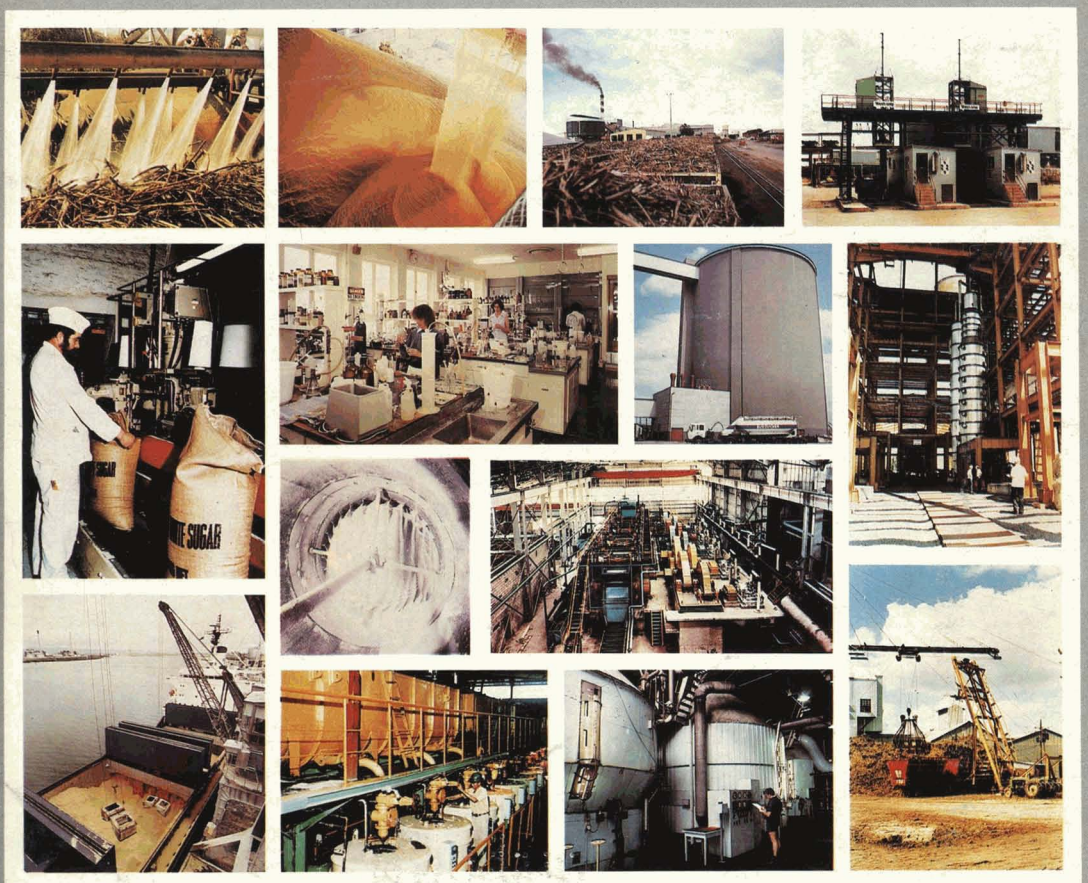
INTERNATIONAL SUGAR JOURNAL



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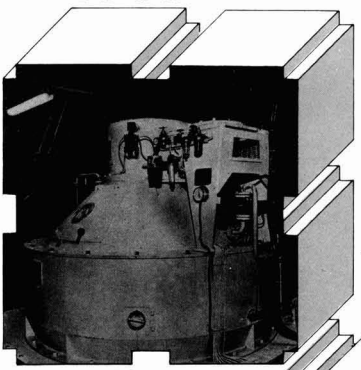
"B5" Continuous centrifugal

The first high capacity (Basket Ø 1.500 mm.) Continuous centrifugal in operation since 1966

More than 15 years of continuous technical experimentation and development in curing low product massecuites.

1966



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The BOSCO "B5" continuous centrifugal has been and is still the only machine of its kind which offers the most exigent Clients proven technological and throughput results along with the cheapest investment, installation and operation costs.

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— Top suspension — Conical basket in stainless steel — Basket size: Ø e 1.500 mm. — Basket angle: 34° —

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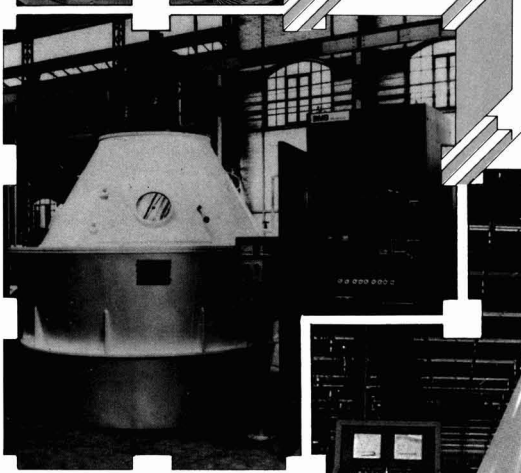

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— Guaranteed Throughput:
For beet sugar massecuite: 12 Ton/hr
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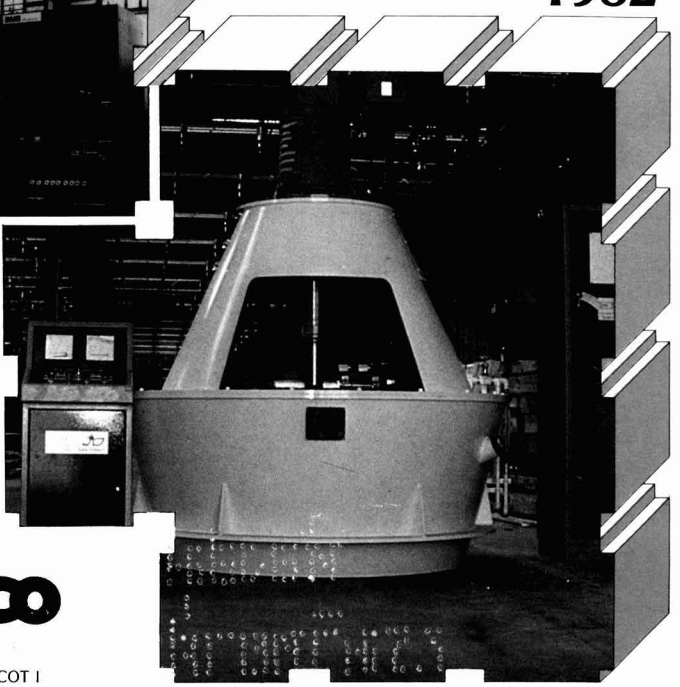
1982



an active presence in the sugar industry

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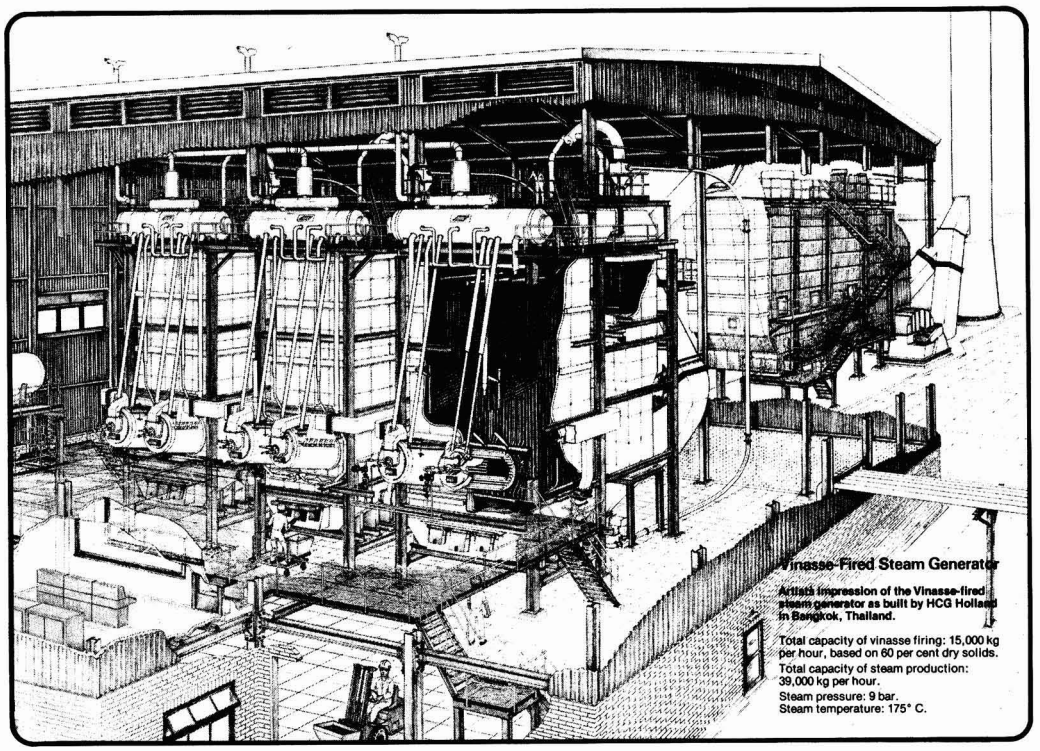
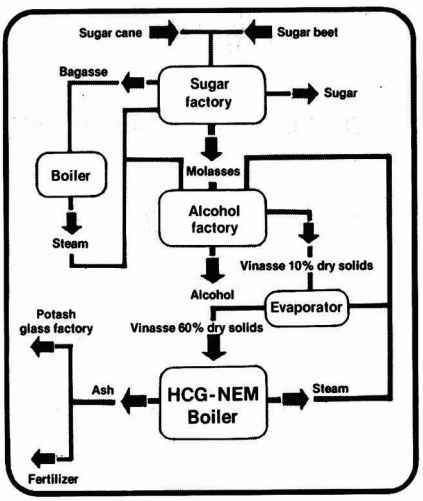
EFFLUENT TREATMENT and ENERGY SAVING through NEM VINASSE BOILER



Vinasse-Fired Steam Generator

Artists impression of the Vinasse-fired steam generator as built by HCG Holland in Bangkok, Thailand.

Total capacity of vinasse firing: 15,000 kg per hour, based on 60 per cent dry solids.
Total capacity of steam production: 39,000 kg per hour.
Steam pressure: 9 bar.
Steam temperature: 175° C.



- During the production of power alcohol as well as industrial alcohol, vinasse is obtained as by-product. By evaporation to 60% solids concentration this vinasse becomes suitable as fuel for the HCG combustion boiler for generating process steam.
- By using vinasse as fuel, the alcohol factory can achieve savings of approximately 50% in fuel consumption.
- HCG has been involved in the development of vinasse-fired boilers for many years. Nine boilers have been built.

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Notes and comments

World sugar prices

The impact of the failure of the Geneva conference to produce a new ISA weighed on the market at the beginning of July and the LDP slid from $133.50 to $125 on July 4. Over the next week there was a recovery to $130 but between July 12 and 25 the price hovered around $120. A further decline then set in and the price sank to $115 on July 31. The LDP(W) started the month at $165 per tonne and fell gradually through the month to reach only $146.50 on July 20. After recovering to $152.50 two days later, the slide resumed and the white sugar price ended the month at $149.

The depressed state of the market has been influenced by a number of bearish factors, including reports of probably higher crops in Australia, Cuba, South Africa and Western Europe, and by release of the ISA special stocks to come in January or perhaps even in 1984. The pressure of surplus supplies nullified the effect of a reported lower crop in India and the announcement of measures in the Philippines to reduce output, while importers continue to obtain supplies on a hand-to-mouth basis, expecting further falls in prices which expectations become self-fulfilling.

According to the *Public Ledger's Commodity Week*[1], most experts have thought all along that depressed prices must sooner or later force producers to re-think production policies. The chances are that this responsibility will fall on the shoulders of those Third World countries which largely depend on sugar for their income, since the developed world has money from relatively wealthy taxpayers to fund production. The Philippines, for example, has said it was trimming production because of poor world prices, but some trade sources feel this may reflect the fact that the country can ill afford to finance bigger output after suffering losses on the market.

A further problem for such countries is their indebtedness to the International Monetary Fund for borrowings under the supplementary financing facility; this was to protect members against shortfalls in export earnings, provided prices were supported by the International Sugar agreement, to become defunct at the end of this year. In a number of cases the countries concerned now have little hope of repaying the loans.

The changing sugar market

An analysis of the basic structure of the free market and its implications has been written recently by A. C. Hannah, head of the Economics and Statistics Division of the International Sugar Organization[2], in part of which he examines changes in the nature of the demand for sugar on the world market.

Import demand has been remarkably stable since 1978 at around 17 million tonnes until 1983. The only year it fell significantly below 17 million tonnes was 1980, which can be explained by the significant rise in prices in 1979/80. To explain the fall in 1983 and to uncover the significant structural change that has occurred it is necessary to subdivide the market into developed and developing importers. This reveals that the apparent stability is in fact the product of two strong but opposite trends – the decline in developed country imports from over 50% of underlying demand in 1979 to less than 40% in 1982, and the equivalent growth in developing country imports from under half to more than 60% by 1982.

This development is not just statistically significant; it represents a quite radical change in the type of market that traded sugar faces and it is particularly important when considering possible future developments. First and foremost, the sugar market has become much more price *and income* sensitive It is necessary to emphasize that these two factors are strongly connected; it is not always obvious that the response of a low income country to low prices may be to purchase the same quantity and save some overseas exchange rather than take the opportunity to increase consumption. Looking at developing country imports from 1978 to 1983, both the price and income factors can be seen at work. Growth was checked, although not by much, by the high prices of 1979 but in 1983 purchases fell by more than one million tonnes as the effects of the world recession began to bite, particularly on the availability of foreign exchange, in spite of continued low prices. To sum up, as a result of this structural shift we now have a market where growth, or lack of it, is determined by the economic situation in developing countries in relation to prices.

Many developing countries are engaged in a drive toward self-sufficiency in sugar. While it may be doubted if they will ever wholly succeed in their aim, whether because of production problems or the tendency of consumption to run ahead of production where consumption levels are low, or both, the general tendency is for the dependence on imports to diminish and import policy to be geared towards making up the deficit rather than being the engine of consumption growth (which would imply more rapid growth in imports at low prices).

The other major shift in structure occurring during this period – a consequence of the growth in developing countries – has been the increase in white sugar imports. Analysis between developed and developing countries shows how dependent the white sugar market is on the economies of the latter, particularly those exporting petroleum. Growth is concentrated in the years 1980 and 1981, particularly the latter, when prices were very low. Since 1981 there has been no growth in this market, in spite of persistently low prices, owing to the recession.

However, it is clear that growth in sugar imports over the period has been concentrated on white sugar. This is hardly surprising considering the price over much of the period, coupled with the fact that more than marginal increases in raw sugar imports by developing countries would have required expensive investment in refining capacity. It is safe to assume that this situation will continue for the future,

1 July 21, 1984.
2 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 351-355.

i.e. what growth there is will be largely in white sugar imports, while bearing in mind that the price and income effects will determine the actual level.

Fiji sugar industry reform[1]

The Fiji government intends to reform the management of its sugar industry. The plan aims mainly at improving relations between growers, mill workers and the authority, and a draft bill, put before Parliament in June, had the backing of the opposition party as well as the government.

The present system, under which cane growing and sugar manufacture are directed by an Independent Chairman and the Sugar Board assisted by an Advisory Council representing all sides of the industry, is to be abolished. The Independent Chairman is to be retained but he is to head a 15-member Sugar Commission representative of the industry while a one-man sugar industry tribunal is to be created to settle disputes and fix harvest quotas. Moreover, an elected sugar cane growers' council is to be established which will have the power to run sugar-related businesses, conduct research and education, and would be involved in maintaining industrial peace. These reforms are intended to get growers more closely involved in the industry's direction.

The current chairman expects the reforms to be implemented early next year.

Mauritius sugar industry authority

The Mauritius Parliament has adopted a bill to set up a sugar authority to streamline the island's trade in the commodity[2]. Under the bill, the authority will "in the national interest, be responsible for promoting the development of the sugar industry on an efficient basis". It will not be responsible for day-to-day running of the sugar trade, which is in private hands, but will draw up national sugar policy and monitor and coordinate research into sugar. It also has the power to advise on measures to keep the industry viable and to review its economic performance, and fine or jail any producer who fails to implement its directives or gives the body false or misleading information.

The Sugar Producers Association has opposed setting up the authority, to be financed by a levy on production. They are also angry about export duties which, they said in a recent statement, were "slowly killing the country". According to official figures, the industry made a profit of 89 million rupees in 1982 but this turned into a loss of 268 million rupees after deduction of export duties.

A commission of enquiry into the sugar industry, set up on the World Bank's recommendations, identified a number of factors related to the industry's poor performance[3]. They included: low world prices and poor climatic conditions which have hindered cane growth; overstaffing and the fact that sugar workers' wages have fallen by 25% in real terms since 1977; stagnant investment in the sugar industry; and the sugar export tax (levied on a sliding scale according to the size of production) which has acted as a disincentive to raising output.

EEC sugar availability and exports finance[4]

Many regions of the EEC are expecting good crops this year and output is forecast in the region of 12.25 million tonnes, white value, or about 1.5 million tonnes more than was produced in 1983/84. After incorporating the output of cane sugar in the French Overseas Departments, sugar recovered from molasses will bring production to some 12.56 million tonnes. This will be augmented by about 1.34 million tonnes entering the Community from the ACP countries and elsewhere under preferential arrangements and the release of 210,000 tonnes of B- and C-sugar which had been set aside out of the previous campaign, bringing the total quantity available for disposal to 14.11 million tonnes.

Despite a gradually rising population, it is an unfortunate fact that consumption in the EEC countries continues to stagnate and is put at 9.4 million tonnes in 1984/85. Exports of sugar in processed goods last year exceeded movement in the opposite direction by 170,000 tonnes and a similar quantity may be expected in 1984/85. Assuming, therefore, that no adjustment is made in either the free stocks or the minimum stocks, there would be, on the basis of these calculations, a quantity of the order of 4.5 million tonnes of surplus sugar for export.

It is one thing to have an export availability but quite another to be able to find adequate outlets; there is now also an increasing availability of white sugar around the world and this might erode the market for EEC sugar. But it is not just the possible lack of markets which poses a threat to sugar exports from the Community; there is also the question of money. At current world market prices restitutions are having to be granted at increasingly alarming levels. In July releases of white sugar were being made with rebates amounting to up to the equivalent of an astonishing £274 per tonne. It is little wonder that the Common Agricultural Policy seems to be in continuous cash crisis. With levies set at maxima of 2.0% of the guaranteed price on A-quota sugar and at 39.5% on B-quota sugar, there is no way that deficits of this nature can be recouped this year or, unless there is a remarkable and unexpected increase in the world market price, in the foreseeable future.

It is sometimes suggested that all EEC exports receive export rebates. This is not the case, and that is one of the reasons why financial problems are also beginning to arise for producers. Exporters of Community sugar naturally receive only the world price from their buyers. So far as sugar produced out of quota is concerned, there is no recourse to Community funds. On the other hand, exporters of quota sugar receive an export restitution but this normally takes 3-6 weeks to arrive during which increasingly expensive financing costs have to be borne. As a consequence, it is now being suggested that some producers, particularly in West Germany, may prefer to deliver sugar into intervention rather than export it.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 304.
2 *Reuter Sugar Newsletter*, May 3, 1984.
3 *World Sugar J.*, 1984, **6**, (12), 39.
4 C. Czarnikow Ltd., *Sugar Review*, 1984, (1710), 133-134.

A water-soluble polysaccharide from stand-over cane

Part II. Isolation and structural characterization from molasses

By J. D. Blake* and J. Littlemore**

Introduction

In Part I of these studies, the isolation and structural characterization of a linear glucan from stand-over cane was reported[1]. It proved to be similar to the polysaccharide described by Bruijn and isolated from deteriorated cut cane.

This paper relates problems involved in the isolation and purification of the polysaccharide from molasses.

Experimental and results

The molasses used in this study was collected from the Burdekin district during a difficult period of processing stand-over cane. It was coded 1.74. At a later stage in the study a sample was collected from the Central district. In this instance, *A*-molasses from a two-massecuite boiling scheme and the *C*-massecuites were very viscous and the *A*-molasses was covered by a froth of glue-like consistency. Samples of the froth and *A*-massecuite were obtained for analysis.

Two other samples coded 11.75 and 7.76 were used for comparative study. Sample 11.75 was collected after resumption of processing following a factory shut-down due to unseasonal heavy rain. Sample 7.76 was collected during a period of normal operations.

(i) Preliminary analyses

Samples were analysed for dry substance, Brix, ash, pol, reducing sugars, sucrose and haze produced in a deionized solution in 50% aqueous ethanol. Results are given in Table I.

Polymeric material was obtained after dilution of a molasses sample (600 g) to 40° Brix and precipitation by addition of three volumes of ethanol. The precipitate recovered by centrifugation was redispersed and reprecipitated twice before dialysis against running tap water for 48 hours. Chloroform and toluene were added as preservatives. Material which remained insoluble at this stage was collected by centrifugation while the soluble portion was recovered by lyophilization. Yields were of the order of 3% on solids but insolubles contributed amounts varying from 15 to 65%.

J. D. Blake

J. Littlemore

Neutral monosaccharide composition after acid hydrolysis of material precipitable by 75% aqueous ethanol was determined by gas chromatography of their alditol acetates. Data obtained are given in Table II.

(ii) Sub-fractionation of molasses components precipitable in 75% aqueous ethanol

Fractional precipitation with ethanol followed the general procedure described by Whistler & Sannella[2]. After initial dispersion in water, the sample was heated for 15 minutes on a boiling water bath at pH 7 to maximize solubilization. Colour in the sample precluded ethanol additions to incipient turbidity and consequently additions were made in measured volumes. Precipitated material was determined gravimetrically after vacuum drying. Results are shown in Fig. 1(a) and (b) for 1.74 and 11.75 molasses respectively. In the latter sample additional information on the fractionation was obtained by determinaion of sulphated ash and total carbohydrate (phenol-sulphuric acid assay).

