wax - on the surface tension of sucrose solution has been studied. The results showed that dextran exerted no effect, while in the presence of waxy materials similar reductions were found in the surface tensions of pure solutions and juices. An equation is proposed, $\gamma = 76.02 - 0.1672T + 719.24BT^{-2.092}$ where γ = surface tension, T is the temperature in °C and B the Brix, for calculation of the surface tension of sucrose solutions in the range 0° - 150°C and 0° - 60°Bx; standard

Cane research in South Africa

Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1984/85, 7.

Separation and measurement of individual amino-acids in cane: A gas chromatographic procedure has been developed for determining individual amino-acids in various factory products. After initial purification and concentration of the amino-acids on a cation exchange column, their carboxyl groups are

esterified and the amino group then acylated. A chromatogram is presented of amino-acids isolated from a molasses sample. The method was to be used to investigate the loss of individual amino-acids with monosaccharide and sucrose decomposition in factory back-end products.

Automated analyses of phenolic compounds and amino-nitrogen in cane process liquors: Colour measurement at 420 nm and pH 7 has limitations when detailed information is required on colorants and colour precursors such as phenolic compounds and amino-acids. However, colorimetric methods based on the Folin-Ciocalteu reaction for phenolics and the ninhydrin reaction for amino-N are reasonably specific and sensitive when applied to cane juice and sugar, and a hybrid Technicon-Cenco AutoAnalyser has been adapted so as to provide a high replicate throughput of samples (50 per hour).

Formation of polysaccharides in recently harvested sugar cane stalks

P. Valdés and C. W. Rodríguez. *Cienc. Agric.*, 1982, (12), 45 - 52 (*Spanish*).

Avoiding infection by means of germicidal solutions and short incubation periods, a study was made of the formation of soluble polysaccharides in small pieces of cane stalk internode. It was concluded that formation of the polysaccharides is related to the number of cuts, the size of the surface affected and the incubation period up to 120 minutes.

Collaborative study on the determination of trace elements in dried (beet) pulp, molassed pulp and molasses. IV. Arsenic

A. W. M. Huijbregts, D. Hibbert, R. T. Phillipson, H. Schiweck and G. Steinle. *Zuckerind.*, 1985, **110,** 797 - 801 (*German*).

See *I.S.J.*, 1985, **87,** 163 - 167.

Investigation of colorants in cane sugar manufacture using gel filtration on Toipearl gels

M. Garcia F., J. Hoque and I. F. Bugaenko. *Rpt. Moscow Technol. Inst.*, 1985, 7 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (17), Abs. 17 R448

Fractionation and investigation of the colouring matter in cane sugar manufacture were carried out using gel chromatography on Toipearl gels. It was found that HW- 40 gel may be used for separation of the colorants.

The effect of the molecular weight of colorants on their adsorption by powdered carbons

M. Garcia F. and I. F. Bugaenko. *Rpt. Moscow Technol. Inst.*, 1985, 6 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (17), Abs. 17 R449.

The removal of colouring matter from products of cane sugar manufacture using Norit active carbon was investigated by gel chromatography on different brands of Sephadex gels. It was found that best separation by the carbon was of colorants having molecular weights in the range 100 - 15,000.

HPLC in the sugar industry - an overview

M. A. Clarke. *Sugar y Azúcar*, 1985, **80,** (8), 21 - 25.

A survey is presented of the literature (with 45 references) on the uses of high-performance liquid chromatography in the sugar industry and for by-products analysis.

Formation of pyrrolidines and piperidines on heating L-proline with reducing sugars

R. Tressl, D. Rewicki, B. Helak and H. Kemperschröer. *J. Agric. Food Chem.*, 1985, **33,** 924 - 928.

Among the reactions of amino-acids with reducing sugars, L-proline plays an outstanding role; more than 120 proline specific compounds are formed depending on the reducing sugars and the reaction conditions. A series of model experiments are reported in which equimolar quantities of L-proline and reducing sugars were heated at 150°C and pH 5 - 6 and an equimolar mixture of pyrrolidine and D-glucose at 100°C, both for $1^1/_2$ hours. Quantitative analysis was made of 19 pyrrolidines and four piperidines by capillary gas chromatography-mass spectrometry using a nitrogen selective detector; the mass spectral data and graphic formulae of 17 of them are presented. Individual components were isolated by preparative GC and investigated by mass spectrometry, infra-red spectrometry and ^{1}H nuclear magnetic resonance spectrometry. 3-(1-pyrrolidinyl)-2-butanone, 1-furfuryl pyrrolidine, 2-acetyl-3-(1-pyrrolidinyl)furan, 3-(1-pyrrolidinyl)-tetrahydro-2-furanone, 2-hydroxy-1-(1-pyrrolidinyl)-1-buten-3-one, 2-acetyl, 2-propionyl-, 2-(2-furyl)- and 2-(5-methyl-2-furyl)piperidine were identified for the first time as proline specific Maillard products.

Carbohydrate analysis

T. Pangarova. *Khim. i Ind.*, (Bulgaria), 1985, **57,** (1), 36 - 39; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (20), Abs. 20 R448.

Methods of carbohydrate analysis are surveyed, including the advantages and disadvantages of GLC, HPLC and TLC. Reactions applicable to carbohydrate analysis are classified.

Colloid determination in beet sugar products as a function of solution pH

V. A. Loseva and R. P. Lisitskaya. *Rpt. Voronezh Technol. Inst.*, 1985, 8 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (20), Abs. 20 R450.

Optimum conditions for coagulation of colloidal matter were determined in raw and purified juice, syrup and molasses. It was found that the maximum colloid content in raw juice occurs at pH_{20} 5 - 5.2. In raw juice, 2nd carbonatation juice, syrup and molasses, the colloid content as determined by acidifying to pH_{20} 5 was 15 - 40% higher than at pH_{20} 4.

By-products

Technology, quality and uses of alcohol produced in Brazil

D. G. Quast, J. M. M. Borges and M. Sobral. *Sugar J.*, 1985, **48,** (2), 13 - 15.

See *I.S.J.*, 1985, **87,** 29A.

Fungal growth inside pressed pulp silage

G. Pahlow. *Die Zuckerrübe*, 1985, **34,** 210 -211 (*German*).

The occurrence of *Penicillium roqueforti* inside beet pulp silage stacks is discussed. Formation of the fungus, which in maize silage has been found to produce at least four mycotoxins that can have harmful effects on animals, can be prevented by cutting the time between the production of the pulp in the factory and finishing of the clamp, ensuring that the silage is air-tight (the fungus relies on oxygen for its growth) and clamped at a sufficiently high temperature (e.g. 45°C) (the fungus forms at <37°C); if the temperature falls below the requisite level, as during long-distance transportation from the factory, sorbic acid and phosphoric acids should be added.

Pressed pulp, a valuable basic feed

Anon. *Die Zuckerrübe*, 1985, **34,** 212 - 213 (*German*).

The feed value of beet pulp silage for dairy and fattening cattle is compared with that of other forms of pulp, beet leaves, beet leaf silage and other fodders; its advantages as a fodder are also indicated. Daily requirements of pulp in rations are discussed, and advice is given on ensilage.

The utilization of copper sulphate in growing-fattening pigs fed final molasses diets

M. Castro, A. Garrido and M. Iglesia. *Cuban J. Agric. Sci.*, 1985, **19,** 29 - 33.

Where final molasses replaces cereal in pig feed, there is need for protein supplementation, but high levels of torula yeast produce a sulphur amino-acid deficiency; however, synthetic methionine has been found to satisfy the requirements of this essential amino-acid. On the other hand, trials in which 125 and 250 ppm copper sulphate was added to final molasses diets showed that 125 ppm was sufficient to give an increase in daily live weight gain without methionine.

Large intestine digestion of pigs fed molasses. II. Passage of digesta. III. Water status

J. Ly. *Cuban J. Agric. Sci.*, 1985, **19,** 35 - 44, 45 - 53.

II. By comparison with maize and high-test molasses (representing 89% and 80% of the dry matter in pig rations, respectively), final molasses at 82.3% caused a lower content of fresh digesta, a reduction in the digesta retention time, a higher water:dry matter ratio in the digesta, and a higher rate of digesta passage in the caecum and large intestine, resulting in excessive faecal liquid. High-test molasses was superior to maize in respect of all the parameters studied.
III. Results for the three types of ration showed that highest daily water adsorption in the large intestine occurred when high-test molasses was fed to the pigs, while it was lowest with final molasses, resulting in a high faecal liquid content.

Process development unit for bagasse hydrolysis and fermentation

Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1984/85, 12 - 13.

