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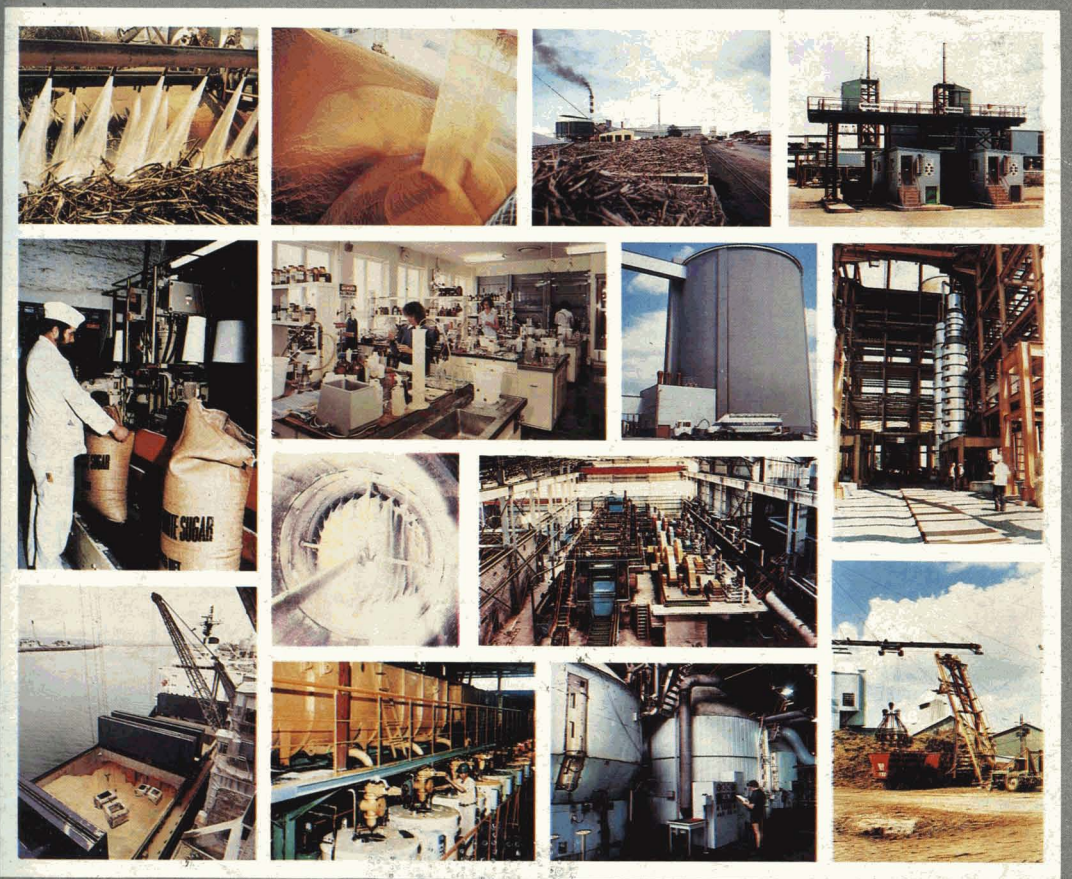

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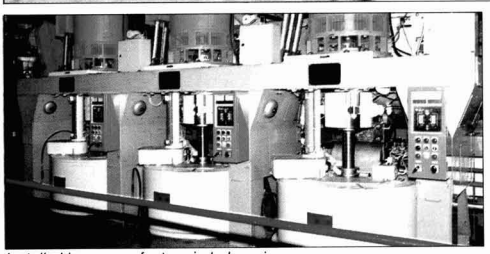