On the basis of the implied fractionation of carbohydrate shown in Fig. 1(a), a large-scale fractionation of 1.74 stand-over molasses was undertaken. A sample (1500 g) at 40° Brix was divided into portions precipitable by 0.5, 1, 2 and 3 volumes of ethanol. The four fractions were exhaustively dialysed and recovered by lyophilization. Sub-fractions at 0.5 and 1 volume were only partly soluble and were separated into soluble and insoluble portions.

The fractions were analysed for sulphated ash, total carbohydrate and relative composition of neutral monosaccharide components. Results are given in Table III.

(iii) Studies on colour removal

Whatman DEAE-cellulose, grade DE-11,

Table I. Preliminary characterization of molasses used in a study of the effects of processing stand-over cane

Sample	Dry substance	Brix	Ash	Pol	HFM[a]	Reducing sugars	Sucrose
1.74	91.4	95	8.3	55.0	3600	12.5	56.6
11.75	76.1	79.6	15.6	32.1	9850	12.0	33.3
7.76	78.5	81	11.4	36.1	5800	18.1	35.5
Pf[b]	–	–	–	–	–	13.7	57.9

[a]Haze forming material referenced against Dextran T110 supplied by AB Pharmacia, Uppsala, Sweden.
[b]Froth component of *A*-massecuite from the Central district.

Table II. Neutral monosaccharide composition of fractions precipitated by three volumes of ethanol

	Sample		
	1.74S*	1.74IS	11.75
	Relative %		
Rhamnose	2	2	1
Fucose	1	–	1
Arabinose	10	14	18
Xylose	7	5	9
Mannose	5	7	6
Galactose	11	16	14
Glucose	65	56	51

*S and IS were soluble and insoluble portions; S represented 85 % of total precipitables.

* Sugar Research Institute, Nebo Road, Mackay, Qld., Australia 4740.
** Dept. of Primary Industries, Mareeba, Qld., Australia 4880.

1 *I.S.J.*, 1984, **86**, 222.
2 *Methods Carbohyd. Chem.*, 1965, **5**, 34.

medium fibrous, was used for this study. The powder, as received, was cycled through 0.5M sodium hydroxide/0.5M

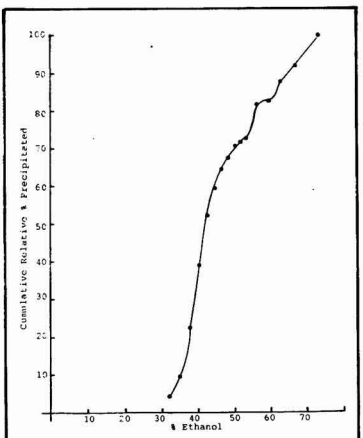

Fig. 1(a). Fractional precipitation of material from stand-over final molasses (1.74) with ethanol; the sample used had been recovered previously from molasses by precipitation in 75% aqueous ethanol

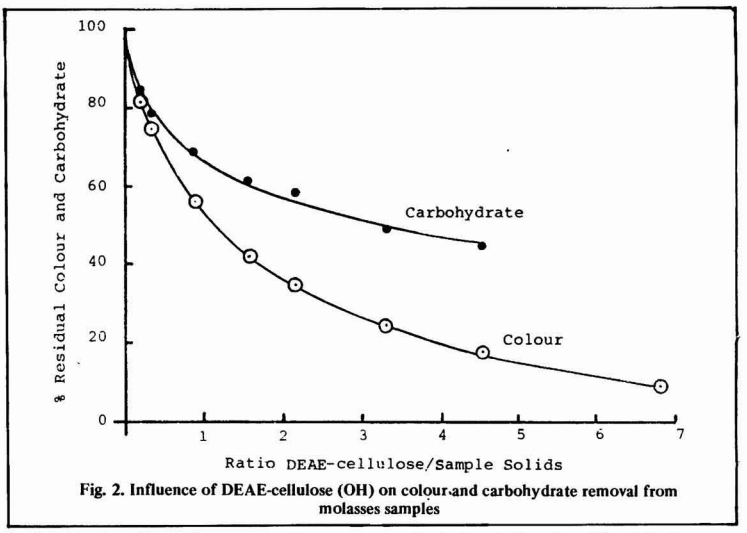

Fig. 2. Influence of DEAE-cellulose (OH) on colour and carbohydrate removal from molasses samples

hydrochloric acid until no more colour could be removed. After removal of fines by sedimentation/decantation the resin in the free base form was air-dried and stored at a known moisture content.

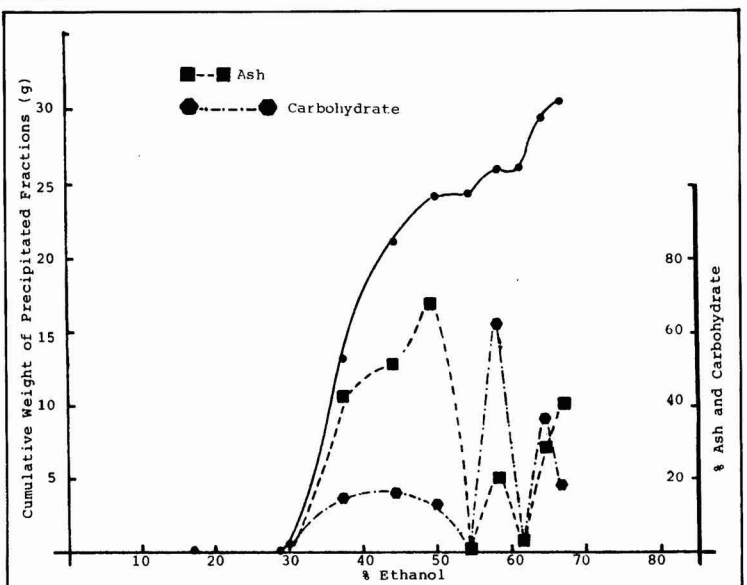

Fig. 1(b). Fractional precipitation of material from final molasses (11.75) with ethanol; the percentage distribution of ash and carbohydrate is also shown. The sample used had previously been recovered from molasses by precipitation in 75% aqueous ethanol

A stock solution (ca. 1% w/v) of material precipitable from 1.74 molasses by 75% aqueous ethanol was prepared by autoclaving a dispersion at pH 7 for 15 minutes at 120°C. Insolubles were separated by centrifugation at 16,000*g* and the supernatant was adjusted to a final volume.

"Colour" curves were obtained by dilution of aliquot portions of stock to 10 ml and reading absorbance at 450, 500 and 600 nm. A total carbohydrate calibration by phenol-sulphuric acid assay was made on the same solutions.

Stock solution (4 ml) was then added to volumetric flasks (5 ml) containing varying amounts of DEAE-cellulose and, after adjustment to volume, the samples stood for three hours at room temperature with occasional agitation. Subsequent centrifugation enabled preparation of a solution for determination of colour and total carbohydrate not sorbed by the resin. In a second analysis 0.5 ml of stock solution was used under comparable conditions. The changes found are shown in Fig. 2.

Attempts to recover carbohydrate from the resin with high ionic strength eluent produced more colour desorption than carbohydrate recovery.

In an investigation of colour removal by column chromatography, material

Table III. Crude fractionation and characterization of 1.74 stand-over molasses using ethanol

Fraction[a]	Yield[b], g	Rel. %[c]	% Carbohydrate[d]	% Ash	Relative % monosaccharide						
					Rhamnose	Fucose	Arabinose	Xylose	Mannose	Galactose	Glucose
0.5 Vi[e]	1.55	15.3	–	–			ND				
0.5 Vs	5.25		7.4	28.6			ND				
1 Vi	0.7	34.7	–	–			ND				
1 Vs	14.7		36.3	8.7	2	1	12	7	5	13	61
2 V	19.18	43.2	12.7	9.1	3	1	29	9	7	23	28
3 V	3.0	6.8	2.4	13.8	2	1	16	7	4	18	52

[a]Volume of ethanol relative to starting volume of molasses solution. [b]Total yield (3.2% on solids) was of same order of magnitude as that obtained by precipitation in 75% aqueous ethanol. [c]Soluble and insoluble portions for each ethanol concentration combined to give the relative composition. [d]Referenced against glucose standard. [e]Vi and Vs: water insoluble and soluble portions respectively.

(2.7 g) dissolved by autoclaving at pH 7.5 and clarified by centrifugation at 12,000*g* was applied to a 16 x 2.1 cm column of DEAE-cellulose (OH) equilibrated to water. After elution of six bed volumes a linear salt gradient to 3M sodium chloride in 7M urea was applied at 0.6 ml/min. This failed to produce a discrete carbohydrate component and yielded carbohydrate in increasing quantities as the ionic strength of the eluent increased. 41% of the starting material was unretained while a further 17% was eluted under the conditions of the gradient. After dialysis and lyophilization these fractions were analysed for monosaccharide composition, the results of which are shown in Table IV.

Table IV. Relative monosaccharide composition of retained and unretained material sorbed by DEAE-cellulose (OH)

Sample	Sugar-relative %				
	Arabinose	Xylose	Mannose	Galactose	Glucose
Starting material	3	2	6	16	71
Unretained portion	5	2	7	16	70
Retained portion	2	3	2	20	70

(iv) Isolation of glucan components

(a) Burdekin sample 1.74

Material precipitable in 50% aqueous ethanol (630 mg) was decolorized and passed through a 25 x 1.5 cm column of macroporous resin AGMP-1 (Ac) equilibrated to 0.01M sodium acetate at 60°C at 1 ml/min. After elution of 250 ml, step-wise changes to 0.1 and 1.0M sodium acetate were made. The unretained portion (ca. 200 mg) when hydrolysed, consisted solely of glucose while the fractions eluted with higher ionic strength acetate contained mainly arabinose and galactose.

Absorption of iodine[3] was used to check the presence of starch components. A broad shoulder in the visible spectrum over 490-520 nm indicated the probable presence of amylopectin dextrins. Authentic sarkaran failed to produce a similar response. A spectrum is shown in Fig. 3(a).

The glucan was dissolved in 20 ml of 0.1M citrate at pH 5.0 and equilibrated to 37°C. β-amylase (Calbiochem, sweet potato) as a 2% solution (1 ml) was added initially and this was followed by another 0.5 ml after four hours. After 24 hours it was found that reducing activity[4] in the digest was constant and absorbance of iodine was no longer detectable [Fig. 3(a)]. The digest was applied to a 95 x 2.5 cm column of Sepharose CL-6B in 7M urea to give the chromatographic profile shown in Fig. 3(b). After dialysis 170 mg of glucan was recovered by lyophilization.

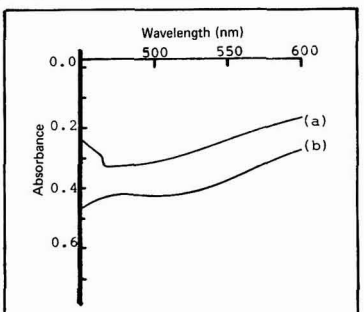

Fig. 3(a). Visible spectrum of iodine complex of 1.74 glucan before (b) and after (a) treatment with α-amylase

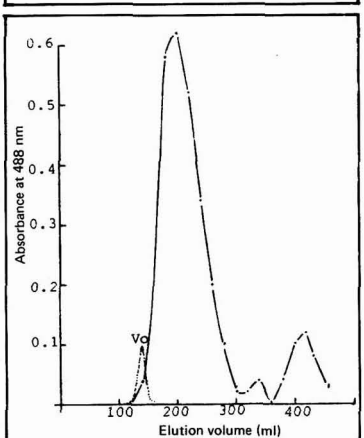

Fig. 3(b). Gel permeation chromatography on Sepharose CL-6B of 1.74 glucan after treatment with β-amylase

3 Manners & Rowe: *Carbohyd. Res.*, 1969, **9**, 107.
4 Nelson: *J. Biol. Chem.*, 1944, **153**, 375.

A rough estimation for the presence of dextran was made with 15 mg of sample digested in 0.02M citrate at pH 6.0 (10 ml) by dextranase (Calbiochem analytical grade, *Bacillus coagulans;* 0.1% w/v) over a 24-hour period. Enzyme (0.2 ml) was added at 0 and 4 hours. Determination of the reducing sugars in the digest by the arsenomolybdate-copper reduction method[4] against a reference digest of dextran 2000 (AB. Pharmacia, Uppsala) enabled calculation of dextran content. This was of the order of 20% and the presence of isomaltodextrins in the digest was confirmed by paper chromatography.

Accordingly, the digestion of the bulk sample was undertaken using a 1% solution of glucan over a 48-hour period at 37°C and making 4 x 0.2 ml additions of dextranase at a concentration of 0.1%. The digest was chromatographed under similar conditions used for the β-amylase digest and produced a similar profile to that shown in Fig. 3(b). A fraction revealed by monitoring absorbance at 278 nm eluted in the void volume of the column. After dialysis and lyophilization, 90 mg of glucan was recovered for structural analysis.

(b) Central district sample

The glucose-rich nature of the froth component sampled from molasses from the Central district prompted purification of this material.

Chromatography on a 95 x 2.5 cm column of Sepharose CL-6B in 7M urea illustrated the problem of colour in purification procedures (Fig. 4). Acid hydrolysis and paper chromatography showed only glucose in the peak fractions of the second component and these were bulked accordingly. This procedure eliminated the minor amounts of arabinose and galactose found in the starting material, and in two runs yielded 800 mg of glucan from 2.0 g of starting material.

The glucan was decolorized using DEAE-cellulose (OH) to recover 350 mg of final product.

Dextranase treatment similar to that outlined for the Burdekin glucan indicated about 16% dextran and this was removed

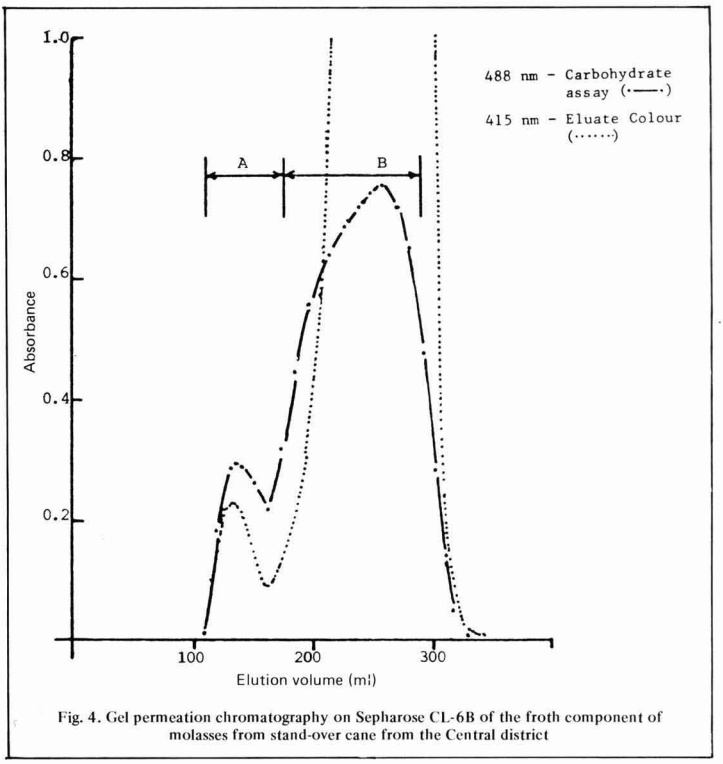

Fig. 4. Gel permeation chromatography on Sepharose CL-6B of the froth component of molasses from stand-over cane from the Central district

using the method outlined above. Chromatography on Sepharose CL-6B gave a profile like that in Fig. 3(b) and a final 136 mg of white material was recovered for structural analysis. Beta-amylase digestion failed to indicate the presence of starch impurity in the glucan.

(v) Structural characterization

Specific optical rotation, periodate oxidation, n.m.r. spectroscopy and digestion by pullulanase enzyme using the experimental conditions outlined in Part I[1] were used for structural characterization. The results are shown in Table V.

Discussion of results

The results show that the glucan isolated from stand-over cane and characterized as sarkaran can occur in sufficient quantities to be associated with problems in the processing of that cane. The most obvious of these are the high viscosity syrups produced and the difficulty in recovering sucrose from molasses. Sucrose concentrations in the product are shown in Table I.

The glucan can contribute to haze-forming material as demonstrated in the dextran assay and clearly indicates a need for more selective analysis of dextran. However, from the quantities of sarkaran present, it is apparent that the dextran assay does not reflect its true concentration. The 11.75 sample collected after a stoppage in factory operations reflects higher dextran levels consistent with such disruptions.

The solubility properties of the glucan may be influenced by the presence of ash components. Fractional precipitation with ethanol produced mostly glucan up to

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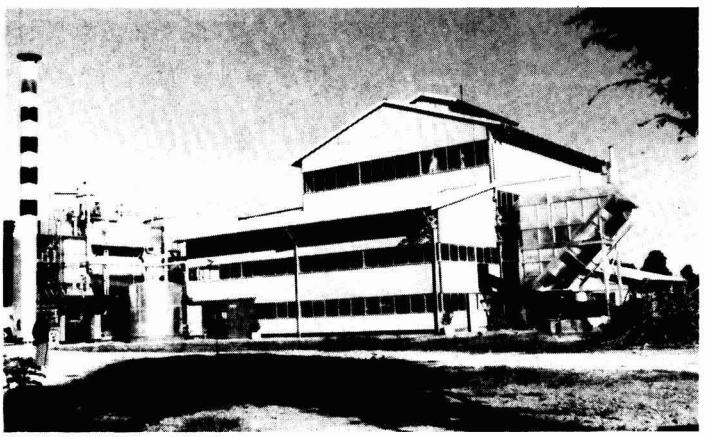

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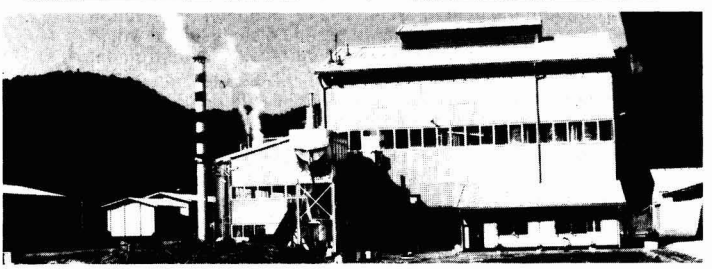

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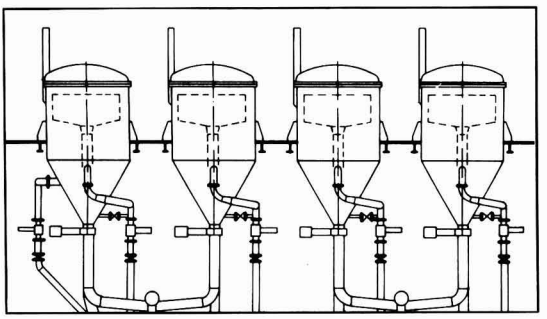

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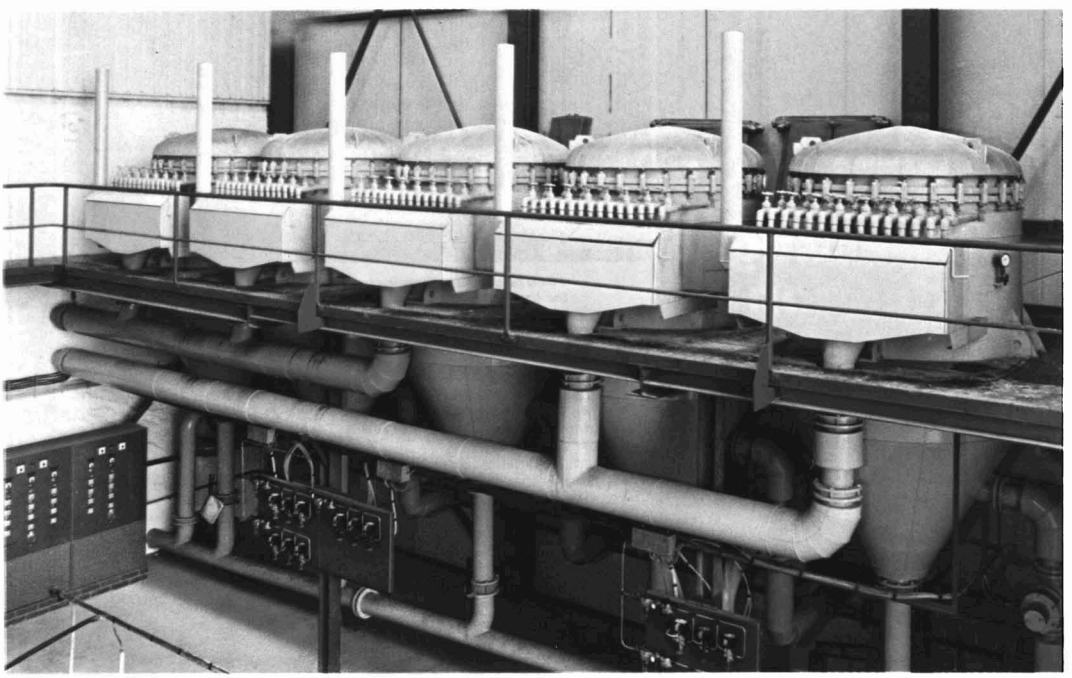

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Table V. Structural analysis of glucans isolated from molasses from two factories processing stand-over cane

Structural method	Analytical parameter	Result	
		Burdekin	Central
Specific optical rotation	$[\alpha]_{589}^{20}$	178°	182°
Periodate oxidation	Consumption IO_4/ahg*	1.25	1.27
	% (1→4), (1→6)	75, 25	73, 27
^{1}H n.m.r.	Integration of anomeric protons, (1→4), (1→6)	73.5, 26.5	70.5, 29.5
Specific enzymes pullulanase	Maltodextrins by paper chromatography in ethyl acetate:pyridine:water (10:4:3)	G_2, G_3, G_4, G_5	G_2, G_3, G_4, G_5
α-amylase		G, G_2, G_3, G_4	G, G_2, G_3, G_4
dextranase		nil	nil

* anhydroglucose unit.