A project forming part of a national program coordinated and largely funded by the CSIRO is described which aims to develop an enzymatic process for bagasse hydrolysis. Stages in the process are: acid prehydrolysis of the hemicellulose to give soluble sugars, mainly xylose; fermentation of the xylose to ethanol using newly selected strains of yeast; washing of the prehydrolysed bagasse followed by dewatering to provide maximum recovery and recycle of the xylose and acid; grinding the residual bagasse in a stirred bead mill to increase its susceptibility to enzymatic hydrolysis; enzymatic hydrolysis of the residual cellulose; alcoholic fermentation of the hydrolysate; and recovery of the lignin-rich residue for use as boiler fuel. A pre-hydrolysis reactor capable of treating 6 kg (dry) batches of bagasse with dilute acid at 92 - 95°C has been constructed and operated to yield 180 mg of xylose per g of bagasse at an acid consumption of approx. 4% on dry bagasse; depithed bagasse generally consumed less acid than whole bagasse, presumably because of its lower ash content. A derelict miniature cane mill fitted with two rubberized rollers reduced the moisture content of the prehydrolysed bagasse to 65%. A specially designed attritor mill having a 35-litre grinding chamber successfully discharged a slurry of 15% solids content, compared with only 8% maximum from a batch mill used previously. Injection of NaOH into the base of the mill and cellulase near the top permitted simultaneous milling of the slurry, adjustment of its pH and mixing-in of the enzyme for subsequent saccharification. Heat generated during milling raised the slurry temperature to approx. 50°C, which was optimum for the enzyme. Studies have shown that polyethyleneglycol of high molecular weight is as effective as polyvinylpyrrolidone in increasing enzyme efficiency during bagasse saccharification, but neither was effective when the substrate was pure cellulose, suggesting that the action of both chemicals was a result of their reaction with impurities that would otherwise have reacted with the enzyme and reduced its efficiency; however, increasing the enzyme loading to about 20 IU per g of bagasse (53% cellulose) greatly reduced the beneficial effect of the chemicals. Enzymatic conversion of cellulose fell appreciably with increase in bagasse slurry concentration (e.g. from approx. 78 to 61% after 24 hr and from approx. 96 to 85% after 72 hr with increase in the initial solids concentration from approx. 7 to 14%) at identical enzyme:substrate loadings. This adverse effect underlines the need to develop a saccharification system in which the end-product is removed simultaneously.

Effect of biotin activity in molasses on yield and

biological activity of bakers' yeasts

G. Sobkowicz, E. Pabi´s and D. Rosól. *Zesz. Nauk. AR Wroclawiu, Technol. Zywn.*, 1984, (3), 75 - 82; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (18), Abs. 18 R375.

The biotin content was determined in six samples of molasses and the yield and biological activity of two strains of yeast cultured on the molasses were investigated. It was found that increase in the biotin content in the molasses raised the yeast yield by 5 - 15% and the biological activity by 9 - 37%.

Trichoderma protein production from cane trash, bagasse and pith

J. L. Movillon, C. S. Abrigo and R. L. Samaniego. *Crystallizer*, 1985, **8,** (2), 17.

Results of laboratory experiments showed that a protein-containing fungal mass in a 10 - 30% yield on substrate was obtained by culturing *T. viride* on a mixture of bagasse, pith and cane trash, using a modified Mandel's growth medium. The crude protein content increased in the range 36 - 45% with incubation time (7 - 14 days), proportion of cellulose (10, 20 and 30%) in the mixture, and volume of air. At pH 4.2 - 5.0 there was no significant variation in protein yield. Feeding experiments with rats showed that, although 20% of the product sustained growth and had an apparent digestibility as high as a number of other protein diets (including skim milk on its own or mixed with the *Trichoderma* protein), it had a lower protein efficiency ratio than the other feeds, possibly caused by S-containing amino-acids.

Some consideration on the partial hydrolysis of cellulose from the prehydrolysis-sulphate pulp of sugar cane bagasse

B. García, R. Quintana P. and S. Askienasi. *ATAC*, 1984, (4), 46 - 51 (*Spanish*).

The dissolving pulp from bagasse was reacted with mixture of HCl and ethanol to effect a hydrolysis and conversion to microcrystalline cellulose. The conditions of temperature, HCl and ethanol concentrations, and time were varied and the products were examined for degree of crystallinity and brilliance by comparison with a standard microcrystalline cellulose imported from Ireland. None of the samples obtained matched the brilliance of the standard although two were very close, and the degree of microcrystallinity was greater in two samples than the standard. It is considered practical to produce high quality microcrystalline cellulose on an industrial scale by the method.

Feeding sugar beet tops

M. Nuttall. *British Sugar Beet Rev.*, 1985, **53,** (3), 4 - 5.

Despite the potential value of beet tops as animal fodder, it is pointed out that during 1975/84 there was a rise from 74% to 82% in the amount of tops ploughed in. Average yield is 40 tonnes of tops per ha in the early part of the campaign. Most of the tops used as fodder are fed *in situ*, the rest either being transported to yarded cattle and rationed rather than fed *ab libitum*, or ensiled. A typical analysis is given of beet tops, and various aspects of their use as fodder are discussed.

Trident Feeds one year on - some case studies

J. Harland. *British Sugar Beet Rev.*, 1985, **53,** (3), 32 - 34.

Three case studies are presented involving molassed beet shreds or pulp (sold under the Trident Feeds brand name) used as fodder for sheep and cattle.

Drying trials and protein enrichment by microbial growth on cane and beet molasses distillery stillage

D. Matteuzzi, M. Dalla Rosa, P. Brigidi *et al. Appl. Microbiology and Biotechnol.*, 1985, **21,** (3/4), 187 - 188; through *S.I.A.*, 1985, **47,** Abs. 85-1297.

In spray-drying trials with a Niro Atomizer, cane vinasse of 15 - 45% dry solids content could be dried to a power with a yield >80%. Beet vinasse could not be dried successfully unless 2% carrageenan or 5% maltodextrin was added to vinasse containing 15% dry solids. Mixed cultivation of *Candida utilis* + *Brevibacterium flavum* increased the crude protein content of beet vinasse from 33% to about 50% on dry solids.

Pulping of bagasse under atmospheric pressure

M. A. Abou-State, F. F. Abd El-Megeid and M. El-Masry. *Zellstoff und Papier*, 1984, **33,** (3), 88 - 89; through *S.I.A.*, 1985, **47,** Abs. 85-1330.

Results of tests in which bagasse was pulped under various conditions are tabulated. Pulping under atmospheric pressure instead of high pressure gave higher yield, a higher degree of delignification, a lower kappa number and a lower bleach consumption. Of different liquor ratios (7:1, 10:1, 12:1) tested at atmospheric pressure, 12:1 gave the highest yield, but 10:1 was preferred; it gave the lowest content of insufficiently cooked fragments. A decrease in alkalinity, from 13 to 10% total Na, had some beneficial and some adverse effects.

Utilization of waste from molasses alcohol distilleries in the manufacture of fibrous gypsum goods

E. A. Kuvaev, A. G. Zabrodskii and A. N. Osovik. *Ferment. i Spirt. Prom.*, 1985, (3), 8 - 11; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (19), Abs. 19 R373.

The possibilities of using the waste from molasses alcohol distilleries as retarder for the setting of extrusion products of fibrous gypsum are indicated. The effect of the waste on properties of gypsum binder and compositions based on it is investigated, and recommendations are given on the ways of increasing the retarding efficiency of the additives. Technico-economic factors of distillery waste utilization are presented.

Patents

UNITED STATES

Alcoholic fermentation

W. C. Muller and F. D. Miller, *assrs.* National Distillers & Chemical Corp. **4,336,335**. May 22, 1980; June 22, 1982.

Ethanol is manufactured by fermentation, with a suitable medium, of an aqueous solution of sugar, e.g. glucose, fructose, maltose, sucrose or a mixture of these containing 10 - 40% sugar by weight (15 - 25%), with a simultaneous passage of heated CO_2 gas through at least some of the medium to vaporize and carry off the ethanol and reduce the temperature of the medium to a level conducive to maximum production. The CO_2 and ethanol are then separated by scrubbing.

Immobilization of starch-degrading enzymes

M. Yoneyama, of Souja, Japan, *assr.* Hayashibara Seibutsu K.K. **4,338,398**. March 13, 1980; July 6, 1982.

Starch degrading enzymes such as α- and β-amylase, glucoamylase and isoamylase are immobilized by modification or cross-linkage with a mono-, bi- or poly-functional reagent, e.g. monoaldehyde or di-isocyanate compounds, cyanuric chloride, dialdehyde starch or dialdehyde pullulan, in a manner that does not substantially insolubilize the enzymes, followed by physical adsorption on a water-insoluble carrier. The resultant enzymes have high activity and the carrier can be easily recovered for repeated use. *Aspergillus* glucoamylase immobilized in this way is suitable for production of a glucose syrup or a syrup of high sugar content.

Fructose separation from glucose

R. W. Neuzil and J. W. Priegnitz, *assrs.* UOP Inc. **4,340,724**. March 27, 1978; July 20, 1982.

Fructose is separated from glucose by adsorption at 20 - 200°C and a pressure between atmospheric and 500 psig on a cation exchange resin in ammonium, sodium, potassium, calcium, strontium or barium form.