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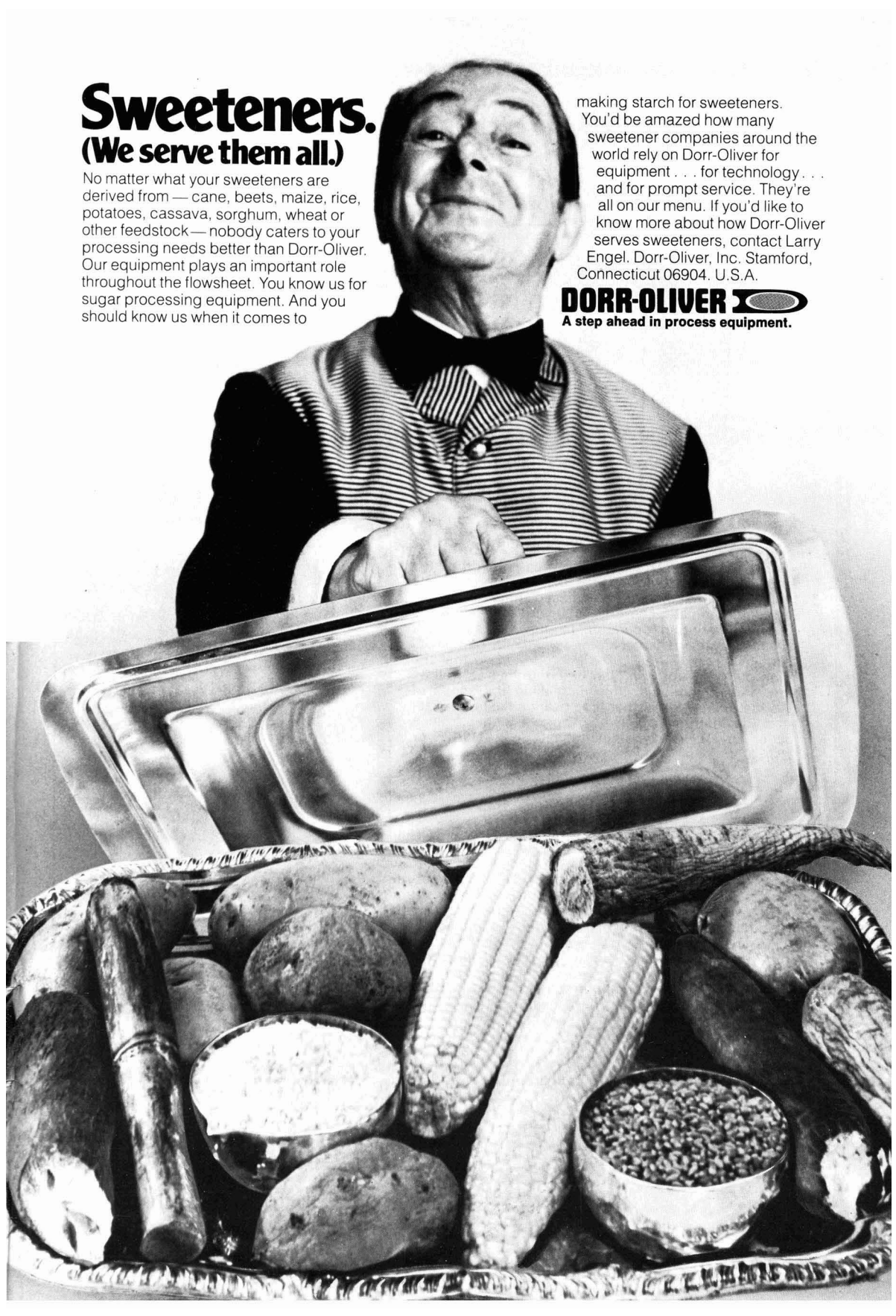
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Notes and comments

International Sugar Conference

As planned, the UN sugar conference resumed in Geneva on June 12 and was scheduled to last for three weeks with the possibility of extension, but the talks foundered on June 29 and only an administrative agreement was narrowly achieved during the next week. Delegates were pressed to proceed with their work rapidly but little progress was made with what emerged as the main difficulty, the size of the individual Reference Export Availabilities (REA's), i.e. the shares for each country of the available market. A group of 13 exporters proposed a formula in which the EEC would have a REA of 4.35 million tonnes, raw value, against the 5.4 million it had been claiming, while the other nine largest exporters would have 95% of their current export quotas. This was predictably turned down by the EEC delegation and the Conference President later put forward other proposals which included REA's of 2.6 million tonnes for Australia and Brazil, 2.2 million for Cuba and 4.9 million for the EEC. This last was acceptable to the EEC provided it was guaranteed for the duration of the Agreement, a condition not acceptable to Australia which also was not willing to accept an REA reduced to such an extent from its claimed 4 million tonnes. Deadlock ensured and eventually it was accepted that no solution would be reached. The delegates then set about producing an administrative agreement which was reached on July 5. This will ensure the continuity of the International Sugar Organization at its headquarters in London for the provision of information and exchange of views, and presumably to provide the opportunity for future meetings aimed at a new Agreement with economic clauses. C. Czarnikow Ltd. notes[1]: "Nearly two years have been spent with three UN Conferences and numerous preparatory meetings in London but the differences between the major exporting delegations which were revealed before the weekend remain significant and strongly held. It has also been a feature of the discussions over most of the past two years that importing countries have not been involved to the extent that would be desirable as any measures must have the widest possible range of support to be successful. Given this and the extent of the present world surplus, we cannot envisage a resumption of negotiations for an ISA with economic clauses within some one or two years".