50% ethanol and thereafter, mostly arabinoglactan (Fig. 1 and Table III). The authors' experience with gel permeation chromatography of these components suggests that the arabinogalactan elutes before sarkaran and is therefore a slightly larger molecule. This, of course, assumes similar solution dynamics for both polysaccharides on porous gels. When the sample is deionized, the amount of haze-forming material is quite low when compared with other samples containing lesser amounts of glucan (*cf.* 1.74 and 11.75, Table I).

It was noted that removal of sucrose, both by repeated washing of precipitates with aqueous ethanol and by exhaustive dialysis, can be very inefficient. Presumably mechanisms of ash-carbohydrate binding, as revealed in the fractional precipitation results and the physical blocking of membrane pores, are operative.

Dissolution of recovered fractions was a problem often experienced and seemed to be related to ash levels in samples. The resultant insolubles were usually rich in inorganic components. However, analyses of the relative composition of carbohydrate in soluble and insoluble portions were similar enough to dismiss the notion that selective solubilization was occurring.

The other problem in isolation of polysaccharides from molasses was the removal of colour. In some cases chromatographic profiles for carbohydrate and colour were identical while, in others, some separation occurred and, by judicious bulking of fractions and rechromatography, material essentially free of colour could be obtained.

In these studies supply of material for analysis was no problem and, as demonstrated in decolorizing experiments (Fig. 2), large losses of carbohydrate could be traded for removal of colour. Relative compositions of carbohydrate fractions as shown in Table IV, reveal that no significant selective loss of a polysaccharide type occurred.

Purification work by chromatographic methods was effected in strong urea solutions to minimize the associative effects of hydrogen bonding. This had little influence on colour removal but did seem to minimize carry-over of the arabinogalactan polysaccharide.

The arabinogalactan impurity in the 50% aqueous ethanol fraction from Burdekin molasses, 1.74, was effectively removed by passage through macroporous ion exchange resin. This observation proved beneficial in subsequent efforts to isolate and purify that molecule[5].

The presence of dextran and starch components in the glucan fraction was partly overcome by enzymic digestion. Final assay with dextranase gave confidence for its complete removal. The removal of starch components was a more difficult problem. The low-intensity iodine absorption band around 500-530 nm indicated the probable presence of amylopectin fragments in which the average chain length limited both the intensity of absorption and the wavelength at which this occurred. Maximum iodine absorption for cane starch amylopectin is around 540 nm[6]. This could not be degraded with α-amylase because that enzyme can depolymerize sarkaran. The best that could be hoped for was that β-amylase would reduce the size of the amylopectin fragments by its action on the outer chains and this would enable some separation by gel permeation chromatography. This was partly successful as demonstrated in Fig. 3(b) but some fragments remained as evidenced by the action of α-amylase on the final product and the high specific optical rotations of both final glucans (Table IV).

Apart from this, there is little doubt that the glucan is essentially sarkaran, the results being supported by similarity of n.m.r. spectra, periodate oxidation and degradation by pullulanase. Its presence in the final molasses is attributed to the stand-over cane being processed at the time that factory problems arose.

Summary

Molasses from sugar factories which have crushed stand-over cane and which have suffered process difficulties have been examined. Problems in the isolation and purification of the causative material are described. There is little doubt that this material has been correctly identified as sarkaran.

Un polysaccharide hydrosoluble provenant de canne laissée en champs. Partie II. Isolement et caractérisation structurale à partir des mélasses

On a examiné des mélasses obtenues dans des usines qui travaillaient de la canne laissée en champs et qui avaient des

5 Blake *et al.: Carbohyd. Res.*, 1983, **115**, 265.
6 Whayman & Willersdorf: *I.S.J.*, 1976, **78**, 67.

difficultés dans les processus. On décrit les problèmes reliés à l'isolement et la purification du matériel en question. Il y a peu de doute que le produit fut correctement identifié comme étant du sarkaran.

Wasserlösliches Polysaccharid aus "Stand-over"-Rohr. Teil II. Isolierung und strukturelle Charakterisierung in Melasse

Die Melasse aus Fabriken, die "Stand-over"-Rohr verarbeiteten und Verarbeitungsprobleme hatten, wurde untersucht, und die Probleme der Trennung und Reinigung der die Schwierigkeiten verursachenden Substanzen werden beschrieben. Es bestand wenig Zweifel, daß diese Substanzen richtig als Sarkaran zu identifizieren seien.

Un polisacarido soluble en agua encontrado en caña restante de la zafra anterior.

Parte II. Aislamiento y caracterización estructural de material proveniente de melaza

Se han examinado melazas obtenidas de fábricas que han molido caña restante de la zafra anterior y que han sufrido problemas en el proceso. Se describen los problemas en el aislamiento y purificación del material causativo. Había poco duda que este material se ha identificado sin error como sarkaran.

Ultrafiltration as an alternative for raw juice purification in the beet sugar industry

By T. R. Hanssens, J. G. M. van Nispen, K. Koerts and L. H. de Nie

(Continued from page 229)

The process variables investigated were:

(i) temperature, controlled by a thermostat in the circulation line and cooler,
(ii) pressure, maintained at about 300 kPa at the feedside of the circulation pump,
(iii) linear velocity, regulated by a butterfly valve in the circulation line, and
(iv) concentration factor, varied by a flow-ratio controller.

During trials with the second stage ultrafiltration the pressure, temperature and concentration factor were controlled manually. The linear velocity was adjusted by means of the pressure difference over the modules with the help of the pressure-valve in the circulation line. This part was placed in front of the fully-instrumented unit mentioned above to make it possible to work with a two-stage ultrafiltration system (Fig. 6).

Feed

The average composition of the feed (F) was that of a typical raw juice from the diffusion tower and scalder (see Table II).

Table II

Temperature	35°C
Brix	15.4%
Purity	87.7%
Insolubles (v/v)	2%
Sand, estimate (w/w)	0.1%
pH	5.9

The raw juice was neither filtered before ultrafiltration nor pretreated in any other way. The aim was to determine the effect of fouling on the performance of membranes and to plan adequate cleaning procedures which required minimal effort.

Permeate or product

A typical composition of product or permeate obtained by one-stage ultra-filtration is given in Table III.

Table III

Permeate or product	
Brix	14.8%
Purity	89.4%

As the composition of permeate depends on concentration factor and the quantity of diafiltration water, an overall mass balance is given in Fig. 4. This shows that 12% (w/w) fresh water on raw juice feed was supplied.

An important criterion for judging the quality of the permeate is the test for the precipitation of protein at pH 2. This is important because of the risk of precipit-ation and column blockage during any subsequent ion exchange treatment.

According to Kofod Nielsen *et al.*[2], an alternative to ion exchange for removing low molecular compounds, is liming with 0.05% CaO on beet; this is substantially less than the 1.5 or 2% CaO on beet used in the traditional beet sugar manufacturing process.

As can be seen from Tables II and III the increase in putiryt is about 2 points. This is comparable to the conventional juice purification process.

The colour of the permeate was a very light violet, but at the composition is different from thin juice, it is difficult to make a colour comparison.

Retentate or concentrate

A typical compositon of the retentate produced is given in Table IV.

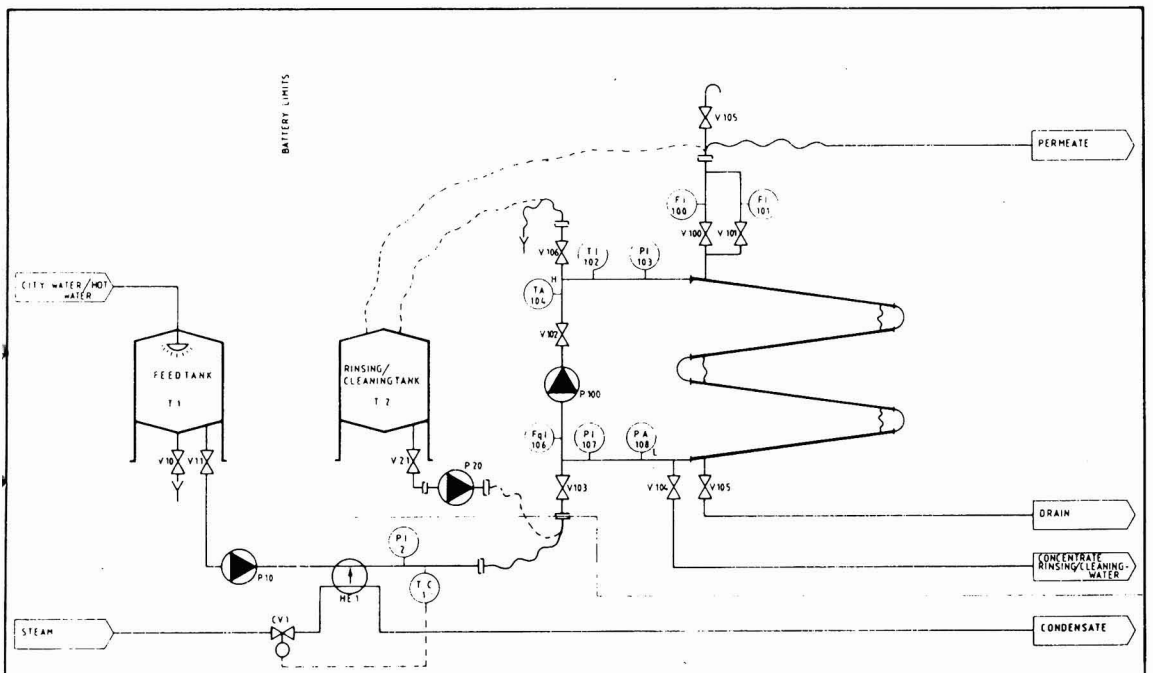

Fig. 6. The first stage of an ultrafiltration plant (by courtesy of WAFILIN)

Table IV	
Rententate or concentrate	
Brix	13.8%
Purity	77.6%

The composition of retentate is dependent on the concentration factor and quantity of diafiltration water (Fig. 5). The sugar loss in the retentate represents 0.7% on beet in the given example.

There are possible applications for the retentate (in this example 8% on beet) in cattle feed. An alternative is to mix retentate with the main stream of the raw juice and send it to the conventional purification by carbonatation; for doubling of the slicing capacity would then give an increase of 0.1% in CaO on beet. However, this is only interesting when there is a need to increase the nominal slicing capacity without increasing the existing carbonatation stage and the lime production facility.

Parameters studied

The alternative values of temperature, concentration factor, velocity, feed pH, etc. that were employed during the trials are tabulated below.

Table V	
Temperature, °C	30, 40 or 60
Concentration factor	2, 5, 8, 10 or 12
Linear velocity, m/sec	3, 3.5 or 4
Diafiltration, %	5, 10, 15 or 20
pH of feed	as is or 7.2
Run time, hr	up to 8

Influence of pressure and concentration factor

The influence of pressure on the flux was small. Some flux increase was noticeable up to 600 kPa with a low concentration factor and a linear velocity of about 4 m/sec above 45°C. With a higher concentration factor and/or lower temperatures and a decreasing linear velocity, the pressure influence will be smaller. An example of the flux *versus* time lapse is shown in Fig. 7.

Effect of pH

It appears that an increase of the pH has a positive effect on flux up to a pH of about 7.2. Compared with untreated raw juice the average flux at pH 7.2 was approximately 50% higher with a concentration factor of 3 (55°C, 3.9 m/sec) and about 20% higher with a concentration factor of 5.

Another observation was that the flux decline was smaller. The advantage of higher fluxes as opposed to higher load of metal ions from the alkali used for pH adjustment in the product depends mainly on the application for the permeate.

In the trials described here the increase of metal ions was about 10 meq/l at pH 7.2. As a result of pH control the overall increase in ultrafiltration capacity at a concentration factor of 10 was 35%; with a diafiltration stage the increase in flux was about 10%. An explanation for this phenomenon may be found in the effect of pH on the colloidal components in the raw

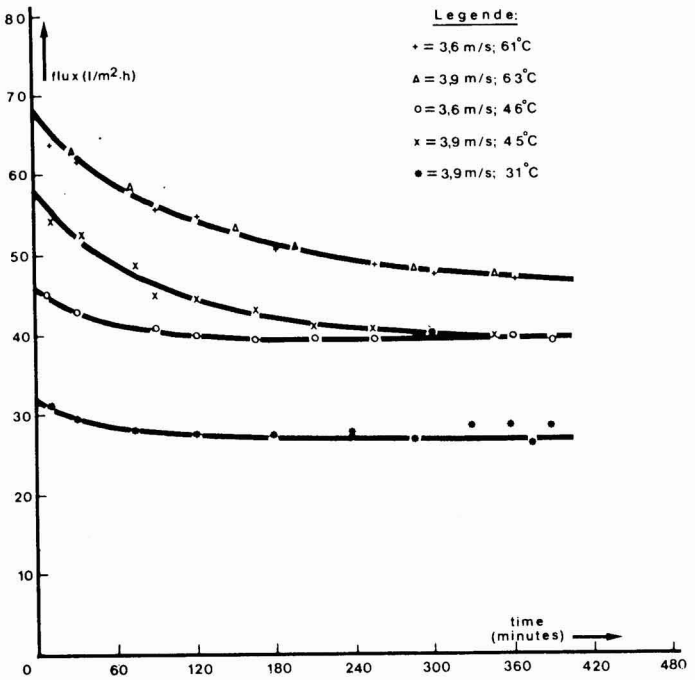

Fig. 7. The flux of raw juice versus time at a constant concentration of 2 and $\bar{P}$ = 500 kPa

juice. The electrical charges of the colloids will also change with pH and may cause the colloids in the raw juice to adhere more firmly to the membrane surface, thus resulting in a lower flux level.

Temperature

At a concentration factor of 2 it was observed that the flux increases at 1.5% per °Centigrade temperature rise. At higher concentration factors the increase was smaller and in the region of 1.0% per °C temperature rise.

Run time

During the first 4 hours there was a rather rapid flux decline, but thereafter the flux became more or less stable. It was found that with a concentration factor of 2 and an average linear velocity of 3.7 m/sec the average flux at 60°C was 53 l/m²/hr during the first 6 hours. After this period it stabilized at 47 l/m²/hr.

The average flux during 6, 10 and 20 hours is given in Table VI.

Table VI

T, °C	Flux, 6hr	Flux, 10hr	Flux, 20hr
	litres/m²/hr		
60	53	50	49
45	41	40	40
30	29	28	28

The conditions were: a concentration factor of 2, linear velocity of 3.9 m/sec, and pH 5.9. The average flux over longer than 8 hours has been extrapolated. The delayed stabilization of flux may probably be attributed to the very low content of colloidal matter in raw juice and to the slow build-up of a colloidal layer. Similar results were obtained at high concentration factors up to a factor of 10.

At this level the tendency to stabilize was present but less clear. Table VII shows the average flux of raw juice over 6 hours at different concentration factors and temperatures. The average flux over 10 hours is given in brackets.

Table VII

Concentration factor	60°C	45°C	30°C
	litres/m²/hr		
2	53 (50)	41 (40)	29 (28)
5	45 (42)	35 (33)	— (—)
10	40 (35)	29 (27)	— (—)

Cleaning procedures

Fouled membranes were cleaned effectively with a sodium hypochlorite solution containing 1500 ppm active chlorine.

The main criterion for adequate cleaning was the level of the clean water flux.

Another criterion was the total cleaning time needed to reach a flux level equivalent to that of the original clean water flux.

The standard washing procedure involved a flushing cycle of the contents of the membranes with water followed by 20 minutes flushing with the hypochlorite solution at 40°C, 430 kPa and 4 m/sec.

In some cases, a good recovery of the clean water flux from heavily fouled membranes was obtained by using a proteinase-containing detergent in combination with the chlorine solution.

Discussion

The results of this study show that it is possible to purify raw juice by ultrafiltration to the same degree as by the conventional method, but that further treatment with 0.05% lime on beet[2], electrodialysis or ion-exchange may be necessary to remove some of the remaining impurities. With the membrane system used there was an increase in the flux with temperature up to 70°C and with pH up to 7.2. Results from the experiments with the linear velocity are more difficult to assess. On the one hand a high linear velocity gives a more stable flux, lower capital

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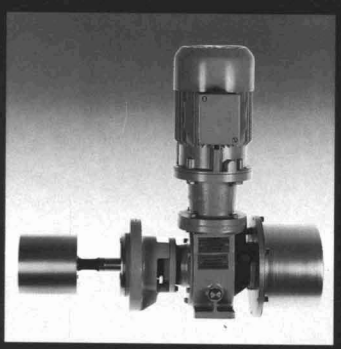

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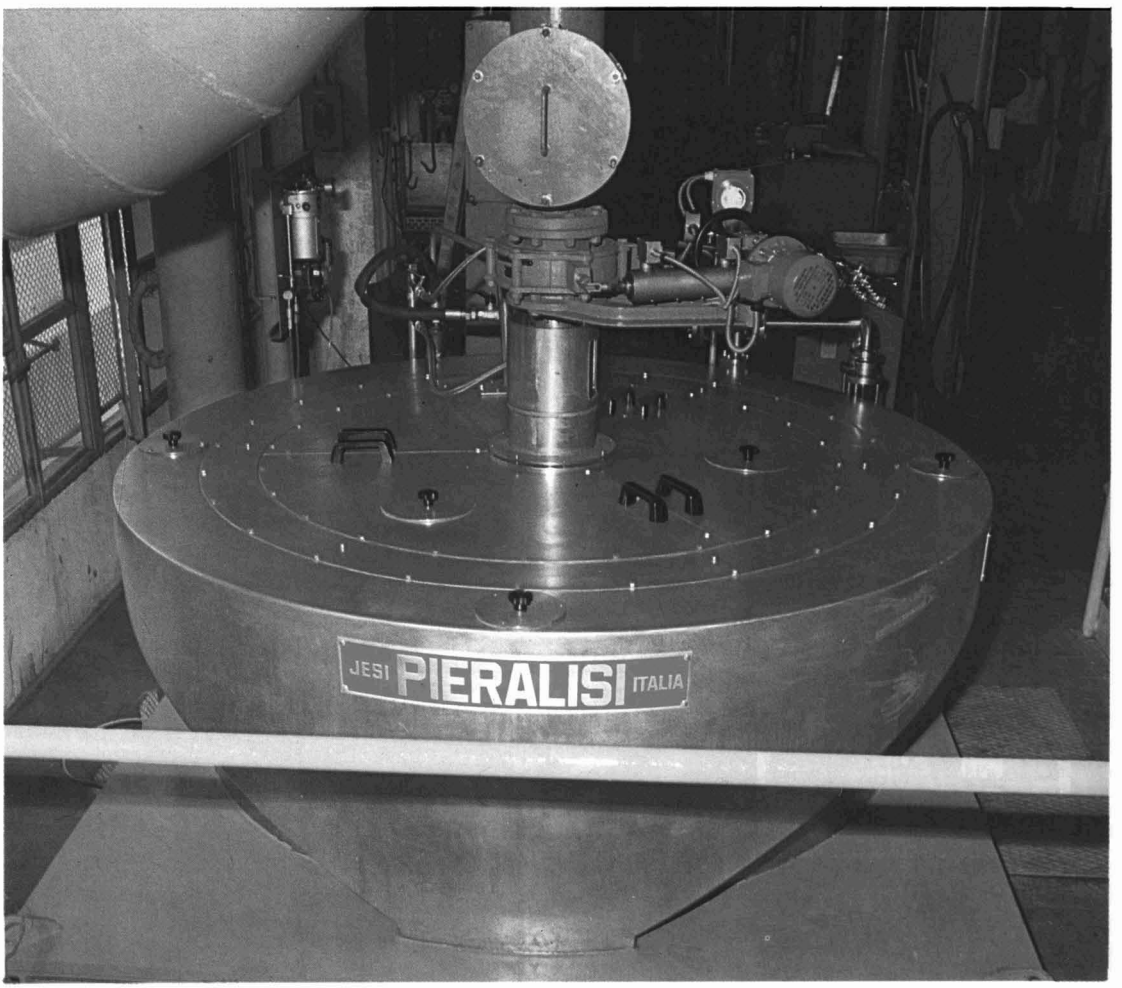

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ISJ Abstracts

Cane sugar manufacture

Technological aspects of cane separation

M. Biddlestone, R. Bryan and L. Humes. *J.A.S.T.J.*, 1978-80, **39-41**, 258-263.

The theory of cane separation into its pith and rind/epidermis components is discussed and a description given of the unit developed by Canadian Cane Equipment Ltd.[1] Investigations were carried out with four cane varieties, three of them in an unburnt state and one of them in both green and burnt state, and the results are discussed in terms of mass and pol balances as a function of work opening. The composition of the three components was also determined. An estimate is given of product yields from separation technology, and projected applications of the products are briefly examined.

Automatic process controls in Jamaican sugar factories

M. Hylton. *J.A.S.T.J.*, 1978-80, **39-41**, 263-265.

An outline assessment is made of automatic control applications, with particular reference to evaporators, boilers and vacuum pans.

Liquid sugar

H. Bourzutschky. *J.A.S.T.J.*, 1978-80, **39-41**, 284-286.

The production process involved in liquid sugar manufacture, handling and storage are described, and the current and future potential of liquid sugar as a product for various industries is indicated. The aim is to show how Jamaica could benefit from liquid sugar manufacture.

New system of conditioning of feed molasses

H. Rahim. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 43-51.

A model of the molasses conditioner described by Mishra[2] was constructed at Bawany Sugar Mills Ltd. for trials in 1977/78. After a number of problems had occurred, some modifications were made, and the conditioner operated in conjunction with a 35-tonne low-grade vacuum pan in the 1979/80 season. Results showed that the average boiling time was reduced by about 30% compared with the system using a mechanical diluter, while steam consumption was reduced and boiling house performance raised. Greater purity drop from massecuite to final molasses was indicative of improved exhaustion.

Sugar mill instrumentation

M. Ahmad. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 37-42.

Instrumentation and controls for various evaporator parameters are briefly described, and an outline is given of cascade and feed-forward control systems.