Glucose isomerase immobilization

S. Ushiro, of Kokubunji, Japan, *assr.* CPC International Inc. **4,343,902**. December 19, 1980; August 10, 1982.

Glucose isomerase is immobilized by treating an aqueous suspension of cells of a glucose isomerase-producing micro-organism such as *Streptomyces olivochromogenes*, *Lactobacillus brevis* or *Bacillus coagulans* with a non-ionic surfactant (Triton or Tween) which solubilizes the isomerase in the cells but not the polysaccharides. The cells are then separated from the suspension and the isomerase adsorbed on an ion exchange resin.

Clarification of glucose syrups

J. T. Rundell, P. R. Pottage and R. J. Harradine, *assrs.* Tate & Lyle Ltd. **4,345,947**. April 28, 1981; August 24, 1982.

Hydrolysed corn or other starch is clarified by a process involving formation of a primary floc between aluminium hydroxide and phosphate ions at pH 3.5 - 6.5, aeration of the syrup and distribution through it of an anionic organic polymeric flocculant to initiate formation of a secondary floc which is allowed to grow. The floc is segregated by flotation and separated from the syrup.

Alcoholic fermentation

U. Faust, P. Präve, B. Dorsemagen and N. Hofer, *assrs.* Uhde GmbH. **4,346,113**. September 18, 1980; August 24, 1982.

A slurry made up of molasses plus nutrients is continuously processed aerobically to yield a yeast biomass at essentially the same time as fermentation to alcohol takes place. The yeast cells consume oxygen in such a way that the fermentation is undisturbed; although the oxygen supply is very limited (a surplus of no more than 1 ppm), so that anaerobic conditions also prevail within the cells, continuous feeding of fresh slurry ensures that enough slurry is always available. The portion of the wort remaining after separation of the alcohol-bearing medium is recycled to the fermenting mixture through which the air is dispersed. The measurable free sugar concentration does not exceed 0.1% by weight, while the active yeast concentration is maintained at 100 - 110% of the specific degree of fermentation. Suitable starting yeasts are *Saccharomyces cerevisiae* and *S. uvarum*.

Newsprint pulp from bagasse

E. J. Villavicencio, of Mexico City, Mexico, *assr.* W. R. Grace & Co. **4,347,101**. November 24, 1980; August 31, 1982.

A high-quality newsprint pulp is produced from depithed, washed bagasse by dividing the latter into two portions, one of which is treated thermochemically and the other thermomechanically. Each process takes place in a two-stage digester; the fibre in the former process is refined between the two stages, but not the thermo-mechanically treated fibre. After digestion, both lots of bagasse undergo separate hot refining, washing and screening; the thermomechanical pulp is also subjected to disc refining before washing, while the thermochemical pulp is bleached after washing and screening. The two pulps are then combined to give a high-grade pulp of 55 - 60 GE brightness, 93 - 96% opacity and a relatively high tear strength; alternatively, only the thermomechanical pulp may be used to provide a lower-grade product.

Glucose isomerase preparation

C. M. Brownewell, of Elkhart, IN, USA, *assr.* Miles Laboratories Inc. **4,348,480**. June 4, 1980; September 7, 1982.

Glucose isomerase is prepared by aerobic cultivation of *Bacillus licheniformis* ATCC 31604 on a medium containing appropriate quantities of suitable nutrients, e.g. agar-agar, xylose, corn steep liquor, yeast extract, ammonium sulphate, K_2HPO_4, magnesium sulphate and manganese sulphate.

Appendix II

Table XIV. Comparison analyses with other methods (in mg/kg)

Ion	Sample type	Method type					
		IC	ICP	Flame photometer	Ion-selective electrode	$AgNO_3$ titration	AAS
Cl^-	*C*-massecuite	21,990	-	-	(1) 24,420 (2) 22,250	22,090	-
	A-molasses	19,200	-	-	(1) 21,450 (2) 20,260	19,700	-
Na^+	*C*-molasses	1,140	-	1,330	-	-	-
	A-molasses	1,290	-	1,520	-	-	-
K^+	*C*-molasses	27,700	-	27,840	-	-	-
	A-molasses	29,420	-	29,460	-	-	-
Ca^{++}	*C*-molasses	7,290	7,290	-	-	-	6,640
	A-molasses	6,760	5,520	-	-	-	5,310
Mg^{++}	*C*-molasses	6,170	6,090	-	-	-	6,120
	A-molasses	3,480	3,210	-	-	-	3,520

IC = Ion chromatography
ICP = Inductive coupled plasma
AAS = Atomic Absorption spectrophotometer

MATERIALS MANAGEMENT

A short cut in white sugar transport[1]

By Andrew Gowers

The E. D. and F. Man group and Thomas Nationwide Transport, respectively among the world's biggest sugar trading and transportation groups, have just spent about $17m (£10.9m) buying and converting an old merchant ship for the bulk shipment of white sugar.

With a large volume of shipping capacity laid up around the globe, freight rates plumbing ever-increasing depths and commodity prices struggling to emerge from their worst depression in decades, it hardly looks the most fashionable of investments.

Yet both companies, which have formed a Singapore-based joint venture to run the ship, newly named the CHL Innovator, are making bold claims for its powers and its potential profitability.

"We believe that the next generation of traders and shippers will not be able to contemplate life without this unique trading and transportation tool," said Mr. Peter Allsebrook, chairman of TNT (UK), the British arm of the Australian-based group, as the Innovator was relaunched on April 25.

"We are certain that (this) is a major step forward for the sugar trade," added Mr. Michael Stone, chairman of Man, which has been trading in sugar from London for more than 200 years and now handles between 4 million and 6 million tonnes of sugar a year, one third of it in the form of white sugar.

Their excitement is explained by what they claim is a key technological advance: the ship's ability to load white sugar in bulk and discharge it in bags, known as the "Bulk-In, Bags-Out" (B/I/B/O) concept.

1 *Financial Times*, April 28, 1986.

A short cut in white sugar transport

This may be the solution to a set of problems that have plagued the sugar trade for years, and could eventually lead to efficiency gains in the handling of other commodities.

Sugar shipping cost—including demurrage and stevedoring charges—have been kept on the high side by the excessive time it normally takes to pack sugar at the port and load it in bags. The bags themselves have tended to suffer damage in transit, leading to heavy insurance costs.

Other companies—Tate & Lyle, for one, before its interest in exporting substantial amounts from the UK waned in the 1970's—have searched for a way around this obstacles for years.

"Sugar importers in North Africa and the Middle East have been taken to the cleaners for years because of the high freight costs and losses in transit," said Mr. Stone.

But, with the newly-converted vessel, bought from Lyle Shipping of the UK for $5.5m and able to carry about 18,000 tonnes of white sugar, loading time will be cut to a matter of days rather than weeks. It will be able to bag sugar in its air-conditioned hold and unload its entire cargo in six days, compared with the duration of around four weeks that is customary for normal ships of its size.

TNT already has some experience in running specialist bulk carriers for items such as alumina. It sees such ventures as an important way of adding value to bulk handling operations, which have been a distinctly unprofitable business of late.

For Man, which provided TNT's entree into the somewhat exclusive world of sugar, the venture is a trading and cost-cutting tool. To maximize the loading and unloading efficiency gains, it will be keeping its voyages short—mainly to countries in North Africa and the Middle East.

Mr. Yves Bonavero, head of Man (Sugar), says the ship looked a profitable venture when it was first mooted three years ago, and still looks profitable now, in spite of the subsequent collapse in general freight rates and bunker fuel costs which have made conventional bulk carriers more competitive—and even though it is strictly a one-way carrier. He says it should pay for itself in about 10 years.

But it is also a stepping-stone for the company's broader ambitions.

Man, faced like other commodity businesses with a slump in earnings from traditional trading operations, is in pursuit of vertical integrations, of ownership of all links of the commodity producing and handling chain.

It already owns sizeable coffee plantations in Brazil, for example; it is keen to make further investments in bulk sugar handling, and it is talking to at least one key North African importer about building a port terminal for sugar. The absence of such facilities in many of the ports that the Innovator will be visiting is a a significant weakness of the project so far.