World sugar prices

India entered the world market as an unexpected purchaser in early June and, as a consequence, the LDP rose from $152 to reach $157.50 on June 7, while the LDP(W) rose from $162.50 to $174 per tonne. Further support was given by purchases by Egypt, Morocco and Sri Lanka but the revival was short-lived and the raw sugar price eased to $145 by June 13 while that for white sugar dropped to $167, after which prices strengthened slightly on a statement that India had acquired 300,000 tonnes. The pressure of overwhelming supplies and not very hopeful news from Geneva kept the prices at a low level in a quiet market, to reach $139 for raws and $164 for whites at one point. When the news of the UN sugar conference failure broke the market slumped and the LDP finished the month at its lowest level of $135.50 and the LDP(W) at $165.50.

E.D. & F. Man[2] comment that the market seemed to be gripped by a mood of almost hopeless depression. "At this stage, the immediate effect of the breakdown of negotiations upon the market for the remainder of 1984 is uncertain. It is difficult to see why producers should be tempted to sell additional quantities of sugar at around 5 cents per pound for 1984 delivery when the early 1985 deliveries carry a 20% premium over 4th quarter 1984. Indeed, free of the obligation to ship their full quota, exporters may feel it worthwhile to delay shipments and benefit from the forward premium. A significant improvement in prices during the coming six months looks improbable. However, the current market price is so low that any sign of a change for the better in the statistical position should make 1985 a much improved year for prices."

South African sugar crop, 1983/84[3]

The 1983/84 season in South Africa was adversely influenced by abnormally bad weather conditions. The season started during one of the worst droughts in living memory and ended with heavy rainfall and damaging floods in the northern areas of the sugar belt. The cane crop over the full season amounted to 13,422,876 tonnes, from which 1,378,465 tonnes of sugar was produced, at a cane:sugar ratio of 9.74. Comparative figures for the preceding year were 19,339,492 tonnes of cane, 2,135,993 tonnes of sugar and a cane:sugar ratio of 9.10.

The season ended officially on March 31, 1984. The only mill which ran in March was Darnall, which had stopped crushing in September 1983 owing to lack of cane but started up again in February. Darnall is continuing to crush into the 1984/85 season but its production up to March 31 has been included in the 1983/84 outturn.

South Africa's drought-hit production is the lowest since the season of 1965/66 when, in another period of drought, only 908,803 tonnes of sugar was made. Although considerable loss of cane will be experienced in the 1984/85 season, owing to flood damage in the Umfolozi and Pongola areas, and total damage is probably in excess of R100 million, it is ironic that the sharply above-average rainfall experienced throughout the industry since October 1983 could produce a record crop in 1984/85.

European beet area, 1984

Last year, Licht's third estimate of European sugar beet areas showed the full scale of damage which had been caused by continuous wet weather. Heavy rains had hampered and delayed sowing operations to such an extent that some areas had had to be abandoned and the third estimate differed substantially from the earlier

1 *Sugar Review*, 1984, (1708), 123.
2 *The Sugar Situation*, 1984, (398).
3 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 265.

estimate. By contrast, 1984 weather conditions allowed much earlier completion of sowings and the third estimate recently published by Licht[4] differs only slightly from the previous one with marginal or no changes. The total area is now estimated at 7,477,000 hectares against the 1983 area of 7,458,000 ha, and the estimates are tabulated below.