Performance of first continuous centrifugal with 25° angle basket at Dadu Sugar Mills, Piarogoth

S. M. Alam, A. W. Qureshi and S. I. Ahmed. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 52-59.

See *I.S.J.*, 1983, **85**, 115.

Gauging factory performance at a glance

A. Aziz. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 82-88.

For comparison of factory performances, the author proposes use of a modified form of a formula derived by Serrano[3]. Basic crusher juice purity, Pb, is given by

$$J + \left(\frac{Pol}{10} - \frac{PS}{TC}\right) + 0.02$$, where J and pol = crusher juice apparent purity and pol, respectively, PS/TC = piculs of sugar per tonne of cane (1 kg = 63.25 piculs), and 0.02 is a constant, representing the increase in % recovery per unit increase in crusher juice purity. Assessment of factory performances has been made on the basis of the formula, and gradings made according to the PS/TC value relative to crusher juice or first expressed juice pol, e.g. a factory is considered to have a good performance when its PS/TC is equivalent to at least 0.10 pol.

Fabcon juice and syrup purification system for improved clarification, filtration and purification of cane sugar juice and syrup

H. Peruelo. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 89-103.

See *I.S.J.*, 1980, **82**, 89; 1981, **83**, 219.

An investigation into exhaustibility of final molasses with respect to the composition

Z. Qadir and M. Aslam. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 104-109.

Factors affecting molasses exhaustibility are discussed, and results of analyses of molasses from four Pakistan sugar factories are compared, showing a molasses total sugar content ranging from 45.63% to 57.40% on Brix.

Mechanical unloading of sugar cane at the factory gate

M. A. Qureshi. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 110-117.

A short survey is presented of cane unloading systems used in different countries, and the cane car tipper at the Jhang factory of Shakarganj Mills Ltd. is described. Advantages and disadvantages of the system, which was first used in 1980-81, are indicated and future plans listed.

Improvements in the carbonatation station at Pattoki Sugar Mills Ltd.

S. H. Naqvi and M. Ali. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 142-146.

Improvements to the carbonatation station were made after a number of problems in its operation had led to poor performance. The modifications

1 See also *I.S.J.*, 1980, **82**, 96; 1981, **83**, 296-300.
2 *ibid.*, 1977, **79**, 123-125.
3 *ibid.*, 1922, **24**, 46.

carried out are described, as a result of which the daily juice throughput was increased from the equivalent of 920 tcd to about 1800 tcd (as against a rated capacity of 1500 tcd).

Planned electrical maintenance of a sugar mill

Z. Ahmad. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 196-215.

Routine checking and maintenance of electrical equipment in a cane sugar factory are described.

White sugar standards

S. H. Naqvi. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 235-240.

The Pakistan standards, FAO/WHO Codex Alimentarius standards, those of the American Bottlers Association and the British Pharmacopeia standards (for sugar used in the pharmaceutical industry) are discussed in relation to white sugar.

Sugar boiling: the instruments and systems

K. Sullivan. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 217-225.

Instruments used in vacuum pans for measurement of supersaturation, consistency, absolute pressure and level are described, and various aspects of pan design and operation discussed. A basic analogue pan control system is shown diagrammatically, and application of such a system to fast boiling of high-purity syrups is described.

Fluid measurement for greater sugar mill control

S. M. Ahmed. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 227-237.

Devices for measurement of flow are described, and their applicability to factory juices, syrups, molasses, water, steam, air, chemicals and lime slurry is indicated. The use of a pitot tube-Annubar system in conjunction with an orifice plate for steam flow measurement is used as an example.

Invisible sugar losses caused by microbial activity

—. Farhatullah. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 245-265.

The literature on cane juice bacteria and dextran formation is briefly surveyed, methods for measuring sucrose inversion are outlined, and investigations on sucrose loss determination reported. The economics of losses by inversion and of inversion control are indicated, and the effectiveness of mill sanitation discussed.

Computer-based pan boiling

M. M. Raza. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 287-298.

A computer program is presented that is designed to provide a complete material balance for a pan station. Five sets of sample mini-computer outputs are tabulated, and an explanation is given of how to use them.

Vapour cell – a unique experience at Shakarganj

F. Rehman and Z. Khan. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 299-305.

A vapour cell added to the quadruple-effect evaporator at the authors' sugar factory to meet increased steam requirements (the alternative of an additional boiler was considered too costly) had the desired effect of reducing steam consumption at a higher crushing rate. Details are given.

A major expansion completed in Colombia. Ingenio Manuelita capacity rises to 6500 tonnes of cane per day

Anon. *Sugar y Azúcar*, 1983, **78**, (12), 49, 51.

Details are given of the changes and new equipment installed for expansion of the sugar factory, which is located in the Cauca Valley. The extension is an intermediate one from the initial crushing rate of 4800 tcd, and provision is made for an eventual expansion to 11,000 tcd.

Sustained cane quality for improved productivity and profitability

E. P. Ocampo. *Crystallizer*, 1983, **6**, (4), 9, 12-13.

The importance of minimizing the delay between harvesting and processing and of minimizing the trash content is discussed with the aid of tabulated data for Canlubang factory. In 1982-83 the ratio of tonnes of sugar (96 pol) to tonnes of cane was the best for five years.

Modified distribution formula for molasses

F. P. Dizon. *Crystallizer*, 1983, **6**, (4), 10-11.

A modified formula is presented for calculation of molasses losses and of boiling house performance in terms of losses.

Sugar manufacture research (in Mauritius)

Anon. *Ann. Rpt. Mauritius Sugar Ind. Research Inst.*, 1982, 48-52.

Details are given of the instrumentation used in a study of sugar factory energy balances, and of the work carried out at three sugar factories during the crushing season. The data obtained are being processed by mini-computer. Results obtained at Beau Champ that are typical for a normal working day indicate hourly steam consumptions of 41.7 tonnes by the turbo-alternators, 26.0 tonnes by the mills, 12.6 tonnes in cane preparation and 17.1 tonnes for other uses; 170 tonnes of cane was crushed per hour, at 13.53% fibre content, giving 91.1% mixed juice on cane, a mixed juice Brix of 12.95° and a syrup Brix of 53.55°. The turbo-alternator efficiencies at Riche-en-Eau factory are plotted for three units. Mention is made of the use of a data-logging system to monitor the energy balances in conjunction with a mini-computer. Operation of the system and some teething problems are described. Trials on the effect of storage conditions

on the gross calorific value and moisture content of bagasse are reported. Results showed that the greatest moisture loss (a reduction from 56.1% to 21.0%) occurred after two months' storage of baled bagasse in a closed store; there was also a high moisture loss in baled bagasse stored under open cover. While the moisture loss in baled bagasse was initially slower than in loose bagasse, the positions were reversed after six weeks. The moisture content of bagasse, baled or loose, stored in the open depended on the weather. The calorific value of bone-dry bagasse varied little and was virtually the same after two months, regardless of storage conditions. A method was evaluated for determination of imbibition efficiency; it is based on determination of the fibre and moisture contents of the mill feed at an assumed level of Brix-free water. The results are used to calculate the Brix of juice obtainable under perfect mixing conditions, and the Brix then compared with that of extracted juice. For samples of finely chopped cane, no significant difference was found between the Brix of extracted juice and the calculated Brix at P = 0.05, indicating that the method may be used confidently in industrial practices.

Cane washing

H. Birkett. *Sugar Bull.*, 1983, **62**, (5), 6-7.

Good cane washing, which can remove up to 80% of the field soil accompanying the cane, can be accomplished by maintaining a very thin cane mat on the table and using enough water to tumble the cane; a good cane washing table should also provide the main cane conveyor with drained cane. While it is generally easy to obtain a thin cane mat under dry weather conditions when not much trash is present, under adverse weather conditions and with deliveries of green cane the mat may be too thick for proper washing. However, even under these conditions the mat could be kept thin by operating the table at maximum speed, although at many factories the table is operated only intermittently. A daily wash water rate of 1.5 gal/min/short ton of cane is usually sufficient, although muddy conditions may necessitate increasing the amount, any additional water helping to thin the cane mat. Some advice is given on correct operation of a wash table, including the heights of the fingers. It is calculated that at some factories as much as 10% wash water (on cane weight) is being entrained, generally because of water application at a point too close to the top of the wash table; the quantity of entrainment increases with trash in cane but can be reduced by using a tall table (long deck) and applying the water about two-thirds up it to provide a drainage area between the application point and the top of the table. Since 10% entrained wash water is equivalent to about half of the imbibition, its quality is important (because it enters the mixed juice); if the wash water used has not been settled, or only partly so, washing of the cane should be followed by another washing with relatively clean water, which would also reduce the risk of evaporator scaling reported from some factories that recycle cane wash water. It is recommended to provide a settling pond adequate for 24 hours' retention of wash water containing 0.5-1.0 lb of sugar per ton of cane; use of two floating aerators is generally sufficient to handle the BOD load and give a clear, odourless water of neutral pH.

Modernization and rationalization of the Réunion sugar industry. Report of a fact-finding mission in Réunion

J. T. d'Espaignet. *Rev. Agric. Sucr. Maurice*, 1983, **62**, 75-80 + 2 pp *(French)*.

Details are given of new equipment and process modifications introduced at four Réunion sugar factories (Le Gol, Savanna, Bois Rouge and Beaufonds).

Boiler make-up water and energy economy

J. T. d'Espaignet. *Rev. Agric. Sucr. Maurice*, 1983, **62**, 81-83 + 2 pp *(French)*.

Sources of steam and high-grade condensate losses are examined; while the total loss is of the order of 15-20% of the boiler output, it may be appreciably higher because of undesirable factors concerning boiler pressure control, steam usage and/or use of boiler make-up water of high mineral salts content. Advice is given on methods of solving the problems, including replacement of raw water with condensate from the 2nd evaporator effect for use as make-up.

Unit for cooling (conditioning) raw sugar

P. V. Poltorak, Yu. D. Golovnyak, A. F. Zaborsin, S. A. Brenman, E. P. Brenman, E. P. Tkachenko, J. Lodos, E. Casanova, I. Diaz, H. Kirch, M. Canales and D. Esson. *Sakhar. Prom.*, 1984, (1), 21-23 *(Russian)*.

Details are given of a raw sugar cooler demonstrated at the special exhibition associated with the 18th Congress of the ISSCT in Cuba, 1983, and based on an experimental model first developed in the USSR and tested at Ciudad Caracas factory in 1979/80. The plant is rated to reduce the temperature from 50-55° to 13-15°C at a throughput of 50-70 tonnes/hr.

TSC's quality control program

Y. C. Yen and S. L. Chen. *Taiwan Sugar*, 1983, **30**, 180-184.

An account is presented of the quality control program used by Taiwan Sugar Corporation for process and final product (including sugar, alcohol, yeast, paper pulp, etc.) and for preventive maintenance of equipment.

Clarifier performances — an assessment

P. V. L. Narasimham. *Proc. 47th Ann. Conv. Sugar Tech. Assoc. India*, 1983, Mg.33-Mg.39.

Factors controlling clarifier design, the operation and performance of multi-tray, multi-feed, multi-withdrawal clarifiers, use of flocculants and the advantages and disadvantages of modern clarifiers are discussed.

Beet sugar manufacture

A more rational approach to introduction of ion-exchange techniques in the sugar factory

G. Rousseau and X. Lancrenon. *Ind. Alim. Agric.*, 1983, **100**, 703-707 *(French)*.

The advantages of juice demineralization by ion-exchange in regard to sugar colour and quality are discussed in the case of Eppeville sugar factory, covering both normal campaign working and post-campaign processing of thick juice from another sugar factory. Comparison is made between the results obtained using a 3-massecuite boiling scheme to produce an *A*- and a *B*-white sugar where ion-exchange is used, and a 3-boiling scheme that provides only one *B*-white sugar where juice demineralization is omitted. In the former case, the *A*-sugar has an EEC rating of 6.7 points (corresponding to Category 1 white sugar) while the *B*-sugar has a rating of 17.5 points (corresponding to Category 2); the *C*-sugar used as remelt has a purity of 98.5 and a colour of 2000 ICUMSA units. Where demineralization is not used, the *A*-sugar has a rating of 8.2 points (corresponding to Category 2); the standard liquor formed from thick juice and remelted *B*- and *C*-sugars (of 1000 and 2000 ICUMSA colour units, respectively) has a purity of 94.5 and a colour of 1650 ICUMSA units. Demineralization is also shown to increase white sugar recovery and the volume of massecuite processed.

Microprocessors in optimum control systems for an evaporator

V. G. Belik and I. I. Kostanzhi. *Sakhar. Prom.*, 1983, (12), 31-33 *(Russian)*.

The components of a microprocessor-controlled system designed for a quadruple-effect evaporator with concentrator are explained.

Investigation of heat transfer and resistance during liquid flow in an annular channel

V. F. Naumenko, I. A. Dubovis and I. I. Sagan'. *Sakhar. Prom.*, 1983, (12), 37-39 *(Russian)*.

Investigations are reported on heat transfer and resistance to it in an annular heat exchanger. The results have been applied to the design of oil heaters for the power-houses at a number of sugar factories. Annular heat exchangers are recommended for their high heat transfer coefficients at low Reynolds' numbers; they have small dimensions and are recommended for use in heating water, raw juice, thick juice and oil.

Reduction in the processing quality of sugar beet affected by varying degrees of storage rot

V. A. Knyazev *et al. Sakhar. Prom.*, 1983, (12), 40-43 *(Russian)*.

Studies were carried out on the effect of rot on processing. Results showed that for each 1% of rotted fibre there was a 1.06 unit fall in thin juice purity, a 0.3% fall in sugar yield and a 4% increase in the quantity of beets that needed to be processed per unit sugar output. Rotting adversely affected processing, increased colour formation and reduced crystallization rate, etc. Advice is offered on application of the regression coefficients, found by statistical analysis of the results, to predict the chemical composition and processing properties of stored beet.

The problem of colouring matter formation in sugar manufacture

F. Heitz. *Ind. Sacc. Ital.*, 1983, **76**, 133-139 *(Italian)*.

After explaining the physical basis of colour perception, the author describes the trichromatic measurement of colour in which he draws a parallel with colour television. He then discusses the occurrence of colorants in the beet sugar factory, grouping them under: those having their source in the beet and first appearing in raw juice (e.g. polyphenols), those such as caramels having their origin in sucrose, and those that are derived from products of sucrose hydrolysis, of hexose alkaline degradation and of the Maillard reaction (e.g. melanoidins). Conditions under which the various colour compounds are formed are described, as are means of preventing and/or eliminating them.

Effect of the thermal condition of piled beet on storage losses

M. T. Amaducci. *Ind. Sacc. Ital.*, 1983, **76**, 140-143 *(Italian)*.

Experiments were conducted in 1980 and 1981 on storage for 21 and 28 days, respectively, of "hot" and "cold" beet, in order to establish the effects of their temperature when first piled on subsequent losses. Graphed results showed that beets stored "hot" after having been left in windrows during the hottest part of the day suffered higher losses than beet piled in the morning after having been left in the soil during the cooler hours of the night. Thus, the sugar losses in the "hot"beet after 4 and 14 days of storage were practically the same as those in the "cold" beet after 14 and 21 days, respectively.

Residence time and juice coloration in an evaporator station

K. Vukov, I. Körmendy and H. M. Loko. *Zuckerind.*, 1983, **108**, 1144-1149 *(German)*.

See *I.S.J.*, 1983, **85**, 378.

Treatment of pulp drying vapours and heat recovery

Anon. *Zuckerind.*, 1983, **108**, 1149-1150 *(German)*.

At Rethen sugar factory, the evaporator had become too small for current requirements, yet it was going to be difficult to enlarge it, so that the decision was made to utilize heat recovered from pulp drying vapour and boiler flue gas in a falling-film evaporator, in which thin juice is concentrated from 17° to 23-25°Bx as a pre-evaporation stage. Details are given of the Alfa-Laval plant for treatment of the waste gas-vapour mixture of 108°C at a rate of 210,000 m^3/hr and of boiler flue gas of 175°C at a rate of 30,000 m^3/hr (which by-passes pulp drying). The plant is located in the open between the main factory building and a new 100-m high boiler chimney.

Technological changes in some of Europe's sugar-producing countries

L. Rosenberg. *Sugar J.*, 1983, **46**, (5), 7-11.

The answers from technologists, representing 10 countries at the May 1983 meeting of the German Sugar Technologists' Association (VDZ) and at the June 1983 meeting of the CITS, to questions put by the author on aspects of beet sugar technology are set out by country. The questions concerned technological changes made during the last five years, technological changes intended during the next few years, and the main tasks of research and development for the next few years. The ten countries represented were: Belgium, Denmark, France, Greece, Holland, Italy, Spain, Sweden, UK and West Germany.

Sugar beet storage under the conditions of 1983

G. Rizescu. *Prod. Veget., Cer. si Plante Tehn.*, 1983, **35**, (10), 31-35 *(Rumanian).*

The climatic conditions of 1983 had a marked detrimental effect on beet physiology and biochemistry – the young seedlings were exposed to a prolonged dry period, while temperatures in late July-early August often exceeded 32-34°C. The consequence was high estimated losses in weight and sugar. The problems of storing beet under such conditions are discussed with the aid of tabulated data showing the effects of degree of wilting, of impurity content, of temperature and of pile dimensions on losses; it is also important to ensure that sub-standard beets are stored separately from healthy beets, which should weigh more than 150 g.

Enteric bacteria in sugar beet processing waste waters

K. R. Mitchell and B. R. Funke. *Environmental Pollution, Series A*, 1982, **28**, (2), 81-88; through *S.I.A.*, 1983, **45**, Abs. 83-1576.

Studies were carried out at the American Crystal Sugar Company beet sugar factory at Hillsboro, North Dakota, throughout the 1978-79 campaign. Salmonellae and faecal coliforms were present in most of the samples of soil adhering to incoming beet. In flume water, counts were high (14×10^6 Salmonellae and 49×10^6 faecal coliforms/100 ml) early in the campaign, and then gradually declined. In the final effluent, stored in a lagoon before being used for irrigation, Salmonellae were present in January-March 1978, but not between June 1978 and April 1979; counts of faecal coliforms ranged from 170 to 46,000/100 ml between July 1978 and April 1979. Neither type of organism was detected in alfalfa grown on plots irrigated with the effluent. Thus use of the effluent for spray irrigation does not appear to be a public health hazard, but there could be a hazard for workers coming in contact with flume water.

Is it possible to reduce losses, reduce fuel consumption and increase throughput with the same diffuser?

J. P. Lemaire and J. Petry. *Sucr. Franç.*, 1983, **124**, 457-464 *(French).*

The Steffen process of juice extraction from cossettes at Frasnes-Lez-Buissenal factory in Belgium is described. The cossettes are heated with juice in two stages from 12.4° to 45.4° and then to 70.5°C, after which they pass to a prescalder, where the juice-cossettes mixture is heated to 75°C (the circulation juice temperature being raised from 75° to 83°C). The mixture is then homogenized during 2 minutes' retention in a horizontal, cylindrical tank with internal movement. The mixture passes to a special type of rake conveyor, provided with grids, for removal of the juice (for recirculation). In this initial stage of the process, some 20% of the sugar in the cossettes is extracted. The second stage embodies six Ferriani presses, five of which are in operation and the sixth is used as standby; each press has a perforated screen exterior and an internal perforated drum driven by a 37-kW motor and rotating at 3 rpm, the applied pressure being regulated by a cone. About 55% of the initial sugar in the cossettes is extracted by these F.1100 presses, after which the cossettes are treated by conventional diffusion, which extracts 23.35% of the initial sugar. The juice from the presses is mixed with that from diffusion for purification. Advantages of the scheme have included a 20% increase in throughput (although bottlenecks in the factory, particularly in low-grade boiling, have made it difficult to maintain the increased slice of 6000 tonnes/day), a 11% reduction in "diffusion" losses from 0.214 to 0.191%, a 12-unit reduction in juice draft to 120% and a fuel consumption lower by 8% (as a consequence of the increased throughput and reduced draft). The system does have an adverse effect on pulp pressing (a 0.7 unit fall in dry solids to 21.7%.

The effect of beet quality on sugar manufacture

L. Wieninger. *Cukoripar*, 1983, **36**, 126-130 *(Hungarian).*

The author, formerly head of the technological department of the Sugar Research Institute in Austria, discusses research on the effects of beet non-sugars on the manufacturing process and white sugar yield. In stressing that it is not the sugar content alone that governs the processing properties of beets, he cites the example of beet samples from two factories which had very similar sugar contents (18.61 and 18.47%) but differed in their alkali and particularly nitrogen contents. By means of equations, the effects of (Na + K) and N on thick juice purity and alkalinity coefficients and of (Na + K) on the melassigenic coefficients are demonstrated; the relationship between raw juice colour and invert content is also shown. The composition of raw and thick juice from the two samples as well as molasses sugar and white sugar yield are compared. From the beet of lower non-sugar content, 17.00% white sugar on beet was obtained, compared with 15.43% from the other beet. Moreover, more limestone and coke was consumed to provide the greater amount of lime needed to treat the juice from the poorer-quality beet, while the total massecuite quantity was also greater.

Heat economy control in beet sugar plants

K. Urbaniec and J. Rucinska. *Sugar Tech. Rev.*, 1983, **10**, 97-182.

The theoretical background to heat economy in a beet sugar factory and the establishment of an energy balance on the basis of the first law of thermodynamics are explained. The approach to analysis of a heat balance is described, and sources of heat loss are indicated. Means of controlling and reducing heat consumption are discussed. Measurement of temperature, pressure and flow and analysis of flue gas are described, and control of water and steam quality discussed. The procedures used to determine water hardness, oxygen consumption and sugar content, pH, alkalinity and other properties are described. Fuel analysis is considered, covering sampling of fuels, determination of the properties of coal and fuel oil, measurement of the heat of combustion and calorific value and control of fuel storage. Under boiler house control are discussed methods of measuring important parameters for a boiler energy balance, combustion control, steam generation and heat balance of the boiler house; under power house control are considered methods of parameter measurement, steam consumption, turbo-generator power output, energy balance and efficiency. Pulp dryer control is discussed, including measurement methods, establishment of mass and heat balances and economical operation. A discussion of control of process heating equipment covers the evaporator, diffuser, juice heaters, vacuum pans and other heat users such as granulators, melters, storage tanks, etc. The operation of auxiliary equipment, including steam throttlers-desuperheaters, barometric condensers, steam traps, steam and vapour lines and vents, is described, and the completion of heat economy reports is briefly discussed.