PROCESSING

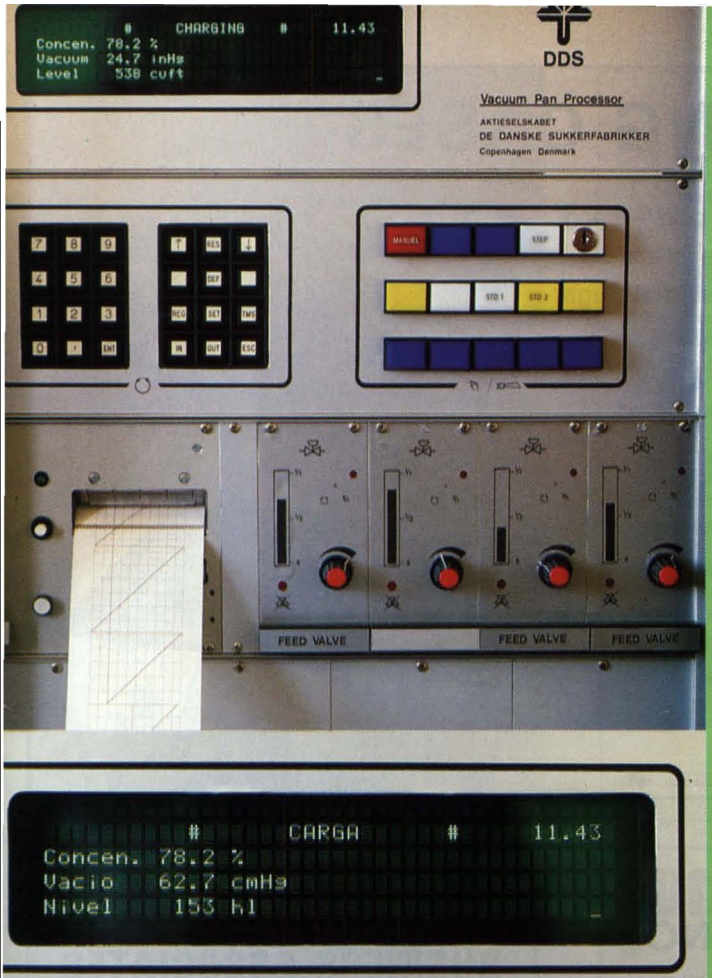
Sugar Industry Technologists Inc. 1986 Meeting

The 45th Annual Meeting of Sugar Industry Technologists took place during May 18 - 21 in the city of Baltimore, Maryland, U.S.A. where the hosts were Amstar Corporation. Some 200 members gathered at the Hyatt Regency Hotel where the first function was a reception on the Sunday evening during which they became reacquainted and could discuss the program which had been provided by the Excutive Director, Stuart Patterson.

The first Technical Session began the following morning, with a welcome from the President, Ted Stephenson, after which Nils Hindefelt of Sweden presented his paper (with Kaj Lilja) on a full-scale comparison of acrylic and styrene resins for sugar liquor decolorization. This was followed by an account by Jean-Paul Merle on fluid bed drying of bone char at C & H Sugar, his fellow authors being Lyle Zemanek and Leon Bates.

The third paper was by Dr. Victor R. Deitz and discussed the air oxidation to ignition of the two components in Canesorb carbon/bone char mixture. After coffee, Dr. Dieter Frank described a new decolorization process devised by himself and his colleagues of Akzo Chemie America, while Christian Laur of Beghin-Say read, on behalf of the author, Guy Gaudfrin's paper on sugar refinery filtration and clarification of carbonatation syrups.

After lunch Leon A. Anhaiser of Imperial Sugar Company presided over a symposium on "Fine tuning a refinery" to which contributions were made by Larry Faucheux of Colonial Sugars Inc. on "Energy", Donald E. Webster of BC Sugar on "Sucrose", Christian Laur of Beghin-Say on "Personnel" and Jeffrey C.



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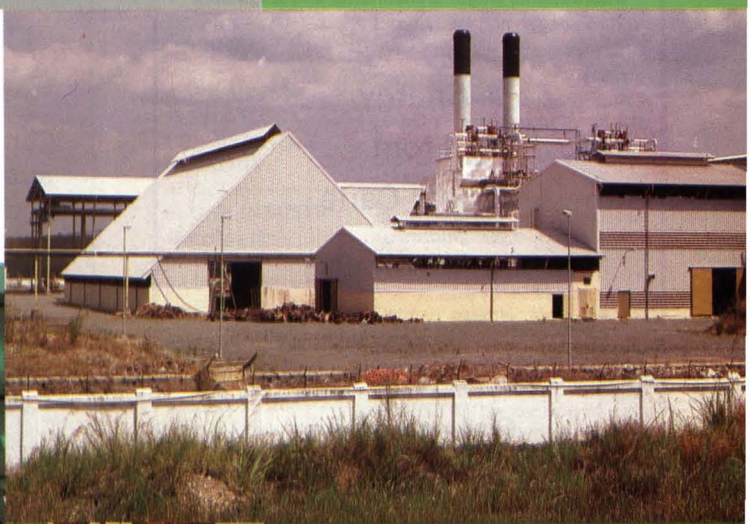

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Robinson of Amstar Corporation on "Maintenance". There followed a question and answer period in which the audience and contributors discussed matters arising from the individual presentations.

In the next morning's technical session, J. B. Wheatley and W. F. Barton described good manufacturing practices for a refinery in a paper written in collaboration with their Lantic Sugar Ltd. colleagues D. R. Bishop and J. R. Kerr. Following this, Denis S. Martin of Tate & Lyle Ltd. presented his paper, written with Malcolm L. Burge, entitled "Product quality: the persistent taskmaster".

The next paper, presented by Alan James of SKIL, was a collaborative study made with Margaret A. Clarke and Rebeca S. Blanco of SPRI and was concerned with the recycling of non-sugars in sugar refineries while, subsequently, Dr. Clarke presented a paper, written with her colleagues Earl J. Roberts, Thanh B. T. To and W. S. Charles Tsang, as an update on dextrans and dextran analysis.

The last paper of the morning was a description, given by Richard Baker of Amstar Corporation, on liquor evaporation in a new, large, single-effect falling-film evaporator at the Baltimore refinery, after which a short account was given of preparations for the 19th ISSCT Congress in Jakarta and an invitation made to SIT members to attend.

After lunch, Thomas N. Pearson of Imperial Sugars presented a paper by himself and Brian Harrison on first liquor evaporation using mechanical recompression as practised at their refinery, folowing which Leif Ramm-Schmidt described the up-grading of batch centrifugal automatic controls at the Finnish Sugar Company's Porkkala refinery in a paper with Ari Rintala. The final paper of the meeting was by Bruce M. Munro of CSR Limited and was a survey of the Australian sugar industry, intended as a foretaste of what SIT members would be able to see at the 1987 meeting, scheduled for May 11 - 14, in Sydney, Australia, and to be preceded by preliminary tour of the Queensland cane belt.

After a number of closing remarks and announcements, the session was wound up by Ted Stephenson,who later presided and provided a welcome address to members at the Awards Banquet. A keynote speech on the present state of the US sugar industry was made by William Buschman, Executive Vice President and General Manager of the American Sugar Division of Amstar Corporation. David M. Humm, Chairman of the Meade Award Committee then presented the Award, for the best paper presented to the 1985 Meeting, to Dietrich Bosse of BMA, Germany, following which Ted Stephenson presented the SIT Crystal Awards for achievements in sugar technology to Donald K. Luke, formerly of Suchar Engineering & Sales Co. and subsequently editor of Sugar y Azúcar, and to Neil S. Pennington, formerly with the Bone Char Research Project and later with C & H Sugar's Crockett refinery of which he became Manager.

The last formal act was the passing of the gavel from Mr. Stephenson to the new President, David Humm, after which Bruce Munro spoke on the 1987 meeting in Australia, and asked for indications of the numbers of members intending to participate so that preparations could be made more accurately.

On the following morning, members were taken by bus from the hotel to the Amstar refinery where they were welcomed by Frank Stowe, the Manager, and conducted through the plant which included an impressive new packaging line for 5-lb bags of granulated sugar and the new evaporator described during the meeting. A luncheon was then offered at a local restaurant by Amstar Corporation for the members before their departure.

FACTORY ENGINEERING

Hydrocyclone separation of mixed juice suspended solids

By Sung-Cien Chiang
(Shi-Tow Sugar Cane Chemical Complex, Guangdong, China)

The suspended solids in mixed juice are mainly from the sugar cane received from the field in the form of sand and silt, trash and humus, etc. and also pith, small fibres and cells from the cane preparation and milling. Sand and slit are abrasive and may cause damage to pumps and tubes. The organic matter during chemical treatment (defecation, sulphitation and carbonatation), may be partially degraded or hydrolysed, increasing the ash and colloids content which will have unfavourable effects on clarification such as lowering the settling rate, giving bad filtering and causing higher loss in cake. Moreover, the fine bagacillo could remain in the juice during clarification and evaporation and could enter the product white sugar.

The quantity of suspended solids in mixed juice in areas of hand cutting such

as in China is usually about 0.4 - 0.8%, but with mechanical harvesting will rise to as high as 10% in juice; in Hawaii, even after cane-cleaning operations, mixed juices may conatain an average of 2 - 4%, and in wet weather 6 - 7% is not uncommon. In the south China cane area the fibre in cane is low and brittle and after cutting, shredding and milling gives more bagacillo (include ruptured cell membrane and hemicellulose) and polysaccharide colloids in mixed juice. Even though the content is low it is sufficient to worsen the clarification and to reduce recovery and quality. The standard mixed juice cleaning system in our factories uses DSM screens with a bar clearance of 0.8 mm; this removes the larger materials but the smaller solids must be eliminated in another way. The DorrClone is one type of hydrocyclone which has been commercially used for this purpose as described by Meade & Chen[1] and Baikow[2]. A 305 mm DorrClone operated at approximately 1 atm. inlet pressure producing 39 mm separation can process mixed juice at a rate of about 37.5 m^3/hr.