	1984	1983
	hectares	
Belgium	120,000	114,000
Denmark	74,000	72,000
France	500,000	472,000
Germany, West	421,000	403,000
Holland	130,000	117,000
Ireland	37,000	36,000
Italy	210,000	215,000
UK	200,000	196,000
Total EEC	*1,721,000*	*1,663,000*
Austria	51,000	42,000
Finland	33,000	32,000
Spain	218,000	241,000
Sweden	52,000	53,000
Switzerland	15,000	15,000
Turkey	354,000	360,000
Yugoslavia	143,000	140,000
Total Western Europe	*2,587,000*	*2,546,000*
Albania	10,000	10,000
Bulgaria	55,000	54,000
Czechoslovakia	205,000	200,000
Germany, East	241,000	257,000
Hungary	109,000	108,000
Poland	480,000	487,000
Rumania	270,000	265,000
USSR	3,520,000	3,530,000
Total East Europe	*4,890,000*	*4,912,000*
Total Europe	7,477,000	7,458,000

In addition to the late sowing in 1983, beet growth was affected by a long drought in the summer. This year results should be better and, while a bumper crop is not to be expected, sugar production is expected to be higher than in 1983/84. Based on average yields between 1979/80 and 1983/84, EEC sugar production could reach 12.9 million tonnes, raw value, up by 1.2 million tonnes from last campaign, while total Western Europe output could reach 17.4 million tonnes.

On a similar basis Eastern Europe's output would be 11.8 million tonnes, raw value, but Licht notes that the average yield for the USSR in 1983/84 was particularly low. With the current good state of crop development the estimate of Soviet beet sugar production, at 7,281,000 tonnes might be too low and last year's output of 8.7 million tonnes might well be repeated.

Stocks and the sugar market

World Sugar Journal has recently published an editorial[5] which asks "How cloudy is sugar's future?" and discusses the influence of surplus stocks, i.e. the total stocks minus commercial stock requirements and minus those held under I.S.O. rules. The editorial notes that it is helpful to look at such stocks in detail rather than in global terms and provides a table, reproduced below:

	1982/83	1983/84	ISO stocks
		tonnes, raw value	
India	3,172,000	1,664,000	125,000
EEC	2,906,000	95,000	0
China	810,000	972,000	0
Cuba	632,000	574,000	387,000
Thailand	618,000	280,000	183,000
US	455,000	1,000	0
Philippines	412,000	254,000	271,000
Dominican Republic	371,000	324,000	167,000
Argentina	337,000	341,000	75,000
Indonesia	332,000	122,000	0
Totals	10,045,000	4,627,000	1,208,000

WSJ notes that surplus stocks decreased substantially between 1982/83 and 1983/84 although, if no new ISA is in effect in 1985, the special stocks (totalling 2,500,000 tonnes altogether) will become available to the market. A major part of the surplus is, however, in the hands of very few countries, notably India. In that country, a significant crop reduction is apparently being experienced, while consumption is showing signs of rising to such an extent that India could be left without any exportable surplus in 1984/85 , Similarly, in the EEC, while the beet area is larger than for 1983/84, this does not necessarily mean a higher sugar output from the 1984/85 campaign and the weather conditions appear similar to those of 1976/77 when sugar production fell in spite of a larger area.

The absence of a new International Sugar Agreement combined with current low world market prices is bound to influence the areas planted to beet and cane. *World Sugar Journal* concludes that the dominant factor at present is uncertainty and that it is a fair assumption that this uncertainty may itself turn out to be a favourable factor for 1984/85.

Philippines sugar production decline possibility[6]

Sugar planters and factory owners, who are operating at a loss, fear their industry may soon collapse unless the world market improves and the government changes its marketing monopoly, according to industry sources. Production in the 1983/84 season is likely to go down to about 1.7 million tonnes compared with 2.4 million tonnes produced in 1982/83 and it is feared that output may fall further next season. One planter said that output is expected to fall because NASUTRA (the government-owned National Sugar Trading Corporation) has not yet paid the planters, including those who have already signed contracts with the government. Industry sources fear that small planters may soon go out of business, leaving production to the highly mechanized big estates, which account for an estimated 70% of production. The big estates may then not have to export sugar because the domestic market, which requires about 1 million tonnes a year, would become profitable.

A spokesman for the Philippine Sugar Commission said the government has commissioned a group of experts to make a comprehensive study of the problems of the sugar industry including financing and marketing.

4 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 323-329.
5 1984, **6**, (11), 4-5.
6 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 350.

HPLC in sugar factories and refineries*

By Margaret A. Clarke and W. S. Charles Tsang

(Sugar Processing Research Inc., Southern Regional Research Centre, P. O. Box 19687, New Orleans, LA 70179, USA)

Introduction

High performance liquid chromatography (HPLC) is an analytical technique that is well established for analysis of sugars, colorants and other compounds in sugar industry laboratories[1-6]. HPLC is routinely used in quality control in production of high fructose corn syrups and other corn products[7-9], and for process control or quality control by many sugar-using industries, such as canning, fruit juice and soft drink manufacture, to analyse the sugars content of their raw materials and products[10-15]. In the sugar industry, HPLC has been used to analyse sugars, polysaccharides[16] and organic acids and colorants[3-5,17-20] among other compounds.