Improving the quality of sugar factory thin juice by anion exchange

E. Gryllus. *Cukoripar*, 1983, **36**, 146-150 *(Hungarian)*.

Details are given of the Gryllus thin juice deliming process[1] and of trials conducted at Szolnok sugar factory over 49 days, in which the colour was reduced from 35.8°St/100°Bx to 32.8°St, the CaO content from 165 to 117 mg/100°Bx, thick juice purity was raised from 87.71 to 88.64, molasses sugar reduced from 2.83% to 2.64% on beet and the soda consumption for evaporator descaling reduced from 165 to 117 kg per tonne of beet.

Erection of a Buckau-Wolf tower diffuser at Petohaza sugar factory

M. Tomordi. *Cukoripar*, 1983, **36**, 150-154 *(Hungarian)*.

Details are given of the Buckau-Wolf tower diffuser of 4000 tonnes/day beet throughput erected at Petohaza, and some information is given on its performance during the 1982/83 campaign, when marked brittleness of the beets caused a reduction in average daily throughput to 3500 tonnes. The guaranteed loss is 0.25% on beet, attainable at 120% draft and a water pH of 5.8-6.1 with 100% press-water recycling.

Chemical and microbiological processes in anaerobic decomposition of waste water, particularly sugar factory effluents

C. Nähle. *Zuckerind.*, 1984, **109**, 19-27 *(German)*.

After a brief account of the history and development of anaerobic processes for effluent treatment, the author describes the three stages in a model of the process of methane formation[2] and then discusses factors affecting methanization, including: the possible presence of oxygen and nullification of its effect by the mixed bacterial population in reducing the redox potential; temperature; substrate components, including phosphate (particularly in regard to the adverse effect of high Ca contents in flume water, whereby any phosphate added is precipitated as Ca phosphate) and other essential nutrients; and the stoichiometry of methane formation. Pilot-plant tests on anaerobic treatment of effluent from liquid sugar manufacture and of settled flume water are reported, with details of the organic acids and total organic carbon obtained after given periods. Carbon conversion to methane with time up to about 60 days is indicated, as well as the specific biogas and methane formation from the flume water and the mud load in the reaction vessel containing the effluent from liquid sugar manufacture. A laboratory-scale experiment on treatment of chloride-containing water is reported. In the first part of the experiment, effluent from liquid sugar manufacture containing $MgCl_2$ was treated; at concentrations up to 50 g/litre, the chloride had no effect on BOD reduction. Subsequent treatment of a 1:1 mixture of the effluent with waste water from a Quentin plant restored the BOD reduction level to normality, but later treatment of Quentin effluent caused a fall from > 80% BOD reduction to 15%; after 18 days' adaptation the efficiency gradually rose to about 50% BOD reduction. The question of Quentin effluent treatment is discussed as are other questions relating to the anaerobic process.

Selecting a geometrical series of sieves

J. Gebler. *Listy Cukr.*, 1983, **99**, 273-275 *(Czech)*.

A series of control sieves for sugar screening has been developed, the size progression of which conforms more closely to the mathematics of classification than the previous empirically established series. The method used in developing the new series is described. For normal purposes, the range is from 3.15 mm down to 0.2 mm; for fine sugar, sieves of 0.125, 0.08 and 0.05 mm mesh are available. Tests have confirmed the validity of the new series, showing close agreement with values obtained by the Powers MA-CV method.

1 See also *I.S.J.*, 1984, 86, 41-44.
2 Bryant, in: "Microbial energy conversion" (Pergamon, Oxford), 1974.

New books

Zuckerwirtschaftliches Taschenbuch (Sugar economic pocket book) 1983/84

Ed. K. Dankowski, R. Barth and G. Bruhns. 254 pp; 10 x 14.5 cm. (Verlag Dr. Albert Bartens, D-1000 Berlin 38, Postfach 380 250, Germany.) 1983. Price: DM 31.00.

The contents of the 30th edition of this pocket book are set out as in past editions; they are divided into three main sections: (1) Statistics of world, European and German sugar production, consumption, imports and exports, prices, molasses data, etc., (2) the International Sugar Agreement, EEC marketing regulations for sugar, and West German pulp and molasses trading regulations, a glossary of trading terms and abbreviations, world sugar prices and contracts, and (3) addresses of international, EEC, West European and West German official organizations, sugar factories and West German plants for manufacture of liquid sugar, glucose, etc. The book contains 57 tables, 5 graphs and 3 maps. While most of the contents are in German, important parts are also in English and French, and table headings are in all three languages.

The industrial utilization of sugar and mill by-products. A literature survey

M. J. Kort. 173 pp; 20.9 x29.3 cm. (Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban 4001, South Africa.) 1983.

This is the 21st report in the series of surveys on the literature of sugar and by-products utilization, and covers work published during 1982. A total of 2138 references are given, condensed from 2310 collected. The layout of the contents is as adopted in the previous report, except for the omission of the chapter entitled "Other sweeteners, natural and synthetic" because of the need to restrict the size of the survey, which had been steadily growing from year to year as a reflection of the ever-increasing literature. Chapter 1, "By-products from sugar manufacture", includes a new section on cane tops and trash; this chapter and Chapter 2, "Livestock feeding", constitute the bulk of the report, with 941 and 249 references, respectively. Chapter 3, "Industrial uses of refined sugar", contains 393 references, Chapter 4, "Sucro-chemistry", has 311 references (no new directions of research have appeared), while Chapter 5, "Nutrition and toxicology", contains 244 references.

Dr. Kort continues to make an admirable contribution to the promulgation of information on sugar matters with his annual reports, which are clearly printed and easy to read.

Sugar processing: the development of a third-world technology

R. Kaplinsky. 148 pp; 13.3 x 21.1 cm. (Intermediate Technology Publications Ltd., 9 King St., London WC2E 8HW, England.) 1984. Price: £7.95 (£4.95 paperback).

This is the result of a study of sugar production by the open pan sulphitation process in India and Kenya to evaluate its practicalities for third-world countries by comparison with the vacuum pan process. As an introduction to the subject, the author traces the history of beet and cane sugar manufacture, and then assesses the economic and social impacts of open pan sugar manufacture based on field work in the two countries mentioned. Details are given of the open pan process and equipment, and information is given (by F. Almond) on the performance of the screw expeller (an alternative to the cane mill) and the shell furnace in open pan processing. The complexity of the factors governing choice of sugar technology is highlighted in this monograph.

The Commonwealth Sugar Agreement 1951 – 1974

J. Southgate. 64 pp; 14.8 x 20.8 cm. (C. Czarnikow Ltd., P.O. Box 602, London EC3P 3EA, England.) 1984.

The Commonwealth Sugar Agreement (CSA) was a means of guaranteeing a continuing market for a number of countries within the British Commonwealth and of guaranteeing supplies of sugar to the UK, at a negotiated price that was fair and stable over a long term. Although it is now part of history, the CSA did act as a basis for negotiations on the continuation of raw sugar supplies from developing countries within the Commonwealth to the EEC under the terms of the Third Protocol of the Lomé Convention and could be regarded as a model for international commodity trade. The author was Executive Director of the CSA for nearly 20 years, in which capacity he was the confidant of all parties to the Agreement and so can be rightly considered the best person to write about it. He has produced an objective account of the origins and implementation of the CSA and of the negotiations for UK membership of the EEC, with particular emphasis on the safeguarding of the interests of the lesser developed sugar producers who had been members of the CSA. The subject has been neatly placed in perspective against the backcloth of world sugar trading and the demands and aspirations of Commonwealth and EEC sugar producers. With the problems concerning the Common Agricultural Policy of the EEC and the lack of success of efforts to negotiate a new International Sugar Agreement, it is rather pleasant to look back on an international agreement that did work.

Ausführliche Beschreibung der Methode nach welcher bei der Kultur der Runkelrübe verfahren werden muss, um ihren Zuckerstoff nach Möglichkeit zu vermehren (Detailed description of the method by which it may be possible to increase the sugar substance in the mangold)

F. C. Achard. 63 pp; 10.5 x 18 cm. (Akademie-Verlag, DDR-1086 Berlin, Postfach 1233, East Germany.) 1984. Price: M 22.00.

This is a facsimile of the original work written by Achard and published in 1799 in which he describes, on the basis of

numerous experiments over a period of 15 years, the processes by which sugar accumulates in the mangold (fodder beet) and how it would be possible to extract the sugar and crystallize it, thus enabling imported cane sugar to be replaced by domestic beet sugar and saving what he calculated as over 4 million thaler. Achard had been appointed Director of the Physical Class of the Prussian Academy in 1782, and from 1784 was in a position to conduct experiments on his estate at Kaulsdorf near Berlin. With destruction of his property by fire in the 1790's, he continued his experiments on a newly acquired estate; yet, even by 1799, he was still not convinced that he had reached a stage where publication of the results was justified, and it was only when pressure was put on him by the board of governors did he submit a manuscript.

A 36-page epilogue to the Achard work, written by E. Junghans, gives an account of Achard's experiments, the financial support provided by the King of Prussia, the subsequent setting up of the first factory at Cunern in Silesia, and the considerable drain on Achard's physical condition resulting from his untiring efforts, including the constant changes and improvements to the machinery, the financial burdens and the establishment of a teaching institute at Cunern, not to mention other problems such as a major fire in 1807 which destroyed or made unusable all of the process equipment.

The work concludes with a general account of the adverse effect on the Prussian sugar industry of the lifting of the Continental Blockade – of 30 factories that had been operating in the Magdeburg region, none worked after 1820 – and of the revival of the industry from 1830; also discussed is the development of beet sugar manufacture in other European countries, notably France, where impetus was given to the establishment of a progressive sugar industry by the protective tariff system of Napoleon.

The book is a worthwhile contribution to the history of the origins and development of beet sugar manufacture and makes very interesting reading.

Making sugar. I. Cane mud filter

Eds. M. P. Arca and R. Esparza. 96 pp; 13.4 x 21.2 cm. (Arca Corporation, P.O. Box 558856, Miami, FL 33255, USA.) 1984. Price: $27.95.

Acra Corporation have had over 20 years of experience in designing, operating and consulting on sugar factories. Out of their check-list system of sugar machinery operation control and pre-maintenance has grown a wealth of knowledge culminating in the publication of a paperback series of trouble-shooting manuals. The first in the series concerns the use of rotary vacuum filters for cane mud treatment. Guidance is offered on preventive maintenance and on the solution to each of 71 specific problems that may arise. An index at the front of the book lists the problems, but unfortunately not in alphabetical order, although it would not take long to find a particular entry. The aim of the book is to provide a book written in everyday language that goes straight to the heart of the problem. The only criticism of the book is the fact that the pages do not fall flat but rather spring back, which could be a nuisance to the technician confronted with a problem who would obviously prefer to have the book open at the appropriate place.
A Spanish version of the manual entitled "Haciendo azúcar – Filtro de cachaza" is also available from Acra Corporation at $27.95.

Australian sugar year book 1984

Anon. 272 pp; 18.5 x 24.4 cm. (Strand Publishing Pty Ltd., GPO Box 1185, Brisbane, Australia 4001.) 1984. Price: $A 28.20.

The latest Australian sugar year book is, as previous volumes, packed with information on the Australian sugar industry. It opens with a section devoted to sugar industry organizations, with details of personnel, and follows this with a sugar factory directory, in which information is provided on the individual factories, their equipment, personnel and performances from 1973 to 1982. A section entitled "Review of the 1983 season" includes comments from sugar industry leaders, a general review of the sugar industry (including the negotiations for a new International Sugar Agreement and recommendations of the Industries Assistance Commission for restructuring of the Australian sugar industry), a review of the situation in the different sugar regions, sugar personalities, sugar industry education, details of annual conferences, BSES field days held in 1983, and extracts from the Sugar Board annual report. The third section contains highlights from the 1983 annual review of the Sugar Research Institute, the report of the Director of the Bureau of Sugar Experiment Stations (BSES), highlights from the 1983 BSES report and a background to the sugar industry. The final section is a collection of sugar industry statistics. The contents of the book are interspersed with very clear colour photographs showing various aspects of the Australian sugar industry. The year book is an invaluable source-book.

Sugar Milling Research Institute annual report 1983/1984

Ed. M. J. Kort. 24 pp; 20.9 x 29.7 cm. (Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban 4001, South Africa.) 1984.

The SMRI is the central scientific organization involved in research work concerning manufacturing problems in the South African sugar industry. Founded in 1949, it is located on the Durban campus of the University of Natal in the heart of the sugar belt, and all 16 raw sugar factories in South Africa plus the Tongaat-Hulett Group refinery are Associate Members of it, while the Institute also provides a technical service to Affiliated Member factories in the neighbouring states of Malawi, Swaziland and Zimbabwe. The annual reports of the SMRI are of interest in highlighting aspects of research which are particularly directed at practical problems that arise in the factory; details are also given of advisory work carried out on behalf of specific factories.

Laboratory studies

Prediction of ash percent final molasses from conductivity measurements

E. V. Roberts and D. Y. Byfield. *J.A.S.T.J.*, 1978-80, **39-41**, 136-138.

Statistical analysis of results obtained for 50 weekly composite samples of molasses from three factories during the 1978 crop showed that good prediction of the sulphated ash content y (%) is possible as a function of the conductivity k (mS) of 5% aqueous solutions. The regression equation obtained takes the form $y = 8.0 \times 10^{-3}\ k + 0.273$ (r = 0.90); standard error is ± 0.73. Some typical examples of calculated and experimental values are compared in a table.

Chromatographic analysis in sugar processing

M. A. Clarke, M. A. Godshall and E. J. Roberts. *J.A.S.T.J.*, 1978-80, **39-41**, 273-280.

The application of HPLC and GLC to analysis of sugars, molasses and alcohols, colorants, sugar degradation products and polysaccharides is discussed and some results tabulated, including the volatile constituents of molasses and sources of flavour in brown sugar.

Developments in analytical methods

S. J. Clarke. *J.A.S.T.J.*, 1978-80, **39-41**, 281-283.

A survey of work carried out at Audubon Sugar Institute in the development of new and modified analytical techniques is surveyed, including research to find a suitable reagent to replace lead subacetate in expressed juice clarification, the application of HPLC to bagasse analysis for sucrose (by comparison with polarimetry), and determination of the pith:fibre ratio as a means of assessing cane millability.

Chemical control (in Mauritius)

Anon. *Ann. Rpt. Mauritius Sugar Ind. Research Inst.*, 1982, 51-52.

While a GLC method for fructose, glucose and sucrose determination in cane juice and molasses proved to be reasonably accurate and precise, the high cost of the equipment involved precluded use of the method for routine factory purposes. A study was therefore conducted to see if an acceptable correlation existed between results obtained by the method and those of the Clerget, direct polarization and Lane & Eynon methods. In the case of cane juice, results were positive and common regression equations were developed for the relationships between GLC sucrose on the one hand and Clerget sucrose and direct pol, respectively, on the other, and between GLC fructose + glucose and total reducing sugars. However, results for molasses samples from four factories showed that common regression equations were unobtainable for sucrose and direct pol, while results for reducing sugars had already showed lack of correlation in 1980. On the other hand, high correlation was found between GLC sucrose and Clerget sucrose and direct pol, respectively, at the same factory, and individual regression equations were possible.

Moisture determination using a micro-wave oven was compared with drying in ventilated, hot-air ovens. In the case of bagasse samples, 16 minutes' micro-wave (5 minutes at maximum power followed by 11 minutes at 33% setting) gave an average moisture content that was not significantly different from that obtained by overnight drying in a hot-air oven at 125°C; similar results were obtained for bagasse dried in the micro-wave oven for 20 minutes at 50% power setting. Almost identical results were obtained when cake from a hydraulic press used for cane analysis was dried in the micro-wave oven for 14 minutes (5 min at full power and 9 min at 33% power; the average moisture content of 38.9% compared with 38.8% using the hot-air oven. Because of problems encountered in the drying of filter-cake in a micro-wave oven, a technique was tested in which an equal weight of water was added to the filter-cake before drying; after 27 minutes in the micro-wave oven (9 min at full power and 18 min at 33% setting) the average moisture content (from 33 tests) was 75.8% compared with 75.7% for hot-air oven drying.

Simplifying the calculation of cane payment by analysis

H. Morganti. *STAB*, 1983, **1**, (5), 41, 44-45 *(Portuguese)*.

A system of tables has been adopted at Usina Da Serra S/A whereby, using a pocket calculator and the basic information, it is possible to calculate easily the value of a delivery of cane on the basis of its analysis according to the formula specified by the regional authorities.

Development of a flow injection analyser for the post-column detection of sugars separated by high-performance liquid chromatography

D. Betteridge, N. G. Courtney, T. J. Sly and D. G. Porter. *Analyst*, 1984, **109**, 91-93.

Details are given of a system developed for determination of reducing sugars by flow injection analysis (FIA) following separation by HPLC. Acetonitrile:water was used as HPLC eluent, and the reducing sugars were determined by the triphenyltetrazolium chloride (TTC) colour-forming method (which is unaffected by acetonitrile). A sample chromatogram obtained for a test solution containing fructose, glucose, maltose and lactose is reproduced as well as calibration graphs for the four sugars. Results showed that FIA as a post-column detection system is a viable, low-cost alternative to refractive index or ultraviolet detection, and it is hoped to improve the performance of the system further by using simple optimization techniques.

Determination of functional groups in glucose isomerase

A. Hoschke, K. Balogh, E. Laszlo and J. Hollo. *Starch/Stärke*, 1984, **36**, 26-30.

Following the introduction and widespread application of immobilized glucose isomerase for the industrial manufacture

of HFS, the most important technological problem was how to increase the fructose content. Investigations are reported on a method involving changing the equilibrium of the enzymatic reaction by modifying the active centre of the enzyme; the selective modification of amino-acid side chains was carried out using specific protein reagents. Results for histidyl, arginyl, lysine, tryptophyl and tyrosyl groups are tabulated, showing that (with the exception of the arginyl groups) nearly 50% of the side chains could be modified. Kinetic evaluation of the results was carried out and the role of the functional groups in the side chains determined. A new hypothesis is proposed for the mechanism of enzymatic reactions.

Preparation of dry clarifying agent for the Sh1-PAZh automatic line

A. A. Lyashenko, A. I. Levitskaya and A. Ya Zagorul'ko. *Sakhar. Prom.*, 1984, (1), 42-44 *(Russian).*

For sugar determination in exhausted cossettes, calcium oxide and aluminium sulphate are added dry to the pressed juice for clarification, using the automatic analysis line of the title. However, problems have arisen as a consequence of the unsuitable state of the dry chemicals, particularly their excessive particle size and, in the case of the aluminium sulphate, its high moisture content; tests were conducted on suitable preparation of both reagents – for CaO a ball mill was used, while the aluminium sulphate was treated in a mincer. Details are given.

Some physical and physico-chemical properties of fructose

N. S. Kadykova, B. I. Leonchik, A. I. Sorokin and N. V. Tokar'. *Sakhar. Prom.*, 1984, (1), 48-49 *(Russian).*

The properties of a 93.5% fructose solution determined includes its hydroxymethyl furfural (HMF) content (found spectrophotometrically at 282 nm) and its dynamic viscosity (at temperatures in the range 20-80°C and 5-80% dry solids). Thermo- and electro-physical properties were also determined for crystals of 0.02-5% moisture content and various particle size fractions: heat diffusivity and specific heat capacity coefficients, permittivity and the tangent of the angle of reduction of the crystal as a function of moisture, dispersivity, temperature and frequency of oscillation in an electro-magnetic field. The results were analysed by the least squares method to give regression equations for the various relationships.

A pipeline viscometer for measurement of massecuite consistency

P. Jalinkova, P. Kadlec and H. Doupovcova. *Listy Cukr.*, 1984, **100**, 12-18 *(Czech).*

A pipeline viscometer similar to that described by Ness[1] was used to measure the consistency of artificial massecuites. It comprised a cylindrical tank immersed in a constant-temperature water bath, with an interchangeable brass tube connected to the bottom of the tank, which housed an electrically driven agitator. The sample was mixed for 20 min before being allowed to flow through the tube; the amount of material flowing in a given time was then measured. Variables were crystal content (20-35%), air pressure (2-50 kPa), flow time (0.5-1.0 min) and tube i.d. (6, 10, 12 and 18 mm). A temperature of 50°C was used in 156 measurements. Good correlation was found between the measured values and those obtained with a rotary viscometer ($r = 0.913$). Comparison was also made between the pipeline viscometer measurements and values calculated using equations developed by a number of authors; best agreement was found with those given by the Wagnerowski equation. The effects of tube diameter and of massecuite crystal and sugar contents on the measurements are discussed.

Observations on molasses exhaustion

K. A. Tzimourtas. *Hellenic Sugar Ind. Quarterly Bull.*, 1983, (52/53), 3-10 *(Greek).*

A brief explanation is given of the mathematical background to the Wiklund molasses analysis procedure and of the Polish test that is based on it. Molasses samples from the 1980 campaign at each of the five Greek sugar factories were analysed by the Polish test under the following conditions: dilution with water to a non-sugars:water ratio of 1.5 and 2.0, addition of 40% by weight of sugar crystals of 0.5 mm diameter, and saturation for 24 hours at 45°C. The final saturation coefficient K_{sat} for each of two samples from each factory was tabulated together with other data, as well as the composition of the initial samples. Values of the constants a and b were calculated for each factory, and curves of K_{sat} *vs.* non-sugars:water ratio plotted together with that for standard molasses. The Polish test was also applied to massecuite samples from Nos. 2-14 of the 15-unit crystallizer station at Platy; the effects of variation in the amount of water added (1%, 2%, 3% and 5.8%) and of saturation time at 45°C (12, 24 and 48 hours) were determined and the optimum found to be 2% water and 24 hours. Use of the Polish test is recommended at least every 10 days as a contribution to optimum molasses exhaustion.