The size of hydrocyclone required for a given application is dictated by the particle size required to be separated. Hydrocyclones of smaller diameter are capable of making finer separation, because of the higher centrifugal forces developed[3]. The Bauer 600 EX hydrocyclone is smaller than the DorrClone; it is currently used for separation of coarse fibre in stock preparation, and has been very widely applied in Chinese pulp and paper mills since the early 1960's. As the conditions for separation of pulp stock and mixed juice are very similar both in fibre forms and consistencies, we decided to test reduction of the suspended solids in mixed juice by use of the Bauer 600 EX. The preliminary tests were performed in the laboratory in the off season using a synthetic "mixed juice" made with brown sugar and bagacillo screened from stock bagasse; thereafter a hydrocyclone battery was installed in a mixed juice by-pass line for plant tests in parallel in the following milling campaign. The plant tests took place in two parts, using one-stage and two-stage separation. Data were collected from daily production reports and special tests carried out in the laboratory.

Test methods

Tests were made on a commercial scale. The installed capacity of the hydrocyclone battery was coordinated to the capacity of the milling train. The main technical and balancing data were taken from the factory's daily laboratory report, but a series of specific analyses were made in the laboratory as described below:

(1) *Total suspended matter*: Evenly stirred mixed juice samples were poured into 10 ml centrifuge separating tubes (dried to constant weight and cooled to ambient temperature) and were then weighed. After treatment in the laboratory centrifugal at 3000 rpm for 15 min. the upper clear juice was decanted, distilled water added and the mixture stirred well with a stainless steel rod (2 mm dia.). It was centrifuged as before, and this procedure repeated until clear washings were obtained (generally washing twice was enough). The tube and solids were then oven-dried to constant weight at 105°C, weighed and the solids % mixed juice calculated. The decantate was collected to determine the EtOH-insoluble colloids, as described below:

(2) *EtOH-insoluble colloids % mixed juice*: When alcohol is added to a solution which contains polysaccharides such as dextran, dissolved starch etc. and protein colloid, a haze may be formed. If heated to 50 - 60°C this will coagulated as a floc and sediment. This weight of the sediment may be expressed as the dissolved EtOH-insoluble colloids in juice. 5 ml of the decantate from analysis (1) is pipetted into a 10 ml centrifuge separating tube, 5 ml of absolute ethanol added and mixed well by stirring. It is then heated to 65°C and kept 5 minutes to flocculate, after which it is centrifuged. After decanting, the residue is washed twice with 5 ml absolute alcohol and dried at 85°C to constant weight.

(3) *Bagacillo % mixed juice*: 500 ml of well-mixed juice sample is filtered through 100-mesh plastic screen, washed with tap water until the washings are colourless, and oven-dried to constant weight at 105°C.

Raw and cleaned mixed juice samples were taken continuously and collected at 4-hour intervals for analysis while the tail juice from the hydrocyclone was sampled from a 15-min batch and collected also at 4-hr intervals. All samples were preserved by addition of 0.5 ml formalin per litre.

Apparatus and installations

The specifications and installation of the Bauer 600 EX hydrocyclone are shown in Figure 1. The flow rates relative to the inlet pressure in a blank test with fresh water and in polishing the crude pulp (0.5 - 0.6% consistency) in a pulp plant are shown in Fig. 2.

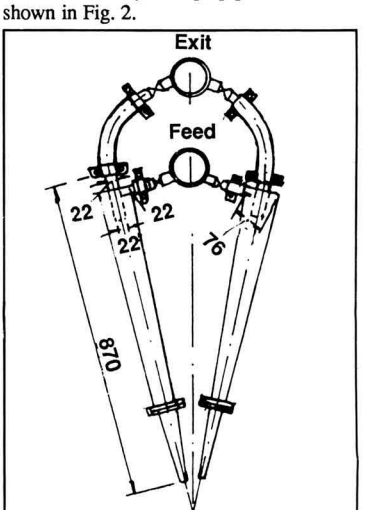

Fig. 1. Bauer 600 EX hydrocyclone, of 5 mm nozzle diameter

The plant tests took place in two steps: single-stage and subsequently 2-stage separation. The installation and flow sheets are shown respectively in Figures 3 and 4. A continuous commercial scale test of single-stage separation with tail juice recycled to the raw mixed juice tank took

1 "Cane sugar handbook", 10th Edn. (Wiley, New York), 1977, pp. 111.
2 "Manufacture and refining of raw sugar" 2nd Edn. (Elsevier, Amsterdam), 1982, pp. 44 - 45.
3 Bloor & Ingham: *Filtration & separation*, 1984, **21**, (4), 266 - 269.

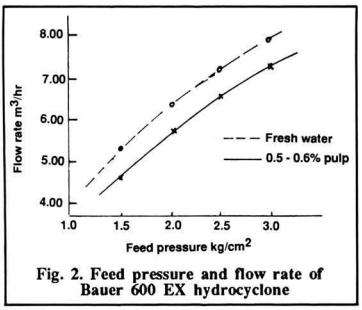

Fig. 2. Feed pressure and flow rate of Bauer 600 EX hydrocyclone

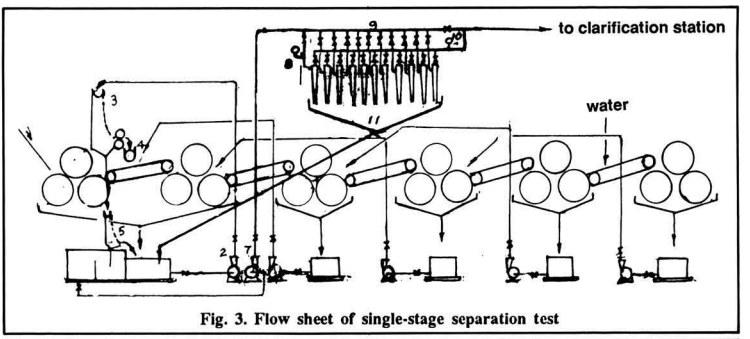

Fig. 3. Flow sheet of single-stage separation test

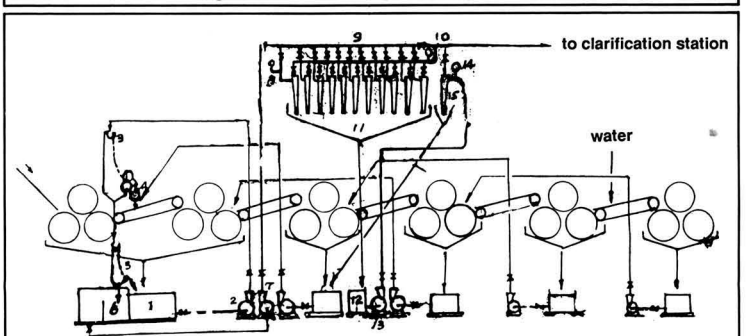

Fig. 4. Flow sheet of two-stage separation test 1. Raw mixed juice tank. 2. Raw mixed juice pump. 3. DSM screen. 4. Screw conveyer 5. DSM screen. 6. Mixed juice tank. 7. Mixed juice pump. 8. Inlet pressure gauge. 9. Bauer 600 EX assembly (22 sets). 10. Exit pressure gauge. 11. Tail juice pan. 12. Tail juice tank. 13. Tail juice pump. 14. Inlet pressure gauge. 15. 2nd stage Bauer 600 EX assembly (2 sets)

place over 136 hours during which 13,142.39 tonnes of cane were milled, the average daily milling capacity being 2319.21 t.c.d. which was higher than the monthly average. From the 15 -day factory report we could observe the following facts:

(1) The dry filter cake % cane (w/w) as well as the filter cake sugar loss are reduced (see Table I). The factory report data shows that filtration in the test period was clearly improved as compared to the blank period.

(2) The clarity of both the clarified juice and filtrate are improved, the latter being the better (Table II).

(3) The sugar loss in molasses is lowered; even though the gravimetric purity is raised a little since the quantity is reduced as shown in Table III.

(4) The quality of sugar is also likely to be improved as shown in Table IV. Especially, the suspended solids are lowered by as much as 16.6%, as compared with the blank.

(5) The total suspended solids, bagacillo and polysaccharides removal during separation are shown in Table V.