The advent of ion-exchange type HPLC columns that can be readily regenerated and have long lifetimes for sugar analysis made HPLC a practical control tool for sugars in many products. There had been some concern that the instrumentation was too complex and/or too delicate for regular sugar laboratory control use; the recent introduction of a simplified instrument, designed specifically for sugars analysis, presented a response to this concern. This instrument appeared suitable for everyday control laboratory use. From November 1982 to March 1983, such an instrument was transported by S.P.R.I. personnel to laboratories in sugar refineries and sugar factories in Louisiana, subjected to normal conditions in the laboratories, and operated on routine samples for periods of five to ten days at each site. Only straightforward direct HPLC analysis was attempted, so that samples could be run with only dilution or filtration as preparation, with no additional reactions required.

This paper presents some results obtained in these studies in an effort to determine the usefulness of HPLC in its current state as a routine control tool in factories and refineries.

HPLC operation

The general principles of HPLC are outlined in Figure 1. A solvent is pumped at high pressure (up to 2000 p.s.i.) onto a column packed with micro-particulate beads. The solvent sweeps up a sample and carries it to the column; the column separates the sample into its different components; the components flow on over the detector, which identifies them. The simplified chromatograph for sugar analysis uses only one pump instead of two reciprocating pumps used in the research model, and a refractive index detector only; a column heater is built into the instrument.

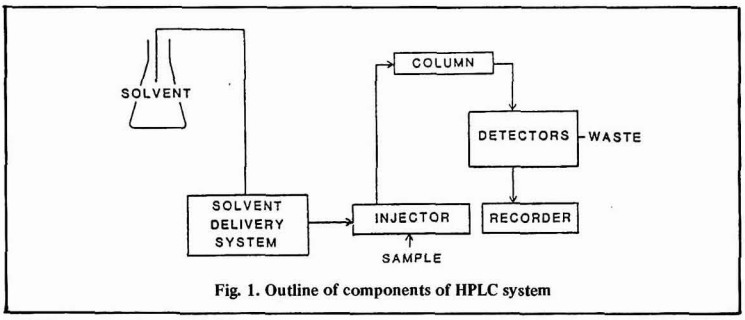

Fig. 1. Outline of components of HPLC system

Figure 2 shows a typical separation of a standard mixture of known sugars. The x-axis indicates time, and the arrow indicates time of injection (start of analysis). The compound is identified quantitatively by the size of the peak. Figure 3 shows typical chromatograms of molasses and cane juice. In addition to sucrose, glucose and fructose peaks, peaks are observed representing total polysaccharides ("poly", including dextran and starch) and ash components ("A"), which can be estimated, although not analysed precisely, by this type of HPLC. Small peaks representing other sugars are also observed. These analyses require from 12 to 15 minutes each, with sample preparation time of 5 to 10 minutes. One sample can be run while the next is being prepared.

Methods and materials

The chromatograph used is a Sugar Analyser I (Waters Associates, Milford, MA 01757, USA), comprising an M-45 pump, Rheodyne 7010 injector system and Model 201 refractive index detector. Data produced by the Sugar Analyser are recorded and handled by a Data Module 730 (Waters Associates) which displays a tracing of the chromatogram, calibrates the area of peaks against a set of standards, and prints out the results. The Data Module contains nine calibration files for standards, with each file holding

* *Paper presented to the 42nd Meeting, Sugar Industry Technologists,* 1983.