Habit modification of sucrose crystals: a lecture

A. VanHook. *J. Amer. Soc. Sugar Beet Tech.*, 1983, **22**, 60-72.

Sucrose crystal habit modification is discussed, with 37 references to the literature. Morphological classification is discussed and the essential features of the form of a single crystal are described. The mechanism of crystal growth and the molecular structure of a crystal are explained, and the effects of various non-sucrose materials on crystal habit indicated. The observations of a number of authors on the adverse effect of raffinose (promotion of needle grain formation) are summarized. The similarity of raffinose to sucrose chemically (as *d*-galactosidosucrose) and, to some extent, structurally suggests the possibility that it unites with the host crystal, at least in part.

1 *I.S.J.*, 1981, **83**, 341.

The occurrence of raffinose throughout a doped sucrose crystal (containing typically 0.3% raffinose on sucrose) indicated a marked degree of chemisorption despite overall crystallographic incompatibility, and x-ray examination of slowly grown doped crystals did not reveal any raffinose. However, the possibility of a hexamer arrangement of sucrose molecules in crystal and solution form could readily provide an open structure within which large molecules such as those of raffinose could easily be included. Since raffinose slows the rate of advance of most sucrose crystal faces, particularly the r′ (101) planes, a very revealing experiment would be to grow a single sucrose crystal in the presence of tagged raffinose and note any spatial distribution by means of radio-autography. Dextran is similar to raffinose in causing crystal elongation, but in the *c* rather than the *b* direction, a result of adsorption on the prism faces; the difference is attributable to the fact that dextran is a polyglucoside with 1-4 C linkages while raffinose has 1-6 linkages. The effect of dextran appears to be aggravated by other components as yet unknown. Much remains to be done regarding the influence of hexoses and of invert sugar on sucrose crystals. When growth is slow, invert is effectively rejected by the growing crystal; however, increase in temperature and supersaturation leads to faster growth, whereupon more and more invert is contained within the crystal. This could be caused by physical rather than chemical adsorption or could be the result of merely being trapped as inclusions rather than being truly adsorbed as might be expected from the chemical similarity of the moieties. However, the crystallographic dimensions of glucose, fructose and raffinose are so disparate that substitutional or epitactic growth would seem improbable, although the dimensions of the separate monosaccharides are quite compatible with the moieties as they occur in the sucrose unit cell. At elevated hexose concentrations and temperatures of 60-70°C, dextrose tends to favour plate-like growth (particularly under quiescent conditions), whereas fructose forms triangles as a result of right end prism enlargement. At room temperature and high glucose content, needles form along the *c* axis and may very well be the result of the different orientation of these moieties within the crystal. Experiments in which 1M sodium lactate was added to sucrose solution showed no effect on the crystals obtained; the same result was found with lactate addition to cane molasses. Nucleation of sucrose crystals in 10-30% aqueous glycerol showed no special habit modifications, whereas in a more concentrated glycerol, e.g. 80-90%, there was approximately 25% elongation of the *b* axis with respect to the *c* axis.

Saccharide separations in reversed-phase high-performance liquid chromatography using *n*-alkylamine mobile-phase additives

C. H. Lochmueller and W. B. Hill. *J. Chromatogr.*, 1983, **264**, (2), 215-222; through *Anal. Abs.*, 1984, **46**, Abs. 2C13.

D-(+)-Xylose, fructose, sorbitol, D-(+)-maltose, lactose and D-raffinose were separated at 25°C on a stainless-steel column (25 cm x 4.6 mm) packed with Partisil 10 treated with dichloromethyl-octadecylsilane, with, as mobile phase (1 ml/min), aqueous 89% acetonitrile containing 20mM tetradecylamine; detection was by refractometry. Greater capacity and selectivity were obtained with this method of separation as compared with one in which the amine additive was part of the stationary phase. The amine could be washed from the column between analyses, which minimized the effect of deterioration observed when using amino-bonded stationary phases.

Determination of carbohydrates by anion-exchange chromatography with pulsed amperometric detection

R. D. Rocklin and C. A. Pohl. *J. Liq. Chromatogr.*, 1983, **6**, 1577-1590; through *Anal. Abs.*, 1984, **46**, Abs. 2C17.

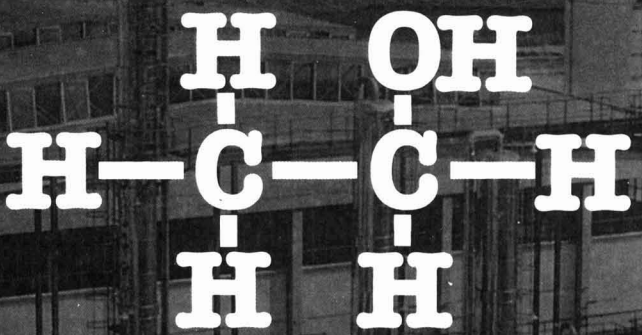
Complex mixtures of carbohydrates can be separated by anion-exchange chromatography on a Dionex HPIC-AS6 column, with aqueous NaOH as mobile phase (containing Na acetate for elution of oligosaccharides) and a detector system that involves oxidation at a gold electrode. Retention times and selectivity are controlled by variation in mobile-phase concentration and column temperature (20-45°C), and oxidation products and other interfering substances are electrochemically removed from the electrode by applying a repeating sequence of three potentials. Results for typical mixtures are presented; detection limits range from 30 ppb for sugar alcohols and monosaccharides to 100 ppb for oligosaccharides, and the reproducibility of peak heights is better than 1%.

Use of volumetric sodium tetraphenylborate method for determining potassium in vinasse

A. C. Fernandes. *Boletim Tecn. Copersucar*, 1981, (15-81), 18-19; through *S.I.A.*, 1984, **46**, Abs. 84-166.

The method is explained and comparative tests *vs.* flame photometry are reported. Its coefficient of variation was 0.18%, compared with 0.85% for flame photometry, while mean results were the same. The basis of the method is reaction of a standard solution of sodium tetraphenylborate with the vinasse sample, followed by back-titration of the reagent against a standard solution of Zephiran chloride (i.e. benzalkonium chloride).

ETHANOL



Sugared or amylaceous raw material
(fruits, beet, cane, molasses, grains, etc...)

Batch or continuous fermentation

Recuperation of CO_2, yeast

Distillation, rectification, deshydratation
High yields - low energy consumption

By-products valorization
Waste concentration
Waste incineration

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investment and lower membrane replacement costs, while on the other hand it results in a drop in pressure and an increase in energy consumption. With an average velocity of 4 m/sec there was no fouling problem and there was no need to pretreat the raw juice. This work contrasts with that of Kofod Nielsen *et al.*[2,8] who found it necessary to pretreat their raw juice.

From the estimate of the production costs in Table VIII, for a fully automatic unit comprising 18-pipe SS, 4.9 m^2 per module, operating 15 weeks/year, 7 days/week, 24 hours/day, the cost of treating raw juice by ultrafiltration is Dfl. 5.55. It is clear that electricity consumption is by far the highest cost factor, but this is mainly due to the use of electricity from the public net (Dfl. 0.17/kWh), which is significantly higher than that of electricity generated in the factory. In making this cost estimate no account has been taken of savings from the carbonatation system, such as the cost of lime production, sludge filtration and the lime-sludge disposal costs.

There are many cost aspects of the ultrafiltration system that require further study.

Table VIII. Cost estimate for ultrafiltration plant over a campaign

Feed	460 m^3/hr
Product	490 m^3/hr
Process temperature	50°C
Membrane area	15,000 m^2
Budget investment (excluding civil engineering)	Dfl. 19,000,000
Running costs:	
Depreciation 10 years (ex. membranes)	Dfl. 1,675,000
Interest 8% (ex. membranes)	670,000
Electricity	2,593,000
Chemicals	68,000
Steam 25 tonnes/day	94,000
Maintenance	335,000
Membrane replacement	1,125,000
Labour	40,000
Water consumption	248,000
Total	Dfl. 6,848,000
Running costs/m^3 permeate	Dfl. 5.55

Conclusions

The following conclusions may be drawn from this study:

It is possible to purify raw juice by ultrafiltration to the same degree as that achieved by the conventional process.

At a linear velocity of 4 m/sec there was no fouling problem and no need for pretreatment.

The cost of treating raw juice by ultrafiltration was DFl 5.55 per m^3 of purified juice.

Electricity consumption accounts for about 40% of the treatment costs.

Summary

A study has been made of the purification of raw juice by ultrafiltration with tubular membranes. The object was to find a new method for replacing the existing carbonatation system with a low energy process at minimal capital cost. In pilot plant trials during the 1981 and 1982 campaigns, it was found that raw juice treated by ultrafiltration gave a thin juice similar in quality to that produced by the conventional method. The filtration rate through the membranes at 50°C and at a linear velocity of 4 $m.sec^{-1}$, was 50 $l.m^{-2}$ membrane/hr in the first 6 hours and 40 $l.m^{-2}$ membrane/hr in the following 20 hours. Under these conditions, the turbulence in the membranes was sufficient to minimize fouling and to make pretreatment of the raw juice unnecessary.

Ultrafiltration, une alternative pour la purification du jus brut dans l'industrie de la sucrerie de betterave

Une étude a été faite sur la purification du jus brut par ultrafiltration à travers des membranes tubulaires. Le but était de remplacer le système actuel par un système à basse énergie et frais réduits. Des pilot-plants, pendant les campagnes 1981 et 1982, prouvent, que la qualité du jus brut ultrafiltré est comparable au jus purifié obtenu par la méthode classique. La vitesse de filtration à travers les membranes à une température de 50°C, et avec une vitesse linéaire de 4 m/s était 50 l/m^2 de membrane/h pour les 6 premières heures et 40 l/m^2 de membrane/h pour les 20 heures suivantes. Sous ces conditions la turbulence dans les membranes était suffisante pour prévenir leur encrassement et pour rendre le prétraitement du jus brut inutile.

Ultrafiltration, eine Alternative für die Saftreinigung der Rohsaft in den Rübenzuckerbetrieb

Eine Studie über Rohsaftreinigung durch Ultrafiltration mit Rohrmembranen wurde durchgeführt. Beabsichtigt wurde um das heutige Carbonatationssystem durch einen Prozess mit niedrigem Energieverbrauch und minimalen Kapitalkosten zu ersetzen. Mittels Pilot-Plant-Versuchen in den Kampagnen 1981 und 1982 wurde festgestellt, dass mit Ultrafiltration behandelter Rohsaft einen Dünnsaft ergab von gleichartiger Qualität, als der, mit der konventionell produzierten Methode. Die Permeationsgeschwindigkeit der Membrane bei 50°C bei einer linearen Schnellheit von 4 m/sec war 50 l/m^2 Membran/h in den ersten 6 Stunden und 40 l/m^2 Membran/h in den folgenden 20 Stunden. Unter diesen Bedingungen war die Turbulenz an der Membranoberfläche ausreichend um Verschmutzung zu reduzieren und eine Vorbehandlung des Rohsaftes unnötig zu machen.

Ultrafiltración como un alternativo para purificación de jugo crudo en la industria de azúcar de remolacha

Se ha estudiado la purificación de jugo crudo por ultrafiltración con membranos tubulares. El objecto fué el desarrollo de un nuevo método para reemplezar el sistema actual de carbonatación por un proceso que requiere menos energía y una inversión minimal. En ensayos de escala pilota durante las campañas de 1981 y 1982, se encuentra que la calidad de jugo crudo tratado por ultrafiltración fué comparable con jugo purificado por el método convencional. El flujo de filtración a través del membrano a 50°C y un velocidad lineal de 4 m/segundo fué 50 litros/m^2 por hora en las primeras 6 horas, y 40 litros/m^2 por hora durante las 20 horas después. Sobre estas condiciones, la turbulencia en los membranos fué adecuada para reducir ensuciamiento al mínimo y para eliminar la necesidad de pretratamiento del jugo crudo.

8 DDS: Danish Patent application 2219639, April 23, 1971.

Clean-up procedures for the HPLC analysis of sucrose, glucose and fructose in Hawaiian sugar cane products

By N. S. Nomura, J. A. Kuhnle and H. W. Hilton

(Experiment Station, Hawaiian Sugar Planters' Association, Aiea, Hawaii, USA 96701)

Introduction

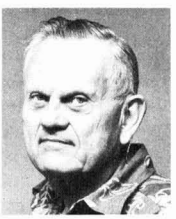
Precise quantitative analysis of sucrose, glucose, and fructose in Hawaiian sugar cane juice, syrup and molasses, using available cation-exchange resin columns, depends on eliminating a number of organic and inorganic impurities, including the lower molecular weight dextrans, that interfere with the peak area integration of sucrose. We have developed clean-up procedures that eliminate most, if not all, interference in the analysis of sugar cane saccharides by high performance liquid chromatography (HPLC). The clean-up procedures have other benefits, including protecting the resin columns, improving base line and peak resolution, and prolonging useful column life.

HPLC has assumed considerable importance for analysis of carbohydrate components in mixtures and may become the preferred method of process control. HPLC is theoretically more definitive for sucrose, glucose, and fructose than polarimetry or alkaline copper reduction, especially in low purity mixtures where interfering substances may rotate polarized light or reduce copper. Development of column packings and conditions for carbohydrate analysis by HPLC must still be considered in a state of flux; aside from the need for improved column packing materials, individual columns are to some extent unique and subject to change with time and with the conditions to which they are exposed. Sample preparation and operation of the system to ensure reproducible results require considerable skill and knowledge of the variables that may be encountered, e.g. dealing with deteriorated samples, differing process conditions, or fouling of the column with use.

Most HPLC of carbohydrates has been conducted on modified silica gel columns with acetonitrile/water as an eluent[1-11]. Early work with cation-exchange resin columns saturated with K^+[6,12] and Ca^{++}[6,9,10,12,13] offered alternatives in which water alone could be used as the eluent, but which often gave inadequate separation of certain components. Aminex HPX-87 cation-exchange resin in the Ca^{++} form[6,9,10,12,14,15,16], sold as the commercial BioRad HPX-87C column, and the Ca^{++}-saturated unspecified cation-exchange resin in the Waters Sugar-Pak 1 column[17] have been most successful, although Abeydeera has achieved good separations with a Shodex S-801/S column in the Na^+ form[18]. The trend toward sulphonated cation-exchange resins for carbohydrate separations seems destined to continue because of the use of water as an eluent and the short time required for analysis. Silica columns with acetonitrile/water eluent have advantages as confirmatory alternatives, as means of greater separation of higher saccharides since higher molecular weight substances have longer retention times, and as means of separation of various disaccharides from each other. The ion exchange resins do not resolve disaccharide mixtures.

N. S. Nomura

J. A. Kuhnle



H. W. Hilton

Each column which we have tried has varied slightly in its ability to separate components in a mixture. Particle size, uniformity of packing, and ageing and fouling of the column all influenced performance. Various clean-up techniques – filtration, centrifugation, guard columns, solid phase extraction systems such as Sep-Pak C_{18} cartridges (Waters Associates), etc. – have been employed, mainly to protect the chromatographic column from fouling. None of the techniques has been designed to remove the interfering substances completely, leaving the desired carbohydrates in solution for analysis.

Hawaiian sugar cane products presented two specific problems with regard to HPLC

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1 Clarke & Brannan: *Sugar J.*, 1979, **42**, (2), 19-23.
2 Clarke *et al.*: *Proc. Ann. Mtg. Sugar Industry Tech.*, 1978, **37**, 333-367.
3 Wheals & White: *J. Chromatography*, 1979, **176**, 421-426.
4 Damon & Pettit: *J. Assoc. Off. Anal. Chem.*, 1980, **63**, 476-480.
5 Hurst & Martin: *ibid.*, 595-599.
6 Wong-Chong & Martin: *Sugar y Azúcar*, 1980, **75**, (6), 40-58.
7 Idem: *J. Agric. Food Chem.*, 1979, **27**, 929-932.
8 Clarke & Brannan: *Proc. Tech. Session Cane Sugar Refining Research*, 1980, 138-149.
9 Tallman: *Varian Instruments Newsletter*, (LC133), 8 pp.
10 Zygmunt: *J. Assoc. Off. Anal. Chem.*, 1982, **65**, 256-264.
11 Ivin *et al.*: *Proc. Australian Soc. Sugar Cane Tech.*, 1983, 187-194.
12 Wong-Chong & Martin: *J. Agric. Food Chem.*, 1979, **27**, 927-929.
13 Scobell *et al.*: *Cereal Chem.*, 1977, **54**, 905-917.
14 Clarke & Brannan: *Proc. Ann. Mtg. Sugar Industry Tech.*, 1979, **38**, 102-112.
15 Charles: *I.S.J.*, 1981, **83**, 169-172.
16 *ibid.*, 195-199.
17 Ivie: *Sugar y Azúcar*, 1982, **77**, (2), 47-53.
18 *Proc. Australian Soc. Sugar Cane Tech.*, 1983, 171-187; *I.S.J.*, 1983, **85**, 300-306.

analysis on the cation-exchange columns. Ripening by natural or chemical means of the 2-year or older crop assured high purity samples in which the ratio of sucrose to reducing sugars measured 40 to 1 or more, especially in juice. Quantitative determination of the small amounts of reducing sugars was complicated by the swamping effect of the very large sucrose peak caused by the attenuation needed for the reducing substances. Conversely, the impurities, especially inorganic salts and aconitic acid included with the juice, resulted in poor resolution and imprecise quantitative measurement of the sucrose peak. The combination of effects led us to develop methods to remove substances interfering with the separation and quantitative determination of sucrose and the reducing sugars.

Materials and methods

A Tracor Instruments HPLC system consisted of a 985 LC master control unit, a high-pressure Tracor 950 pump, and a model 910 Fresnel-type refractive index detector. The output signal was fed to a Spectra Physics SP4100 integrating microprocessor. A variable wavelength ultraviolet detector (Tracor 970, operated at 195 nm) could also be used as a dual monitor.

Two analytical columns were employed: BioRad Laboratories Aminex HPX-87C and Waters Associates Sugar-Pak I. Both contain cation-exchange resins of the sulphonated styrene-divinylbenzene copolymer type saturated with Ca^{++} ions. The Aminex HPX-87C column was operated at 85°C and an eluent rate of 0.6 ml per minute; the Sugar-Pak I was operated at 90°C and 0.5 ml/min. The eluent for both columns was double-distilled, deionized, degassed water. In order to maintain Ca^{++} ion saturation, calcium acetate (0.1 mM) was added to the Sugar-Pak I eluent and $Ca(OH)_2$ solution to the Aminex column eluent to bring it to pH 7.0-7.5.

A third column, a Whatman Partisil PXS 10/25 PAC, was also used to verify removal of non-carbohydrate material and determine whether disaccharides other than sucrose were present in detectable amounts. The column was eluted with 87:13 acetonitrile:water, at a flow rate of 1 ml/min, refractive index detection at 32x attenuation, and ultraviolet detection (195 nm) at 8x attenuation.

Figure 1 presents a flow chart of the best of three alternative clean-up procedures with sugar cane products. Diluted molasses or syrup was first centrifuged to remove suspended solids. Mixed juice was filtered. After further dilution, the clear supernatant was passed through a solid-phase extraction cartridge packed with octadecyl-bonded silica (Waters Associates Sep-Pak C_{18}, Analytichem International Bond Elut C_{18}, etc.) which removes colour (probably mainly derived from phenolic constituents), non-polar materials, and dextrans of lower molecular weight up to about 150,000.

The C_{18} cartridges were first conditioned by washing with 4 ml of spectrograde methanol, followed by 4 ml of distilled, deionized water. For quantitative sample recovery without overloading, the first 2 ml of eluate was discarded, and the next 1 to 3 ml collected. Using the Waters Sugar-Pak 1 column, the sample could be injected at this point for analysis. For the BioRad Aminex HPX-87C column, and for cleaner separation of peaks on the Waters column, it was necessary to remove interferences that may co-elute with sucrose. The BioRad interference is believed to be mainly aconitic acid, which can be removed by any of three commercially available solid-phase extraction cartridges: Analytichem International Bond Elut PSA, a weak anion exchange resin; Waters Associates Sep-Pak Alumina

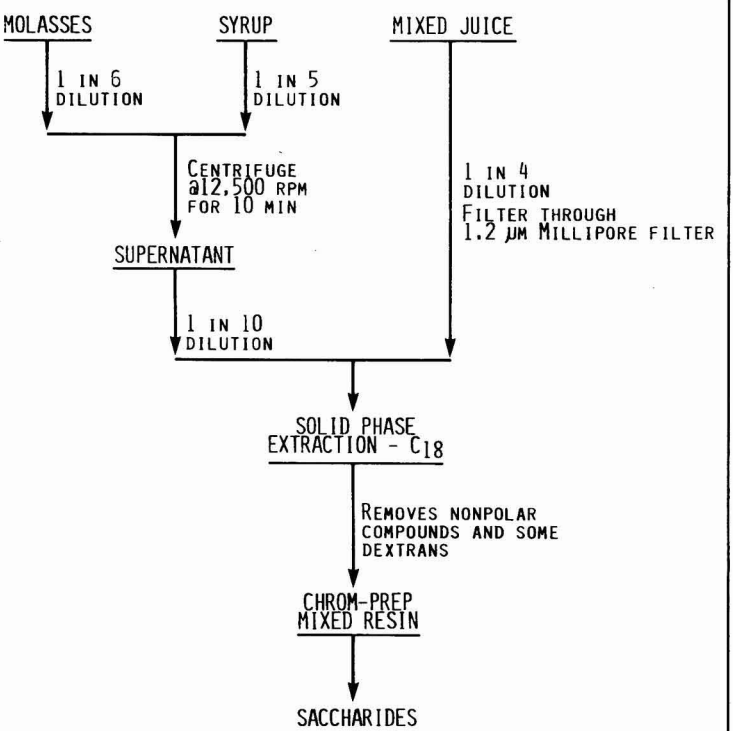

Fig. 1. Clean-up procedure for sugar cane mixed juice, syrup, and molasses for high performance liquid chromatographic analysis

A; and Hamilton Company Chrom-Prep, a mixed-bed ion exchange resin. The Chrom-Prep has the additional advantage of removing the ions of inorganic salts appearing as a peak preceding the aconitic acid and is the preferred clean-up cartridge.