(6) Capacity and power consumption: the average feed pressure is 2.25 kg/cm², below the optimum 3.5 kg/cm² for maximum flow rate, minimum tail flow and good removal. Owing to the fact that the mixed juice tank was of insufficient volume for smoothing the

Table I. Dry filter cake % cane and sugar loss in filter cake % sugar in cane

	Before (1)	In test (2)	After (3)	Total blank (1) + (3)	Test % blank (1) + (3) - (2) / (1) + (3)
	Feb. 1-4	Feb. 5-10	Feb. 11-16		
Cane milled, tonnes	8,338.7	13,939.3	11,595.5	19,932.2	-
Dry filter, cake % cane	1.16	1.11	1.16	Ave 1.16	-4.31
Sugar in cake, % sugar in cane	0.696	0.575	0.795	Ave 0.755	-23.2

Table II. The clarity of clarified juice and filtrate (mm)

Items	Before and after (blank)	In test	Compared with blank
Clarified juice	179.16	188.8	+5.3%
Filtrate	95.49	121.06	+26.7%

Table III. Reduction of sugar loss in molasses

	Before Feb. 1-4	In test Feb. 5-10	After Feb. 11-16	Before and after average	Change compared with blank (+ or -)
GP	33.18	34.01	33.39	33.31	+2.1%
Sugar loss % sugar in cane	5.46	4.94	5.31	5.37	-8.0%
Molasses % Cane	2.53	2.06	2.28	2.38	-13.44%

Table IV. Comparison of sugar quality

	Pol	Moisture, %	Invert, sugar, %	Colour, ICUMSA units*	Suspended solids mg/kg	Ash, %
Before test (Feb. 1-4)	99.75	0.0385	0.032	100	18.63	0.082
After test (Feb. 11-16)	99.77	0.0358	0.0334	104.8	14.02	0.090
In test (Feb. 5-10)	99.79	0.0382	0.0303	103.5	13.40	0.089
Total blank	99.77	0.0370	0.0327	101.9	16.06	0.086

* We use Stammer as the unit of colour value, the conversion being 1 Stammer unit = 80 ICUMSA units

Table V

	Date / Sample	Feb. 5	Feb. 6	Feb. 7	Feb. 8	Feb. 9	Feb. 10	Average
Total suspended solids, %	Feed	0.825	0.800	0.769	0.805	0.792	0.815	0.806
	Exit	0.716	0.696	0.695	0.685	0.670	0.710	0.690
	Tail	1.85	1.790	1.800	1.870	1.850	1.860	1.840
Tail % feed, w/w		9.68	9.61	10.13	9.73	9.13	10.38	9.82
Removal, %		21.55	22.17	22.90	22.60	21.33	23.69	22.42
Bagacillo, %	Feed	0.32	0.32	0.38	0.34	0.34	0.36	0.343
	Exit	0.24	0.24	0.28	0.26	0.24	0.26	0.253
	Tail	1.17	1.05	1.27	1.08	1.34	1.22	1.169
Removal, %		35.13	32.52	33.86	30.90	35.98	35.17	33.49
Colloidal poly-saccharides	Feed	0.292	0.250	0.196	0.180	0.190	0.248	0.226
	Exit	0.278	0.220	0.175	0.165	0.179	0.240	0.207
	Tail	0.423	0.522	0.382	0.319	0.300	0.317	0.400
Removal, %		13.92	20.69	19.68	17.14	14.42	13.26	17.38

Table VI. Mill extraction and other related data

Period	Average milling rate, t.c.d.	Mill extraction, %	Imbibition water % cane	Bagasse Fibre, %	Bagasse Pol	Cane Fibre, %	Cane Pol
Test	2323.21	97.58	17.75	47.35	1.56	10.93	14.03
Blank	2325.49	97.53	18.30	47.43	1.56	10.96	14.07

instantaneous change in juice flow, the inlet valve of the assembly could not open enough, as the air suction at low level could cause pressure pulsation (0 - 6 kg/cm³). Not only for safety but also to prevent clogging of the tail nozzle we had to keep the operation at low pressure.

The average milling rate in the test period was 2323.21 t.c.d. and mixed juice hourly flow was 88.25 m³. The assembly available comprised 20 sets so flow per set was 4.4 m³/hr. This may be compared with the case shown in Fig. 2 where, with 0.5 - 0.6% consistency and the same pressure, flow rate will be 6.0 m³/hr. Power consumption is such that the installed power of the pump motor did not need to be increased during our tests; this pump ordinarily operated at 60% of rated load.

(7) There was no bad influence on the extraction as may be seen from Table VI.

Two stage separation with tailings disposed of on the bagasse blanket

For reducing the quantity of tailings to be disposed of another two sets of hydrocyclones assembly were added as a 2nd stage and the final tail juice disposed of on the blanket of bagasse before the 2nd mill. In 8 days of tests, 18,369.1 tonnes of cane were milled between March 7 and March 14 and the periods March 5 and March 15 taken as the blank. Results are shown in Table VII.

The removal of total suspended solids, bagacillo and polysaccharide colloids are as shown in Table VIII.

Discussion

(1) *Evaluation of the efficiency of separation.*

The efficiency of the hydrocyclone may be predicted from the cut size X_{50}, which means the diameter at which 50% of the particles are removed. From the formula of Bradley[4],

$$X_{50} = 8.2\ [D_c \times 3 \times \mu/Q^{1.2}\ (\rho - \sigma)]^{0.5}$$

where X_{50} is the cut size,
D_c = diameter of hydrocyclone (= 3 in)
μ is the viscosity of M.J. (=1.5 centipoises),
Q is the flow rate (20 gal/min),
σ is density of mixed juice (= 1.06), and
ρ is the particle density (= 1.56).

The calculated X_{50} of 7.06 μm is much smaller than that for the Dorrclone which is 39 μm. The smaller particle size means they have more specific surface, and could adsorb or adhere more colloidal or other suspended solids such as bagacillo, when more impure matter could be removed. At present, reduction of 20 - 30% bagacillo and 10 - 20% of sugar loss in filter cake and molasses have been achieved.

(2) One may fear that decreasing the content of bagacillo in mixed juice will have a bad influence on the filtration. We therefore made an experiment on the feed and exit juice from the hydrocyclone, first heating to 65°C, adding milk of lime in a dosage of 2 mg of available CaO/ml and then gassing to pH 6.8 - 7.2 with SO_2. After heating to 98°C sedimentation and filtration tests were made in the

4 "International mineral processing" (London), 1960.

Table VII. Results of second-stage separation

Items	Test period	Blank period	Result +/-	Result +/-, %
Sugar loss in filter cake % sugar in cane	0.693	0.885	-0.246	-27.73
Dry filter cake % cane	1.085	1.133	-0.048	-4.24
Clarity in mm				
Clarified juice	138.1	119.0	+19.1	+16.05
Filtrate	92.85	79.5	+13.4	+16.79
Sugar loss in molasses % sugar in cane	4.95	6.78	-1.83	-27.0
Molasses % cane (w/w)	2.19	2.94	-0.75	-25.5
Gravity purity	33.56	33.51	+0.05	-
Milling rate, t.c.d.	2296.14	2062.9	-	-
Mill extraction, %	97.53	97.37	+0.16	-
Bagasse				
pol	1.63	1.70	-0.07	-
moisture, %	45.85	46.30	-0.45	-
Imbibition water % cane	19.86	18.97	+0.89	-
Cane				
sucrose, %	14.15	13.91	+0.24	-
fibre, %	11.06	10.98	+0.08	-
Sugar quality;				
Pol	99.75	99.74		
Moisture, %	0.033	0.034		
Invert sugar, %	0.03	0.031		
Colour value (ICUMSA units)	116	116		
Suspended solids, mg/kg	18.92	21.70		
Ash, %	0.073	0.076		

Table VIII

Items	Feed, %	Exit, %	Underflow (tails), %	Removal, %	Total, removal, %	Underflow/ Feed
Total suspended solids, %						
1st stage	0.782	0.666	1.676	24.63	-	11.49
2nd stage	1.676	0.770	5.84	62.23	15.21	17.73
			Overall underflow/feed			2.04
Bagasse %						
1st stage	0.33	0.23	1.11	38.64	-	-
2nd stage	1.11	0.48	4.00	64.36	24.87	-
Polysaccharide colloids						
1st stage	0.255	0.233	0.421	18.96	-	-
2nd stage	0.421	0.243	0.556	23.59	4.47	-

laboratory. The results are shown in Figures 5 and 6. They show the sedimentation characteristics to be the same, while the filtration rate is improved after cleaning. This may be due to the decrease in colloidal matter, and is also expressed in the decreased sugar loss in filter cake.

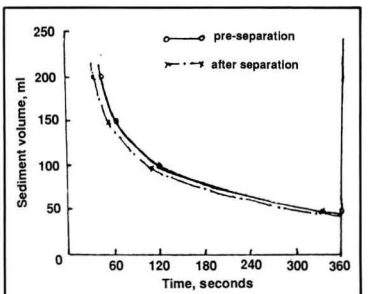

Fig 5. Sedimentation test pre- and after separation

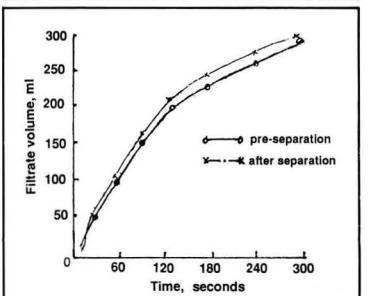

Fig 6. Filtration test pre- and after separation

(3) The only abnormality in this application is the clogging of the tail nozzle, when an abrupt change of pressure occurs. This may be overcome by maintaining the pressure automatically, and having enough reserve capacity in the mixed juice tank. As a remedy for the inevitable case of interruption it is recommended to instal an automatic appliance to fill water in the cyclone when the pressure suddenly changes to a crucial value.