1 Palmer: *Anal. Lett.*, 1975, **8**, (3), 215-224.
2 Clarke & Brannan: *Proc. Sugar Ind. Technol.*, 1978, **37**, 333-368, 1979, **38**, 102-112; *Proc. Tech. Session Cane Sugar Refining Research*, 1978, 136-145, 149-157; 1980, 138-149.
3 Smith: *Proc. Tech. Session Cane Sugar Refining Research*, 1977, 19-34; *Proc. Sugar Processing Res. Conf.*, 1982, 256-264.
4 Smith *et al.*: *ibid.*, 1978, 81-91.
5 Charles: *I.S.J.*, 1981, **83**, 169-172, 195-199.
6 Wong-Chong & Martin: *Proc. 17th Congr. I.S.S.C.T.*, 1980, 2373-2388.
7 Samuelson: "Advances in Chromatography", Vol. 16. (Marcel Dekker, New York) 1978, pp. 113-149.
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11 Wade & Morris: *J. Chromatography*, 1982, (240), 257-261.
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13 Hurst & Martin: *J.A.O.A.C.*, 1980, **63**, 595-599.
14 Wilson: *J. Sci. Food Agric.*, 1981, **32**, 257-264.
15 Richmond *et al.*: *J. Agric. Food Chem.*, 1981, **29**, 4-7.
16 Vane: *Proc. Sugar Processing Res. Conf.*, 1982, 248-255.
17 Paton & Smith: *ibid.*, 1982, 1-23.
18 Curtin & Paton: *Proc. 17th Congr. ISSCT*, 1980, 2361-2372.
19 Tsang & Clarke: *Paper presented at 14th Ann. Symp. on Adv. in Applied Anal. Chem.* (New Orleans), May 1983.
20 Marsili *et al.*: *J. Food Sci.*, 1981, **46**, 52-59.

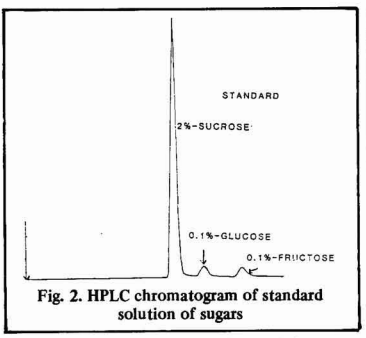


Fig. 2. HPLC chromatogram of standard solution of sugars

information for several peaks, and the unknown or sample can be calibrated against any or all of them. Calibration files were renewed with data from standards injected periodically, to guard against possible changes in the separating and detecting systems. The calibration file closest to the sample concentration range was the optimum choice. The Rheodyne 7010 automatically injects 20 μl of sample.

Injections were made with Hamilton syringes (700 series, Rheodyne Model). Columns used were (1) SugarPak (Waters Associates) or (2) HPX 87C, (BioRad Laboratories, Richmond, CA 94804, USA). Both columns contain cation-exchange resins in the calcium form, of particle size 15-30 μm diameter, and are commercially available. These columns operate best at 85° to 90°C, and are heated in the column heater built into the Sugar Analyser. It was found unnecessary to heat the solvent, as this was heated in the tubing leading to the column.

The solvent was a 20 ppm solution of calcium propionate or calcium acetate in HPLC-grade water, prepared in a MilliQ water clean-up system to have conductivity below 2.5 μmho/cm.

Sample preparation for syrups included dilution (to 5 to 10% total sugars), and filtration through a SepPak C-18 (a half-inch column of fine anion exchange material) to remove excess colorant and chloride, in order to improve column life. The SepPak was washed with two or three bed volumes of sample solution before a sample was collected, in order to avoid any loss of sample in clean-up. The sample was then filtered through a 0.45 μm Millipore filter held in a Swinney adaptor. About 150 μl of prepared sample are required for injection. Cane juice (unleaded) was not diluted, and was filtered through a glass-fibre filter pad, in a Swinney adaptor, before SepPak filtration.

The SugarPak column was reversed (to flow rate) every day, and regenerated every two weeks. The HPX 87C column was regenerated every two weeks. Manufacturers' regeneration procedures were followed.

Pol and Brix were measured using the various automatic polarimeters and Abbé refractometers available in the refineries and factories visited.

Results and discussion

The instruments performed satisfactorily under test in factories and refineries. Instruments were transported to test sites in a station wagon. There were no problems from temperature or humidity changes (instruments were used in the main body of the laboratory, not in specially controlled areas) or power fluctuations. An isolation transformer was placed between the Data Module and the line voltage for safety. HPLC grade water was brought to the sites; other chemicals and equipment required, such as a balance, were available there. Regular sugar laboratory personnel were able to operate the instruments satisfactorily.

The precision and accuracy of the analyses have been determined in the home laboratory[2]. Precision is shown in Table I, where "n" represents the number of injections measured. With regard to accuracy, in recovery studies now in press[21], recoveries have been shown to be: sucrose 98%; glucose 96%; and fructose 93%, which are very satisfactory.

Table I. Precision of sugar analysis by HPLC

Sugar	n	C.V. of area integrated
Sucrose	7	0.56%
Glucose	6	0.96%
Fructose	4	0.50%

HPX 87C Column; 85°C; R.I. 8X; Waters System, WISP Injector.