Operation of the clean-up columns for optimum recovery was as follows:

Sep-Pak Alumina A

1. Elute the cartridge with 5 ml spectrograde acetonitrile followed by 5 ml of distilled deionized water.
2. Blow out or suck out any excess residual water.
3. Pass 2 ml of sample at ambient temperature through the cartridge and discard.
4. Add more sample, discarding the first 1 ml and collecting the next 1 to 2 ml.

Bond Elut PSA

1. Elute the cartridge with 1 ml of spectrograde methanol, followed by 1 ml of distilled deionized water.
2. Remove excess residual water.
3. Pass 1.5 ml of sample through the cartridge and discard.
4. Pass 1ml of sample and collect.

Chrom-Prep Mixed Bed

1. Elute the cartridge with 1 ml of spectrograde methanol, followed by 1 ml of distilled deionized water.
2. Remove excess residual water.
3. Pass 1.5 ml of sample through the cartridge and discard.
4. Pass 1 ml of sample and collect.

If any of the eluates appeared turbid, we filtered them through a 0.45 μm Millipore filter before injecting into the HPLC system.

Mannitol was used as an internal standard for quantitative measurement since it was stable, non-fermentable, and easily resolved on the columns.

Results and discussion

Excellent resolution of pure standards of sucrose, glucose, and fructose in purified water was obtained on either of the two cation-exchange resin columns described

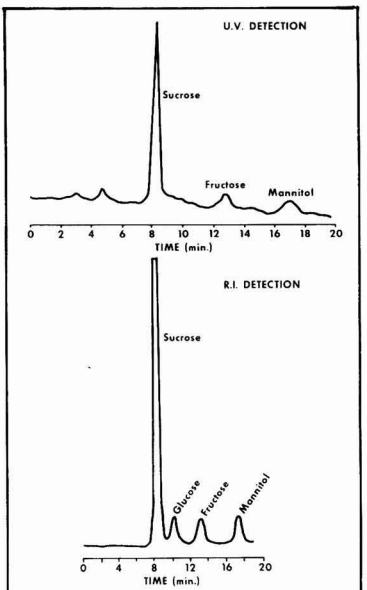

Fig. 2. Analysis of sugar standards. Analytical column: BioRad HPX-87C; Column temperature 85°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.6 ml/min; Dual detection: UV at 195 nm x 16 and R.I. detector x 32

in this paper (e.g. Fig. 2). Relative standard deviations for sucrose peak area integration of less than 0.5% were obtained. Such precision for diluted, untreated cane juice, syrup and molasses has not previously been possible for us because of the co-elution of interfering substances; on the BioRad Aminex HPX-87C Ca^{++} column the interference preceded and merged into sucrose (Fig. 3), and on the Waters Sugar-Pak I Ca^{++} column glucose tended to merge with sucrose as the column was used, although separations were initially good on the freshly regenerated column. Guard columns packed with the same packing as the analytical column and intended to minimize column fouling have not helped materially with interference or ageing.

Our original clean-up procedure with the solid-phase extraction cartridge packed with octadecyl-bonded silica (Sep-Pak C_{18}) removed non-saccharide coloured constituents and lower molecular weight

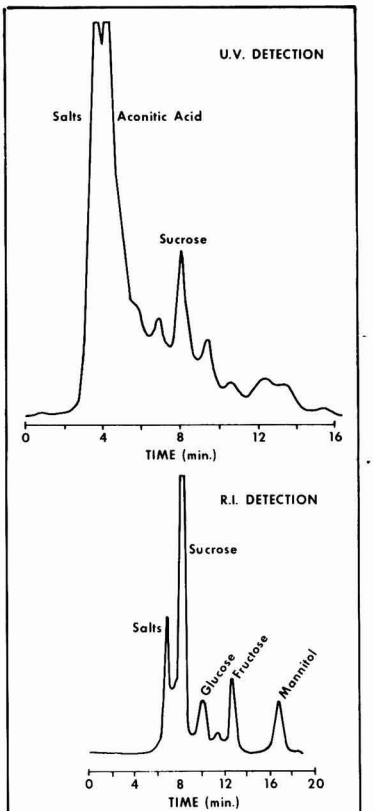

Fig. 3. Analysis of final molasses using Sep-Pak C_{18} clean-up. Analytical column: BioRad HPX-87C; Column temperature 85°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.6 ml/min; Dual detection: UV at 195 nm x 16 and R.I. detector x 32

dextrans, but allowed much of the major interference to pass through (Fig. 3). Dual detection of dilute molasses filtrate with ultraviolet (195 nm) and refractive index monitors showed intense ultraviolet absorbance as two peaks preceding and tailing into sucrose, while the standards absorbed only to a moderate degree (Fig. 2). Unrefined sugar cane products are known to contain inorganic salts, *cis*- and *trans*-aconitic acid, and possibly oligo- and polysaccharides, including dextrans if there has been appreciable deterioration of the juice. Lactic acid, ethanol, and glycerol may also be present as fermentation

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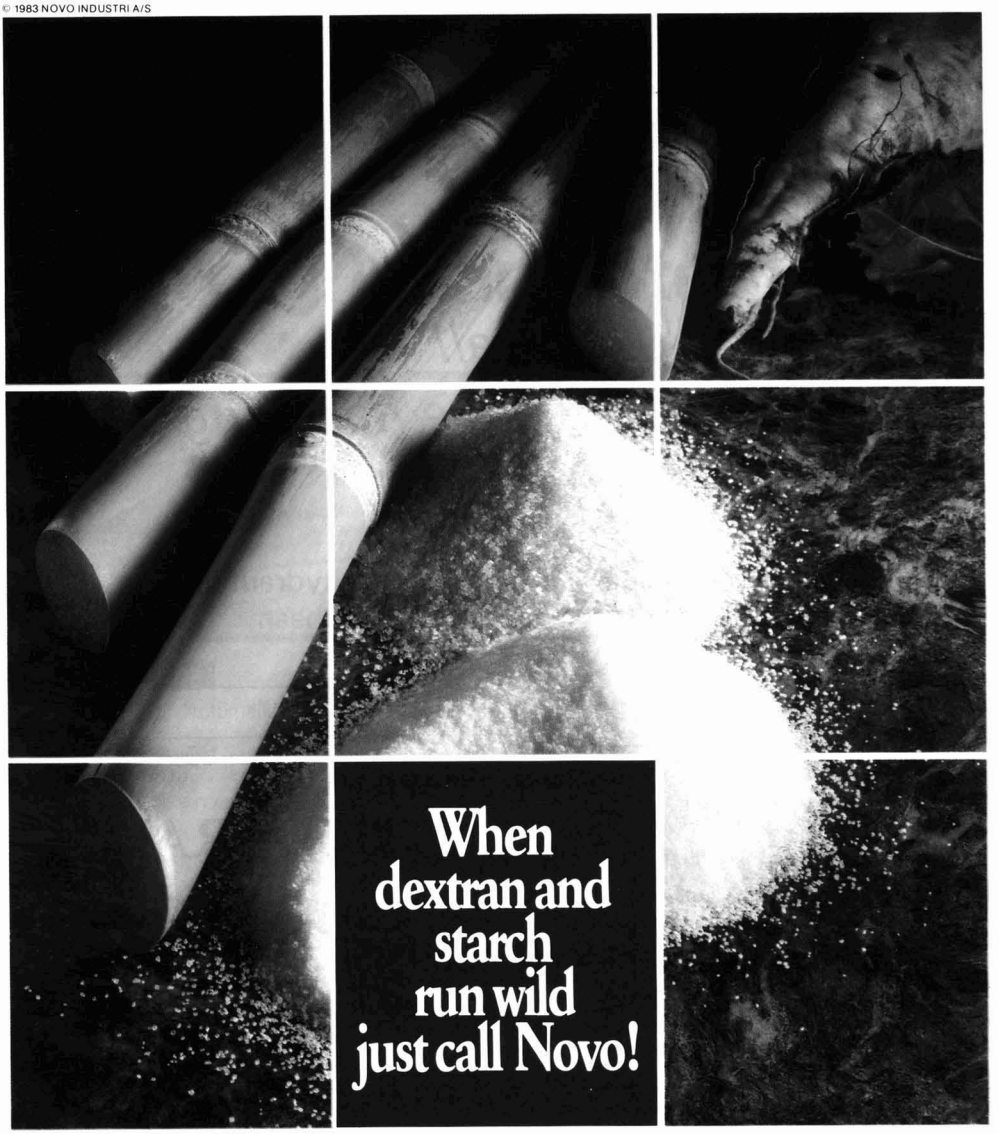

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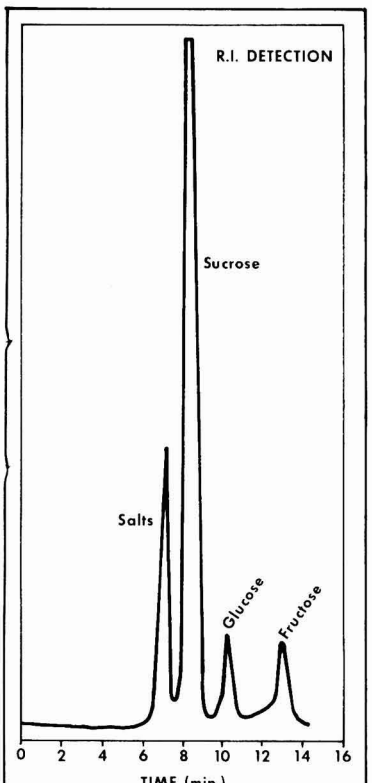

Fig. 4. Analysis of molasses using Sep-Pak C_{18} and Bond Elut PSA clean-up. Analytical column: BioRad HPX-87C; Column temperature 85°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.6 ml/min; Detection: R.I. detector x 32

products although their elution characteristics on the BioRad column are sufficiently unique for identification[16].

HPLC analysis of authentic *cis*- and *trans*-aconitic acid yielded peaks and ultraviolet absorption similar to those of part of the sucrose interference. The *trans*-isomer eluted as a shoulder and the *cis*-isomer directly under sucrose. Both were present in the samples, but the *trans*-isomer predominated. A weak anion exchange filter cartridge (Bond Elut PSA, Analytichem International) removed the apparent aconitic acids from molasses (Fig. 4), while increasing the "salt" peak in the refractive index detector. Waters Sep-Pak Alumina A, an acid alumina, also removed the organic acids (Fig. 5). However, the detectors still showed the presence of an apparent inorganic salt peak.

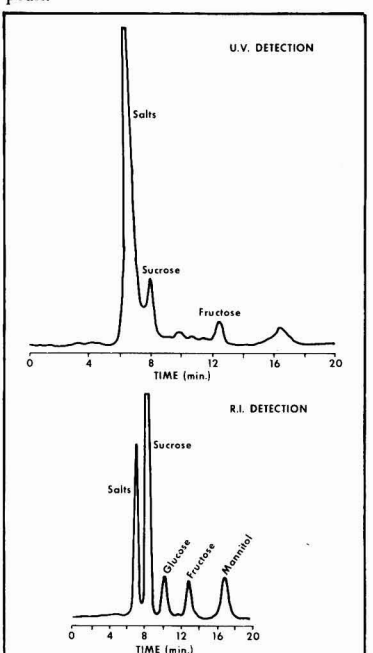

Fig. 5. Analysis of final molasses using Sep-Pak C_{18} and Alumina clean-up. Analytical column: BioRad HPX-87C; Column temperature 85°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.6 ml/min; Dual detection: UV at 195 nm x 16 and R.I. detector x 32

A Hamilton Chrom-Prep mixed-bed ion-exchange resin cartridge removed all apparent ionic interference, including the organic acids, resulting in the cleanest chromatograms with both detectors (Fig. 6). Figures 7 and 8 show the Waters Sugar-Pak I column with Sep-Pak C_{18} clean-up only and Chrom-Prep treatment of molasses. Cartridge overload left the small initial double peak. No lactic acid or glycerol appeared in any samples.

Recovery of carbohydrates using the Chrom-Prep clean-up was consistent and essentially quantitative (Table I). Removal of ionic impurities revealed a small shoulder or peak of unknown composition just prior to sucrose elution (Fig. 6-9),

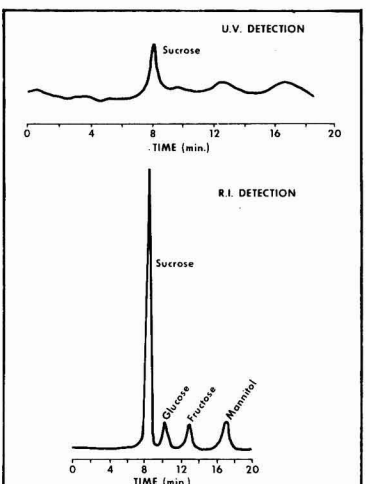

Fig. 6. Analysis of final molasses using Sep-Pak C_{18} and Chrom-Prep mixed-bed resin clean-up. Analytical column: BioRad HPX-87C; Column temperature 85°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.6 ml/min; Dual detection: UV at 195 nm, x 16 and R.I. detector x 32

which we attribute to a naturally occurring oligosaccharide. Co-chromatography of raffinose, trehalose, and cellobiose with molasses or juice yielded results unlike the unknown. Sep-Pak C_{18} removes dextrans below 150,000 MW, and higher MW dextrans are eluted earlier. It seems unlikely that the unknown is a "kestose" because it appears in fresh juice as well as in processed products. Of all carbohydrates available to us, melezitose, a trisaccharide supposedly of insect origin, chromatographed most nearly like the unknown. Indications are that the unknown was a trisaccharide, although its identity is uncertain. Using melezitose as a standard, interference with sucrose in molasses on the BioRad column approximated as much as 3% on sucrose weight. The Waters Sugar-Pak I gave somewhat better separation (Figs. 8-9), at least on a freshly regenerated column and after other interference was removed. Results on either column may be consistent for a given type of sample unless cultivars differ in the amount of trisaccharide present. Abeydeera[18] also achieved reasonable separation of the trisaccharide

Table I. Sugar standards recoveries using solid phase extraction*

Type	n	Sucrose	Glucose	Fructose	Mannitol
		(%)			
Sep-Pak C_{18} + Chrom-Prep mixed resin	10	99.1 ± 1.5	99.0 ± 5.9	97.1 ± 5.3	100.5 ± 1.9
Sep-Pak C_{18}	5	101.2 ± 1.8	97.9 ± 2.8	97.0 ± 2.8	100.3 ± 1.9
Bond Elut PSA	3	95.7 ± 2.5	105.7 ± 2.8	98.4 ± 3.5	97.0 ± 3.8
Chrom-Prep mixed resin	3	100.5 ± 2.2	105.6 ± 3.1	100.4 ± 2.8	102.5 ± 2.8
Sep-Pak Alumina	3	97.5 ± 1.1	97.3 ± 1.2	91.4 ± 2.0	97.3 ± 1.1

* Analytical column: Waters Sugar-Pak I; Column temperature: 90°C; Mobile phase: Deionized, degassed distilled water containing 0.1 mM calcium acetate; Flow rate: 0.5 ml/min; R.I. detector x 32 attenuation.

Table II. Precision of sucrose, glucose, and fructose analyses by HPLC of molasses*

n	Concentration (% by wt.) Sucrose	Glucose	Fructose
1	5.86	0.907	1.25
2	5.88	0.924	1.27
3	5.86	0.936	1.31
4	5.81	0.900	1.25
5	5.84	0.915	1.26
6	5.83	0.923	1.29
7	5.86	0.934	1.27
8	5.85	0.914	1.27
$\bar{x}$	5.85	0.919	1.27
s	0.021	0.0125	0.020
CV	0.36	1.36	1.57

* Samples diluted and prepared as shown in Fig. 1. Computations are based on 6 to 1 dilution of original molasses.

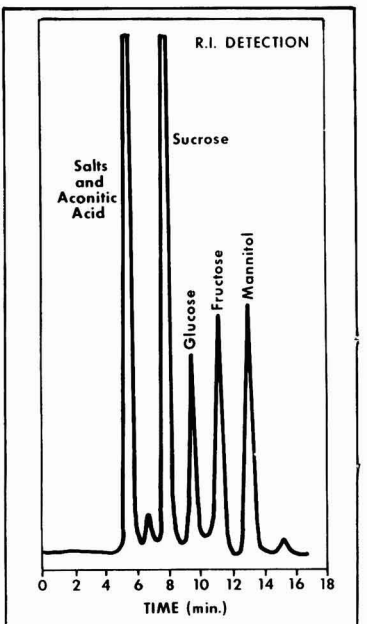

Fig. 7. Analysis of molasses using Sep-Pak C_{18} clean-up. Analytical column: Waters Sugar-Pak I; Column temperature 90°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.5 ml/min; Detection: R.I. detector x 32

on the Shodex S-801/S cation-exchange resin column in the Na^+ form. The small peak is identified as kestoses, using raffinose as a standard for comparison. Mannitol eluted with glucose on the Shodex column and could not be used as a standard.

Precision measurements for sucrose and reducing sugars on replicates of diluted molasses and juice are given in Tables II and III, respectively.

An attempt was made to determine whether disaccharides other than sucrose were present, especially in samples where the sugar cane had been treated with a chemical ripening agent such as glyphosate (Polado). Only the modified silica column separated mixtures of sucrose with other disaccharides. Although not shown, lactose, trehalose, and melibiose separated easily with lower limits of detection at 5% on sucrose; maltose and cellobiose were not completely resolved from sucrose but

Table III. Precision of saccharide analysis by HPLC of cane juice*

n	Concentration (% by wt) Sucrose	Glucose	Fructose
1	7.32	0.296	0.328
2	7.28	0.300	0.329
3	7.25	0.296	0.325
4	7.27	0.297	0.324
5	7.26	0.300	0.327
6	7.27	0.302	0.326
7	7.27	0.303	0.333
8	7.22	0.310	0.325
$\bar{x}$	7.27	0.301	0.327
s	0.028	0.0047	0.0029
CV	0.39	1.55	0.89

* Concentrations calculated on basis of sample as received

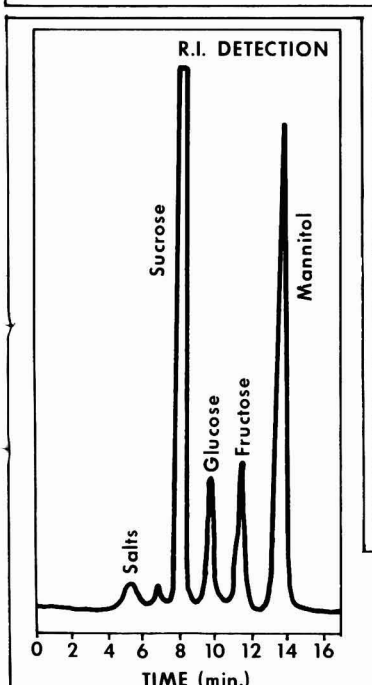

Fig. 8. Analysis of final molasses using Sep-Pak C_{18} and Chrom-Prep mixed-bed resin clean-up. Analytical column: Waters Sugar-Pak 1; Column temperature 90°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.5 ml/min; Detection: R.I. detector x 32

could be detected at 5% concentration and resolved at 15%. Within these limits no disaccharides other than sucrose were found.

Chrom-Prep cartridge clean-up, combined with the Sep-Pak C_{18}, offered optimum performance on the cation-exchange resin columns by reducing refractive index and ultraviolet interferences to minimum levels. Similar clean-up for the silica column showed only the saccharide absorption in the ultraviolet monitor.

The various clean-up techniques also offer a method to recover the interfering substances for further characterization. Methanol removed the impurities from the clean-up cartridges although dextran precipitated later from the methanol solution. No attempt has been made to remove the impurities quantitatively.

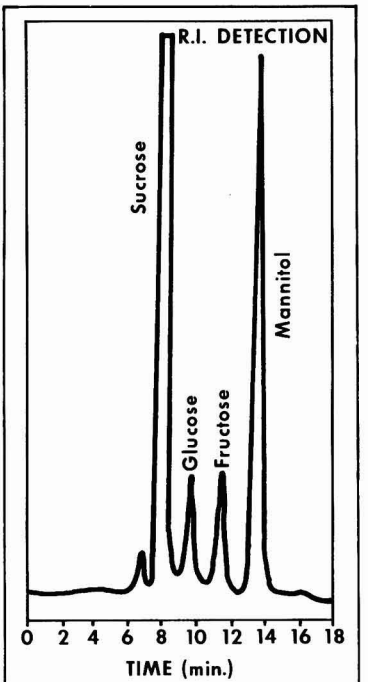

Fig. 9. Analysis of sugar cane mixed juice using Sep-Pak C_{18} and Chrom-Prep mixed-bed resin clean-up. Analytical column: Waters Sugar-Pak 1: Column temperature 90°C; Mobile phase: Deionized, degassed, distilled water; Flow rate: 0.5 ml/min; Detection: R.I. detector x 32

Summary

Solid phase extraction (SPE) cartridges removed substances interfering with the HPLC analysis of sugar cane saccharides in juice, syrup, and molasses on cation-exchange resin columns. A combination of a C_{18}-bonded silica cartridge, to remove colour, non-polar substances and lower molecular weight dextrans, plus a mixed-bed ion exchange cartridge, such as the Hamilton Company Chrom-Prep, to remove organic and inorganic ions, resulted in a solution with the least interference and saccharide resolution approximately equal to that of pure standards. Detection and quantitative measurement with a Fresnel-type refractive index monitor was used in conjuction with an ultraviolet absorption scan at 195 nm to indicate the

Clean-up procedures for the HPLC analysis of sucrose, glucose and fructose in Hawaiian sugar cane products

removal of non-saccharide absorbing interference. The clean-up improved base line resolution and protected the resin column, thereby prolonging column life. Recovery of sucrose, glucose, and fructose was followed using mannitol as an internal standard. An unidentified peak, probably a trisaccharide, present in amounts up to 3% on sucrose in molasses could be resolved after clean-up.