(4) Hydrocyclones are low-cost apparatus for efficient liquid/solid, liquid/liquid, solid/solid and even gas/liquid separation and are described in detail in the works of

Svarovsky[5] and Mozlay[6]. In many beet factories a hydrocyclone is applied for the cleaning of the milk of lime, and there have even been some attempts to separate the mud from 1st carbonatated juice but this has not yet succeeded.

The single-stage separation system is better in respect of cleaning and energy, but gives a large amount of tail juice for recycling. In the two-stage system the efficiency of cleaning is lower but the tailings are very small (2 - 3%) and may be directly disposed of to the bagasse blanket to recover the sugar. The end effects of both these two systems are nearly the same.

Summary

The Bauer 600-EX hydrocyclone assembly may be used to remove suspended matter (including bagacillo) from mixed juice to give better results in clarification and filtration in plant tests. The single-stage system gives higher removal but also higher recycling, while the two-stage system gives less removal than the former but very small amounts of tailings, easy to handling. Both systems provide nearly equal benefits.

Acknowledgments

The author wish to express appreciation to Mr. Liu Shao-an, the Managing Director of Shitow Sugar Cane Chemical Works for sustaining this suggestion, encouraging its realization in commercial tests and permiting publication.

5 "Solid-Liquid separation", 2nd Edn. 1981, 167.
6 *Filtration & separation*, 1983, **20**, (6), 474.

MATERIALS MANAGEMENT

Deterioration of sugar

By S. A. Brooks
(Sugar Technology Research Unit, Barbados)

Introduction

During the past 20 years the Barbados sugar industry has regularly monitored the conductivity of sugar delivered for storage at its sugar bond using a Kappa meter. With advances in technology it was considered opportune to purchase a more recent, but simple, instrument to carry out the work of the Kappa meter. In establishing the accuracy of the hand-held Nova Sina MIK 200 relative humidity and temperature instrument which was fitted with an enSS-3(4) sensor, three grades of sugar were stored in the sugar bond over a period of 157 days during 1984.

Background

The water vapour pressure of a sample of sugar has come to be regarded as significant for the storage quality of sugar, because it indicates the hygroscopicity of the sugar; i.e., if it is lower than the partial water vapour pressure in the surrounding atmosphere, water will condense on the sugar. It is also related to the level of the moisture content upon which microbiological growth depends. However, water vapour pressure is highly dependent on temperature and it is tempting to compensate for this by considering the ratio:

$$\frac{\text{Water vapour pressure of sugar}}{\text{Vapour pressure of water at same temperature}} \quad (1)$$

In the case of air, when expressed as a percentage, this is called the relative humidity. Powers[1] referred to the equivalent sugar reading as the equivalent relative humidity (E.R.H.) as per equation (1).

Procedure

Three sugar samples, each of about 5 tonnes, with pol varying from 94.74 to 97.74, were placed separately in the same part of the sugar bond. Relative humidity determinations were all made at approximately the same time of day over the 157 days of the test with the Nova Sina MIK 200 meter with the en SS-3(4) probe sensor. Composite sugar sub-samples from each deposit were collected at irregular intervals and taken to the laboratory for pol, moisture and colour determinations.

The Nova Sina MIK 200 together with the enSS-3(4) probe is quoted as having an accuracy of better than ±2% RH and 0.5°C at room temperature. The measuring element for relative humidity consists of an electrolytic resistor, the

1 *Proc. 12th Session ICUMSA*, 1958, 98 - 101.

electrical value changing with the ambient air humidity. Temperature is sensed with an NTC resistor. Operational instructions supplied with the instrument were clearly stated and easy to follow. The instrument, although ruggedly constructed, gave rapid measurements of both the relative humidity and temperature, whether the air was being sampled or the sugar. However, instrumental equilibrations were necessary before any readings could be made and this was followed by a stability reading for each sampling position in the sugar heap.

Results and conclusions

The results listed in Table I were subjected to statistical analysis and the appropriate regression analysis. This analysis indicated clearly that the results conformed to the following linear equation:

$$DI = 2.16\ RH - 109.34$$

Regression analysis subsequently yield the following statistical data.

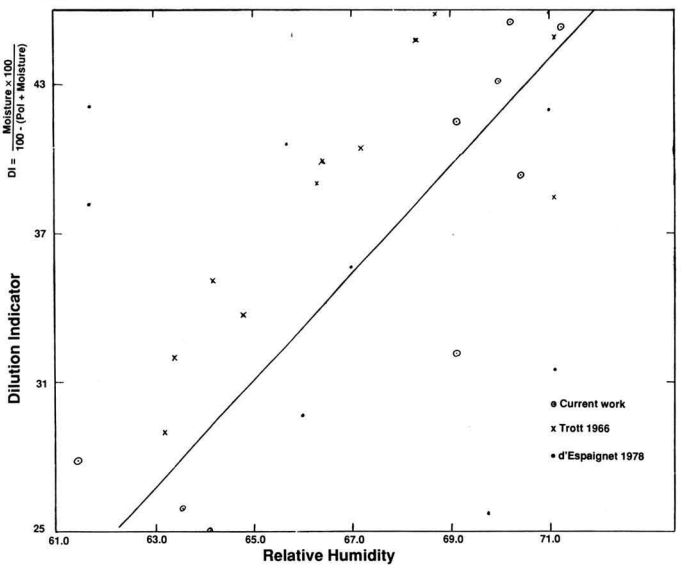

Fig. 1

Table I

Type	Test period (days)	Pol	Moisture	D.I.	Temperature (°C)	ERH %
1	17	97.52	0.54	27.84	30.2	61.47
	59	97.08	0.88	43.14	28.8	69.98
	157	97.06	0.92	45.50	29.4	70.24
2	0	94.74	1.28	32.16	29.0	69.12
	7	95.00	1.03	25.94	30.2	63.57
	8	95.20	0.96	25.00	30.5	64.13
	49	94.34	1.66	41.50	29.0	69.12
	147	94.29	1.61	39.30	29.5	70.42
3	59	97.28	0.86	46.24	28.4	69.12
	157	97.24	0.86	45.30	29.3	71.26

Standard error of estimate for regression	4.095
Correlation coefficient	0.864
t - statistic for correlation coefficient	4.86
Significance of correlation coefficient	0.002

In addition, Trott's results[2] and d'Espaignet's results[3] can be satisfactorily accounted for over the range of values studied (Figure 1). Furthermore, the latest correlation coefficient is better than that previously reported by these two authors.

On a point of interest, this study actually followed the deterioration of three different sugar samples over a period of 157 days, while previous studies looked at different sugar samples. The results suggest that the rate of deterioration of sugar does not depend on the sugar sample, thereby supporting work which had been carried out previously on this topic.

2 *Proc. 14th Session ICUMSA*, 1966, 119 - 120.
3 *Proc. 17th Session ICUMSA*, 1978, 317, 320 - 324.

Facts and figures

Zimbabwe sugar exports, 1985[4]

	1985	1984
	tonnes, raw value	
Botswana	40,647	37,429
Canada	35,633	45,392
EEC	30,576	43,836
Morocco	29,522	15,815
Portugal	63,894	48,080
US	19,315	28,286
USSR	0	14,971
	219,587	233,809

Sugar marketing seminar[5]

An inter-regional seminar on sugar marketing was held in Georgetown, Guyana, during April 7 - 11, organized by GEPLACEA and United Nations Centre on Transnational Corporations. Topics discussed included: "The impact of technical changes in the HFCS and sugar-chemical industry", "Sugar marketing with transnational companies", "A producer's option to sell his raw sugar or make a tolling operation", "Use of the New York Exchange for hedge", "Freights on the world sugar market" and "Diversification as an alternative to sugar exports".

4 *I.S.O. Stat. Bull.*, 1986, **45**, (3), 52.
5 *GEPLACEA Bulletin*, 1986, **3**, (3), Inst. Inform.-2.