In general, direct HPLC analyses worked well on dilute samples such as juices and waters, and on low-grade materials, where there is a significant amount of glucose and fructose, but was not satisfactory for high purity liquors (above 92 purity) where the glucose and fructose peaks were overwhelmed by the sucrose peak.

One advantage of HPLC analysis that became increasingly apparent was its ability to give a picture of the multiple components of a sample. A pol reading gives one number, whereas an HPLC analysis gives several numbers that go to make up pol, plus a picture, i.e. a chromatogram, of the sample so that changes are readily visible. When cane juice samples showed a drop in pol, HPLC could show in a few minutes whether the cause was that the invert levels had changed or stale cane had appeared, as shown by an increase in dextran levels, or whether sucrose has simply decreased. In waste

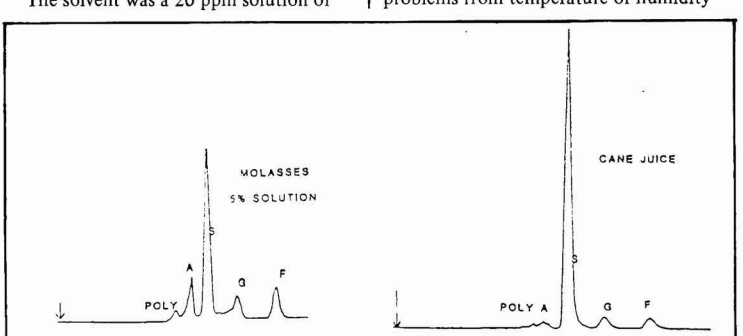


Fig. 3. Typical chromatograms of molasses and cane juice

21 Clarke & Tsang: *J. Chromatography*, in press.

water samples, a colorimetric carbohydrate test, e.g. using α-naphthol, might show a positive test, but could not show, as HPLC could, whether this was caused by actual sucrose loss or by trace polysaccharide contamination. This ability to present both numbers and a visual analysis was extremely valuable in problem-solving, especially when relatively untrained personnel were present, because the nature of the change was emphasized. More highly trained personnel were required to understand what the change was, how to explain it, and to correct, if necessary.

Factories

HPLC was tested for use in juice analysis, mud and bagasse wash waters, boiler feed and other waters, condenser waters, crystallizer massecuites, molasses and effluent waters.

In the analysis of juice for payment in Louisiana, pol is generally measured in a core sample using an automatic polarimeter. HPLC analyses were used to analyse the true sucrose % cane, and to show how the pol contributions from other sugars and polysaccharides such as dextran affected the observed pol reading. In Table II is given the equation for calculation of pol value from % sugars and other components analysed by HPLC.

Table II. Calculation of pol value from HPLC analytical data

$$Pol_{Calc} = Pol_{sucrose} + Pol_{glucose} + Pol_{fructose} + Pol_{dextran} + Pol_{kestose} + Pol_{x}$$

Substitute concentrations times pol ratios for pol:

$$Pol_{Calc} = 1.0(suc) + 0.8(glu) - 1.3(fru) + 3.0(dex) + 0.4(kest) + x$$

The polysaccharide estimate is taken as dextran. Kestose is a trisaccharide in cane juice that elutes in this system between ash and sucrose. The x factor represents those optically active compounds which may be present but are not accounted for in the equation, e.g. lactic acid, mannose and galactose.

Table III shows how the equation is applied to results from a juice analysis, and Table IV shows comparison of the true sucrose value of several juices with the observed pol value. It will be seen that the calculated pol value, which takes into account the effects of other polarizing substances on the pol measurement, moves the observed pol value toward the true sucrose. In effect, Pol_{calc} is a corrected Pol_{obs}, with not all corrections considered.

Table III Calculation of juice pol from % components by HPLC

	Juice E		Pol factor		Pol contribution
% sucrose	15.11	X	1.0	=	15.11
% glucose	0.39	X	0.8	=	0.312
% fructose	0.47	X	−1.3	=	−0.611
% dextran	0.05	X	3.0	=	0.15
% kestose	0.2	X	0.4	=	0.08
			Pol_{calc}	=	15.04

The difference between Pol_{obs} and sucrose shows the amount of sucrose in cane that was over- or underpaid.