The cation exchange columns failed to separate mixtures of disaccharides. An amino-cyano polar bonded silica column (Whatman Company Partisil-10 PAC) with an acetonitrile/water solvent system resolved all mixtures of disaccharides with sucrose. Only maltose and cellobiose partially overlapped sucrose and could not be identified below 15% in the mixture. Within these limitations, sucrose was the only disaccharide encountered in any sugar cane product, including those where glyphosate (Polado) had been used as a chemical ripener for the sugar cane.

Commission Internationale Technique de Sucrerie

On May 15 and 16 the members of the Scientific Committee of CITS met in Thessaloniki, Greece, by invitation of Hellenic Sugar Industry A/S. Arrangements were in the hands of Mr. P. Christodoulou, Director of the Platy sugar factory, which was visited by members on May 16. Some 50 members, from 12 countries, took part in the meeting, at which the President, Professor G. Mantovani, announced the death of the former President, Professor Dr. F. Schneider, in whose memory a moment of silence was observed.

During the meeting 18 short papers were presented and discussed, on the general topics of crystallization, environment protection and energy saving. Some of these papers may be published in due course.

At the administrative meeting of the Committee it was decided that the 18th General Assembly of CITS shall be held in 1987 in Bologna, by invitation of the Italian sugar industry, and that the priority themes to be laid down are: "Sugar degradation", "Colour" and "Pulp". Papers on these subjects may be proposed to the Secretariat of the Commission (Dr. R. Pieck, Aandorenstraat 1, B-3300 Tienen, Belgium) up to the end of 1986. Papers to be presented to the General Assembly will then be chosen from among the submissions.

The Committee also appointed three new members: Messrs. N. Broughton (UK), P. Christodoulou (Greece) and J. Degeest (Belgium). Sub-Committees on "Measurements and process control" (Chairman Dr. P. van der Poel), "Crystallization" (Chairman Mr. F. Heitz) and "Colour formation" (Chairman Prof. Dr. E. Reinefeld) are continuing their activities.

A further meeting of the Scientific Committee is planned in 1985.

Personal notes

The late Professor F. Schneider

We regret to report the death on May 11 of Prof. Dr. Ferdinand Schneider, one of Germany's outstanding sugar technologists and educators. He was born in 1911 in Backnang and studied at the Universities of Tübingen and Freiburg as well as the Technische Hochschule Dresden, gaining his Dr.Phil from Munich University in 1934. He carried out research on leather and albumen and enzyme chemistry but between 1939 and 1944 served in the German army and was wounded several times.

In 1944 he joined the teaching staff of the Technische Hochschule Danzig but in 1946 went to the TH Braunschweig where in 1948 he became Professor. Here he was the leading spirit in the formation of a new sugar school and research institute and remained until his retirement in 1970. During this time the Institute built up its enviable reputation for thorough research in cooperation with the industry, and Professor Schneider formed a team which continues this work to the present day. He received international recognition, serving as Chairman of the German National Committee of ICUMAS and later as President of its Scientific Committee. His contribution to the sugar industry stretched far beyond the boundaries of his own country and he will be remembered for his many contributions to the literature, not least "Sugar Analysis – ICUMSA methods" which he edited.

Brevities

Greek sugar crop reduction[1]

Sugar production in the 1984/85 campaign will probably be substantially lower than in 1983/84. Owing to persistent rain, sugar beets were sown on only 275,000 hectares by mid-April, compared with the planned area of some 40,000 ha. Hellenic Sugar Industry A/S hoped that a further 3500 ha would be sown but growers will probably have turned to other crops in the meantime. Moreover, it is feared that this year's yields will be lower owing to the so far unfavourable weather conditions. Hence sugar production is expected to decrease by some 100,000 tonnes, white value, against last year. In order to cover domestic requirements, Greece will probably have to import an estimated 80,000 tonnes of sugar.

Czechoslovakian sugar factory expansion[2]

Processing capacity of the Hodonin sugar factory in Czechoslovakia, built in 1885, is to be doubled to 3000 tonnes/day by Autumn 1986. Equipment will be supplied by Poland and Czechoslovakia and it is intended that the work will not interrupt normal campaign operations. Nemicice nad Hanou factory, built in 1910, is to be expanded from 1380 to 2000 tonnes/day, while Uherske Hradiste factory, built in 1868, is also to be reconstructed.

Brazil sugar factory expansion[3]

By a series of modernizations of its cane milling system, Usina Santa Elisa, in Sertãozinho, SP, will be able to crush 21,000 tonnes of cane per day in the season which started in May. All its equipment, including knives, crushers, rollers and intermediate carriers, were manufactured by Zanini S.A. Equipamentos Pesados.

Alcohol manufacture from bagasse[4]

The government-subsidized Association for Development of Petroleum Alternatives announced that Japan was to start trial mass production of alcohol from bagasse in May, using a new, low-cost process. The association, which comprises 23 biotechnology-related companies, is expected to complete a test production plant in Hofu, in Yamaguchi prefecture, which should produce alcohol at well below its current wholesale price of 280 yen per litre. The plant, which will have a daily production capacity of 200 litres of alcohol from 720 kg of bagasse, uses a new 5-stage process and promises a highly competitive car fuel for the future.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 278.
2 *Listy Cukr.*, 1984, **100**, 118-119.
3 *Zanini Noticias*, 1984, (April/May), 5.
4 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 285.

Brevities

Sugar industry research in South Africa[1]

An Action Committee for Mechanical Engineering, formed by the South African Council for Scientific and Industrial Research, held a seminar with top engineers from the sugar industry in order to coordinate research and establish contact between industry and government scientists. Four fields for possible action were identified: mechanical trash separation from cut cane, structural analysis and testing of harvesting equipment, power measurement for turbine-driven equipment, and the pneumatic transport of bagasse.

Sudan sugar production[2]

White sugar production in Sudan in the 1983/84 season reached 400,000 tonnes, according to official statistics. The Kenana Sugar Company alone produced 250,000 tonnes during its season, which ended in March, while the other three factories had made 150,000 tonnes and were expected at the end of May to produce eventually a further 30,000 tonnes. A total outturn of 430,000 tonnes would cover the consumption requirements of the country, whereas last year production was less at 359,000 tonnes, white value.

Morocco sugar imports resumption[4]

Following settlement of an outstanding arbitration award, a trade embargo has been lifted[5] and international operators will now be prepared to participate in buying tenders, including one for 15,000 tonnes of bulk raw sugar for September/October delivery.

Taiwan sugar crop reduction[6]

1983/84 sugar production will reach only 600,000 tonnes, well below that of 1982/83, according to Taiwan Sugar Corporation estimates. The decline is attributed to a reduced cane area (80,000 hectares against 86,000 ha in 1982/83) and the reluctance of farmers to plant cane because of declining world market prices.

Ethiopian sugar scheme shelved[7]

Bidding on contracts for the $250 million Fincha sugar project has been halted and it is not clear if the scheme is to go ahead, according to an AED report quoting sources close to the scheme in Addis Ababa. Two Indian firms had submitted low bids for the civil works and had been invited to Ethiopia for consultation; however, bid bonds have been returned to the original bidders, which have been told to await further instructions.

French sugar exports, 1983[3]

	tonnes, raw value
Raw sugar	
Belgium	1,118
Bulgaria	12,600
Lebanon	2,855
Portugal	22,997
Sweden	3,800
Tunisia	16,075
USSR	143,858
Other countries	2,286
	205,589
White sugar	
Algeria	30,936
Belgium	180,694
Benin	1,710
Cape Verde	3,261
China	242,647
Congo	9,776
Djibouti	2,029
Dubai	42,071
Egypt	30,179
French Polynesia	1,728
Gambia	15,575
Germany, West	87,409
Ghana	7,392
Guinea-Bissau	1,086
Guinea Republic	5,503
Guyana	1,077
Holland	5,648
Iran	15,978
Iraq	128,956
Ireland	3,908
Israel	26,269
Italy	217,747
Ivory Coast	9,207
Jamaica	9,783
Jordan	30,245
Kuwait	20,466
Lebanon	2,329
Liberia	9,631
Maldives	1,087
Mali	23,369
Martinique	4,072
Mauritania	1,480
Mexico	129,056
Niger	1,734
Nigeria	550,556
Oman	11,971
Peru	2,446
Poland	1,212
Qatar	9,788
Réunion	3,612
Saudi Arabia	97,102
Senegal	8,926
Sierra Leone	1,059
Spain	45,341
Sri Lanka	221
Switzerland	66,057
Syria	45,960
Togo	25,521
Tunisia	3,804
UK	22,280
Upper Volta	4,857
US	22,517
USSR	235,374
Yemen, North	31,089
Yemen, South	15,198
Yugoslavia	7,542
Other countries	14,655
	2,531,126
Total exports	2,736,715

Austria sugar exports, 1983[8]

	1983	1982
	tonnes, raw value	
Czechoslovakia	0	3,260
EEC	25,675	27,492
Norway	11,201	17,770
USSR	50,652	52,770
Yugoslavia	45,336	2,174
Other countries	214	82
	133,078	103,548

UK measures against rhizomania

The Ministry of Agriculture has prohibited imports of sugar beet plants and unprocessed sugar beet seed into the UK except under licence in order to minimize the risk of the beet disease rhizomania from reaching Great Britain. Licences will only be issued when the plants come from farms free of rhizomania and will be subjected to inspection both before export to the UK and whilst the crop is growing. Rhizomania was found in Italy in 1977 and has gradually spread to northern France, Germany and Holland. It results in stunted roots with low sugar content and is carried by a soil fungus, the spores of which can persist in the soil for many years. British Sugar plc has distributed leaflets to beet growers showing the symptoms and calling for notification if incidence of the disease in a field is suspected.

Colloquium on prevention of air pollution

The Commission on Air Pollution Prevention of the Association of German Engineers, in cooperation with scientists, administrators and industry, is organizing a colloquium on odorous substances in October 1985 and is calling for papers on the main topics: sources and technical control measures, administrative measures, effects of odours and odour assessment, and dispersion of odorants. Beet sugar manufacture has been identified as one source of odour as an air pollutant. Information may be obtained from the VDI, Kommission Reinhaltung der Luft, Postfach 1139, D-4000 Düsseldorf, Germany.

Japan refined sugar production, 1983[9]

According to the Japan Sugar Refiners Association, white sugar output during calendar year 1983, amounting to 2,032,000 tonnes, was down some 4.6% from the 2,130,000 tonnes produced in 1982. The decrease occurred mainly in the first half of 1983; production in the second half of the year was virtually the same as in 1982.

1 *S. African Sugar J.*, 1984, **68**, 127.
2 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 320.
3 *ibid.*, S62-S63.
4 *Reuter Sugar Newsletter*, April 25, 1984.
5 See *I.S.J.*, 1983, **85**, 258.
6 *World Sugar J.*, 1984, **6**, (11), 39.
7 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 319.
8 *I.S.O. Stat. Bull.*, 1984, **43**, (2), 3.
9 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 348.

Holly Sugar Corporation 1984 annual report

By extensive capital improvement programs at all its sugar factories in the year to March 31, 1984, Holly was able to achieve substantial reductions in unit manufacturing costs in spite of abnormal weather conditions and a shortage of beet acreage in the Tracy, Hamilton City, Worland and Torrington factory districts which reduced sugar output. The spring 1984 harvest in Northern California began in mid-March, a month earlier than in recent years, while favourable weather has also allowed growers to plant the autumn crop early. Holly's new California beet varieties – HH-37 and HH-38 – have increased sugar per acre by about 15% and all the Holly beet area will be planted to them in 1985. Beet seedling transplant research at the University of Nebraska has been supported and methods are being developed for use of this technique to give the crop a longer growing season and higher yields; limited transplanting has been done in the areas of the Sidney, Torrington and Hereford factories in 1984. A solar drying strip has been constructed for pressed pulp adjacent to the Tracy factory, while sales of undried pressed pulp have been increasing. The site of the former refinery at Santa Ana, California, was sold, as was the process equipment from the HFS facility at Tracy. The Corporation made a net profit of $9,424,000 against a loss of $13,306,000 in the year to March 31, 1983.

Continuous boiling trials

On page 149 of our May 1984 issue we published an abstract of an article "Continuous *A*-pan boiling trials at Maidstone sugar factory" by G. P. N. Kruger, in which we incorrectly described the pan as one of Fives-Cail Babcock manufacture. In fact, the pan was a unit designed and manufactured by staff of Tongaat-Hulett Sugar Ltd. and was found to be significantly superior to a FCB continuous pan in several respects.

Pakistan sugar season, 1983/84

The 1983/84 cane crushing season came to an end on May 11 after 162 days, against 172 days in 1982/83. The cane crop was grown on 905,300 hectares, 0.70% less than the 911,700 ha of the previous crop, and the yield rose from 35.64 tonnes/ha in 1982/83 to 38.11 in 1983/84. The total crop amounted to 34.5 million tonnes against 32.53 million in 1982/83. The 39 factories crushed only 13,469,000 tonnes (39%) of the crop, however, whereas in the previous season 36 factories crushed 12,491,000 tonnes (38.4% of the crop). White sugar production amounted to 1,133,000 tonnes against 1,110,000 tonnes in 1982/83, an increase of 2%.

Dominican Republic sugar production, 1983[1]

In 1983 the Dominican Republic produced 1,209,456 tonnes of sugar. Production in 1984 is expected to reach 1.1 million tonnes and the estimates for 1985 are similar to those for 1984.

Breakthrough in bagasse conversion to alcohol[2]

Research groups in the Bagasse to Ethanol Sub-Program of the South African Council for Scientific and Industrial Research have been working on the enzymatic conversion of the cellulose fraction of bagasse to glucose and its subsequent fermentation to alcohol. The economic success of a process would be enhanced if the hemicellulose component of the bagasse – amounting to up to 32% – could also be used. Hemicellulose may be readily hydrolysed by dilute acid to xylose but this is not converted rapidly nor in high enough yield to alcohol. Recently, however, CSIRO workers have discovered a yeast which is particularly good at carrying out the conversion and mutation of this yeast may provide a process for industrial application in which xylose fermentation plays a key role. A large-scale laboratory unit is being assembled at the SMRI to investigate the technologies developed by the various research groups.

Italian sugar industry restructuring[3]

The European Commission has approved a sugar industry restructuring plan of the Italian government which would use state funds to create a financing company to take shares in various private sector concerns with the aim of maintaining sugar production and beet cultivation. However, the Commission has refused an Italian request to raise its production quota because Italy is the only EEC member state to have been granted an A-quota increase in 1980 (by 90,000 tonnes to 1,320,000 tonnes) and because the present combined A- and B-quota of 1,570,000 tonnes covers consumption which reached 1,520,000 tonnes in 1982/83. Authorization of state aid to help persuade farmers not to abandon sugar beet cultivation was granted on condition that it is limited to a five-year period and does not increase Italy's output above the combined A- plus B-quotas.

Over-quota Indian sugar exports[4]

In 1983 India exported 782,464 tonnes, raw value, of sugar against an ISO quota of 705,000 tonnes. As a result, the government has asked the ISO to waive the excess and not count it against India's export quota for 1984, which is the same as for last year. The ISO has, in fact, decided that the excess should be charged against India's 1984 quota but this may turn out to be a meaningless exercise since, if in 1984 India does not abide by the ISA decision and again exceeds its reduced quota entitlement, nothing can be done about it in the absence of a new Agreement.

Japan cane sugar production, 1983[5]

The 1983 sugar cane crop in Japan amounted to 2,530,000 tonnes, up 27,000 tonnes from the year before, according to the Ministry of Agriculture. An estimated 296,500 tonnes of raw sugar was produced from the 1983 crop against 255,018 tonnes in 1982. The 1983 cane area amounted to 35,200 hectares against 33,900 ha in 1982.

USSR sugar imports and exports, 1983[6]

	1983	1982	1981
Imports		*tonnes, raw value*	
Argentina	120,493	127,473	149,637
Australia	85,000	157,000	0
Austria	52,746	50,214	14,052
Brazil	1,005,024	362,115	346,612
Bulgaria	0	41,099	2,746
Canada	0	21,652	13,641
Colombia	35,000	36,000	12,000
Cuba	3,040,521	4,224,329	3,098,809
Czechoslovakia	1,083	0	0
Dominican Republic	286,131	193,777	14,478
EEC	897,567	1,263,322	873,107
Finland	25,981	4,300	62,157
Gabon	0	0	5,413
Germany, East	225	21,652	4,209
Guatemala	0	64,373	0
Hungary	0	76,223	0
Mozambique	0	24,700	0
Nicaragua	22,750	5,079	0
Philippines	232,256	215,585	280,889
Rumania	61,723	45,255	28,742
Thailand	121,847	428,692	265,552
US	0	0	40,381
Yugoslavia	0	0	506
Unknown	9,743	0	0
	5,998,090	7,362,840	5,203,931
Exports			
Afghanistan	67,076	147,387	84,984
Benin	1,624	0	0
Bulgaria	4,330	0	4,333
Iran	0	65,728	20,843
Korea, North	433	0	0
Mali	0	0	2,707
Mongolia	36,667	32,854	43,357
Vietnam	5,413	10,826	10,825
Yemen, South	32,478	9,841	16,146
	148,021	266,636	183,195

After-hours trading on the London sugar market[7]

The Management Committee of the United Terminal Sugar Market Association, which runs the London sugar market, has sanctioned the transfer of after-hours trading in London to the floor of the market itself for a trial period of three months from July 2. Until that date, inter-office trading continued outside the market – so-called "kerb trading" – but under the new arrangements trading continues after the closing calls, with any business registered included in the following day's turnover.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 412.
2 *S. African Sugar J.*, 1984, **68**, 127.
3 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 295.
4 *World Sugar J.*, 1984, **6**, (12), 37.
5 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 368.
6 *I.S.O. Stat. Bull.*, 1984, **43**, (4), 41-42.
7 C. Czarnikow Ltd., *Sugar Review*, 1984, (1707), 120.

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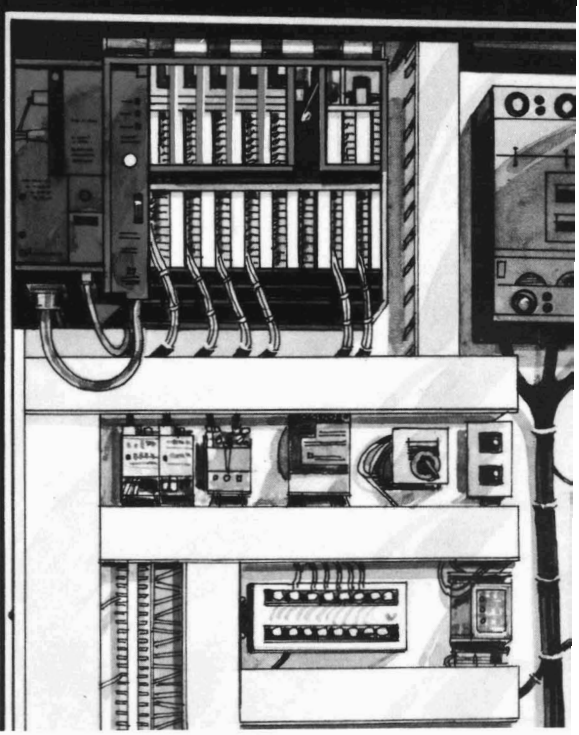

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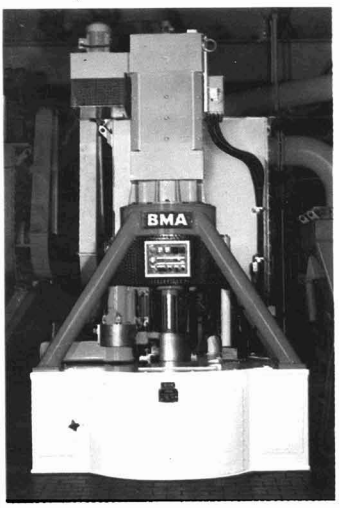

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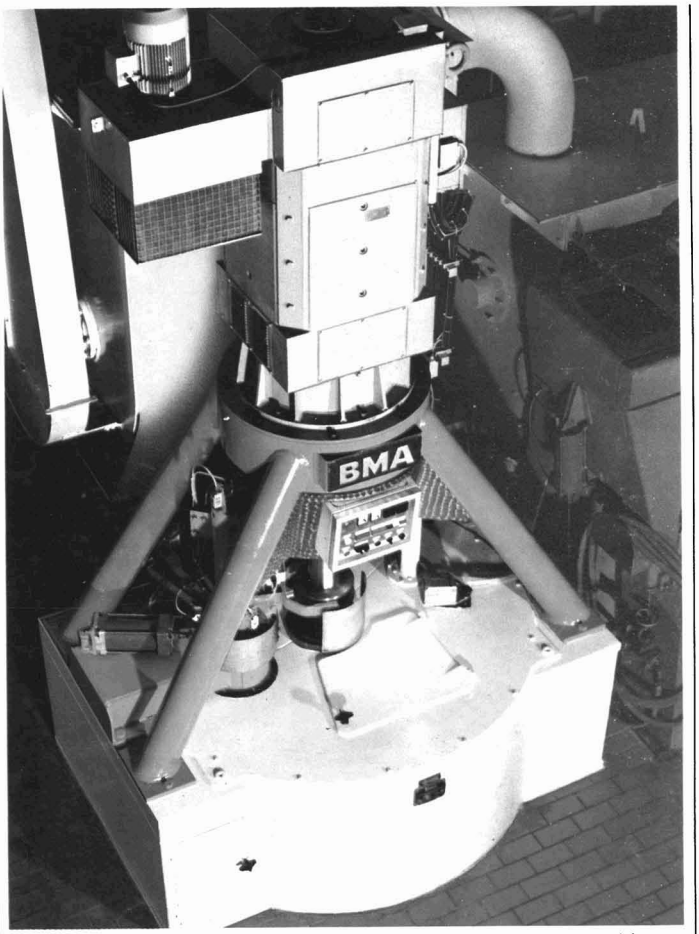

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