Facts and figures

Canada sugar imports, 1985[1]

	1985	1984
	tonnes, raw value	
Australia	475,804	417,517
Belize	25,138	12,488
Brazil	43,173	0
Colombia	14,130	13,095
Cuba	140,455	256,426
Dominican Republic	0	22,248
EEC	2,648	54
Fiji	18,990	0
Guyana	9,354	5,803
Korea, South	1,594	0
Malawi	0	7,046
Mauritius	0	13,715
South Africa	186,941	161,431
Swaziland	110,981	60,159
US	89,433	33,764
Zimbabwe	39,013	50,295
Other countries	302	187
	1,157,956	1,054,228

S.P.R.I. workshop on raw sugar quality: present and future

This workshop, to be held at the Desoto Hilton Hotel, Savannah, Georgia, U.S.A., will emphasize recent changes worldwide in raw sugar quality. Changes in specifications and in harvesting and production systems have brought about a general improvement in raw sugar quality. New processes and combined production of raw and refined sugars have affected the traditional sugar factory, and its products. Experts will hold Workshop discussions on the following areas: (1) colour, pol and raw sugar quality, (2) ash, invert and raw sugar quality and (3) microbiological control and raw sugar quality. There will also be an opening general session, a closing general discussion session, and opportunity for informal discussion among participants. Sessions will be consecutive, so that each participant may attend every session. Technologists, scientists and all interested parties involved in sugar and sugar cane production, manufacturing and refining, and suppliers to the sugar industry are invited to participate. The registration fee for the Workshop is $275 per person, reduced to $25 for delegates from S.P.R.I.-sponsoring companies. Further details may be obtained from S.P.R.I., Box 19687, New Orleans, LA 70179, U.S.A. (Telephone 504-589-7037, Telex No. 2452740 MCI).

Fuel alcohol symposium

The 7th International Symposium on Alcohol Fuels will be held in Paris at Palais des Congrès at Porte Maillot during October 20 - 23. It will continue from the 6th Symposium held in Ottawa in May 1984 and will assess progress made in research and development. Details are available from M. Pierre Leprince, Institut Français du Pétrole, B.P 311, 92506 Rueil-Malmaison Cedex, France (scientific program) and P.M.V. 7e Symposium International, 130 rue de Clignancourt, 75018 Paris, France (registrations, etc.).

"Big Four" sugar exporters meeting

Representatives of the four largest sugar exporters — Australia, Brazil, Cuba and the EEC — met during the May meeting of the International Sugar Organization. Little progress was made in reaching agreement on the form of a new agreement which might stabilize sugar prices in a more remunerative range. Earlier, Brazil had proposed a system as in the International Coffee Agreement where an export quota would be established each year with each exporter having a renewable market share based on past performances and the size of the total quota adjusted in accordance with the rise and fall of the price level. Australia is believed to oppose scrapping of the minimum export entitlement because the country is vulnerable to severe effects of such adjustment while exports amount to more than 75% of production. Another topic of discussion was Cuba's sales to the Eastern Bloc.

Austria sugar factory closure[2]

After long negotiations, all interested parties have agreed to shut down the sugar factory in Bruck with effect from March 31, 1986. The existing sugar surplus, the very difficult domestic situation and lack of possibility for exports or for alternative outlets have forced the Austrian sugar industry into this step. Household sales of sugar in Austria have shown a decreasing tendency since 1982/83, as have sales to the sugar processing industries. As a consequence, the domestic market is reduced substantially, to some 280 - 290,000 tonnes a year, and economics dictated a rationalization of the country's production since cost of production precludes diversification of sugar to other uses.

New Guatemala distilleries[3]

The 120,000 litres/day alcohol plant owned by Ingenio Palo Gordo is expected to have started manufacture by the end of March, using molasses and cane as raw materials. Another facility, owned by Ingenio Pantaleón, was expected to be built in May, with a production capacity of 180,000 litres/day of anhydrous alcohol.

USSR glucose and HFS[4]

By steadily increasing capacity, glucose production in the USSR has risen to 2.4 times that of 1983 and the country is now self-sufficient so that imports from western countries have stopped. According to the five-year plan for 1986-90, the Soviet Union is to start manufacture of high fructose syrups.

Cuba sugar crop estimate reduction[5]

It is reported from Havana that unseasonal rains have been delaying the crop in Cuba. According to the official daily, *Granma*, the milling average in the central and eastern parts of the country had dropped to 63% of capacity (from the normal 82%) owing to the rains; it was also underlined that it is at this time of the year that the cane has the highest sugar content and that the damage caused is the greatest. Observers in Havana estimated that the Cuban crop might be under 7 million tonnes in 1985/86 as opposed to a target of 8.5 million tonnes.

China sugar production target[6]

The sugar production target in the draft Seventh Five-Year Plan (1986 - 1990) is scheduled to rise to between 5.5 and 6.0 million tonnes, white value, or 23.6 - 34.8% higher than 1985. Calendar year sugar production was 4,450,000 tonnes, white value, up 17.1% from the year before. This expansion had been mostly in the cane sugar sector (30.2% increase in the cane crop) rather than beet sugar (7.6% increase in the beet crop). Total retail sales of sugar in 1985 were up 15% from 1984.

Panama alcohol project[7]

Manufacture of anhydrous alcohol is to begin in Panama following agreement between cane growers at Chiriqui and the Victoria sugar company which has said that, from 1987, it will use all its cane crop for alcohol.

FDA and sugar consumption safety[8]

Sugar consumption at current levels in the United States is not harmful to health, according to Allan Forbes, Director of the Nutrition and Sciences Office of the Food and Drug Adminstration. At a World Sugar Research Organization symposium in London in May he told how the FDA had conducted a three-year review of scientific literature on the effects of sugar on health, as well as the most detailed study of how much sugar people eat. This showed that, in contrast to an apparent consumption of 125 g per person per day in the US, the actual figures is only 43 g, conference sources attributing the difference to waste, as in restaurants. Asked whether food labelling should specify the amount of added sugar, Forbes said that this would be misleading as it would add to the myth that there is a difference between added sugar and sugars which are naturally present in food.

PERSONAL NOTES

We regret to report the death in September 1985 of **S. N. Gundu Rao,** Director of the National Sugar Institute at Kanpur, India, between 1956 and 1964. Previously he had worked from 1940 at the Ravalgaon sugar factory, of which he became General Manager, and on resignation from the Institute he returned to the industry as Technical Advisor to the British India Corporation, later serving as an Advisor to the Deccan Sugar Institute in Pune, Maharashtra.

1 *I.S.O. Stat. Bull.*, 1986, **45**, (3), 8 - 9.
2 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 181 - 182.
3 *Amerop-Westway Newsletter*, 1986, (149), 14.
4 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 228.
5 *GEPLACEA Sugar Letter*, 1986, (14).
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 204 - 205.
7 *Amerop-Westway Newsletter*, 1986, (149), 14.
8 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 319.

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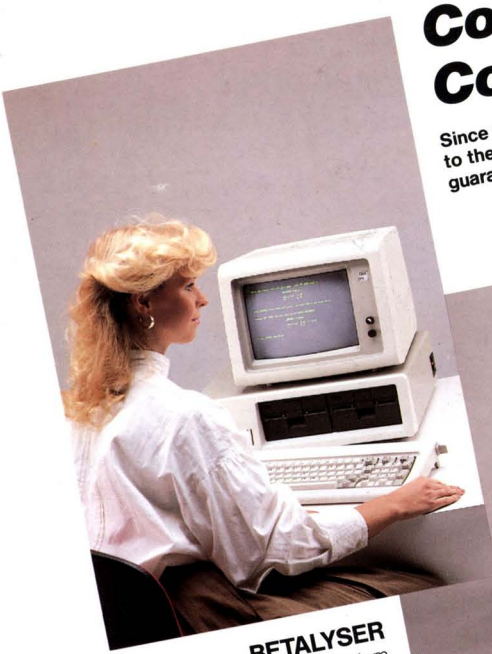

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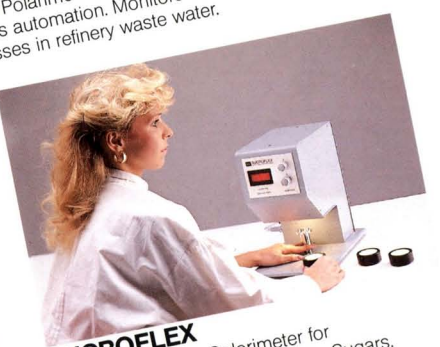

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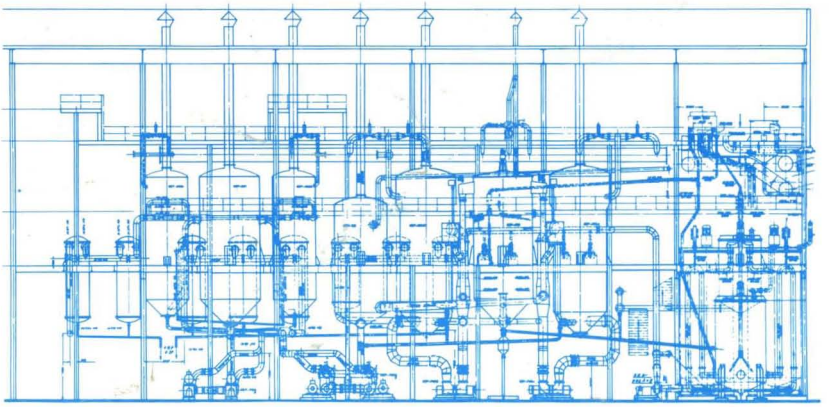

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