The glucose and fructose values are seen to be the major effect on sucrose pol values in normal cane juices, in agreement with the observations of Morel du Boil & Schäffler in their study of juice sucrose by GLC[22]. Badly deteriorated juices (from old or frozen cane) were not encountered during this study, although differences (increases) in polysaccharide levels were observed after rainy weather. These increases were presumed due to older cane which had been cut before the rains and brought to the factory after the weather had cleared. Figure 4 shows differences in laboratory treated juices between fresh juice and juice held at 30°C for 36 hours. The increase in dextran (polysaccharide peak) is caused by the action of *L. mesenteroides* on the sucrose in the juice; lactic acid (L.A.) is a by-product of

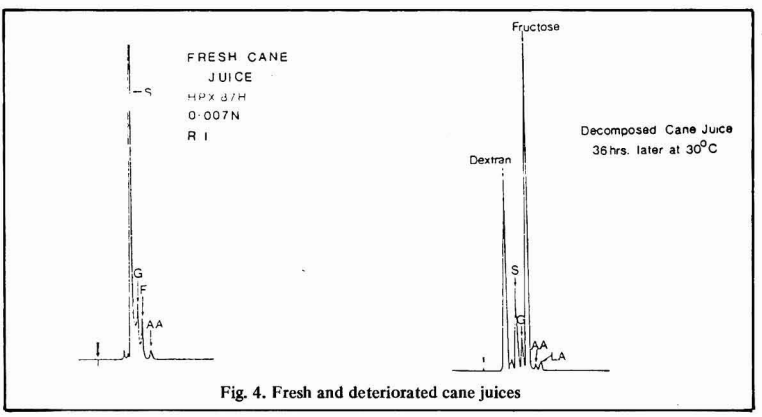


Fig. 4. Fresh and deteriorated cane juices

Table IV. Comparison of true sucrose (HPLC) with observed and calculated pol values

Juice	$Sucrose_{LC}$	Pol_{calc}	Pol_{obs}	$Pol_{obs} - Sucrose_{LC}$
A	18.65	18.25	17.64	−1.01
B	18.81	18.99	19.05	+0.24
C	15.16	15.38	15.51	+0.35
D	15.45	15.24	15.20	−0.25
E	15.11	15.04	15.80	−0.69

22 *Proc. Tech. Session Cane Sugar Refining Research*, 1978, 107-135.

this action. The notable increase in fructose concentration is caused by fructose remaining after the micro-organism had removed the glucose moiety from the sucrose. "AA" represents aconitic acid. HPLC is the obvious analytical tool to explain the situation when frozen, stale or mistreated cane makes false pol a real possibility.

Also in the area of cane juice analysis, Table V shows differences in first expressed (crusher) juice, (residual) juice from the last roll, (dilute) mixed juice, and clarified juice. It is known, of course, that sucrose in first expressed juice is higher, and non-sugars in residual juice proportionately lower, as in Figure 5, but the demonstration of the relative quantities offers the eventual possibility of tuning mills to give maximum sucrose.

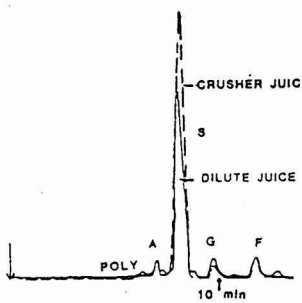


Fig. 5. Comparison of crusher juice (first expressed) with dilute juice (mixed juice)

Table V. Cane juice analysis by HPLC

	% Sucrose	Glucose	Fructose	Ash	Polysaccharides
Crusher juice	14.57	0.23	0.31	0.15	0.05
Residual juice	6.53	0.30	0.30	0.05	0.13
Dilute juice	12.51	0.34	0.39	0.21	0.08
Clarified juice	12.64	0.17	0.31	0.06	0.13

Table VI shows the analyses of bagasse wash, showing sugars lost to bagasse, and mud filtrates, which are usually recycled with mixed juices, and emphasizes how much non-sucrose is recycled with mud filtrates.

Figure 6 shows an analysis of factory waters, both of which showed negative to an α-naphthol test. HPLC revealed traces of sucrose in both boiler feed water and steam.

Table VI. Analysis of bagasse wash and filter mud filtrates by HPLC

	% Sucrose	Glucose	Fructose	Ash	Polysaccharides
Bagasse wash	0.93	0.03	0.02	0.02	0.03
Mud filtrate (1)	6.48	0.75	0.38	1.07	0.08
Mud filtrate (2)	6.80	0.24	0.36	3.10	0.10

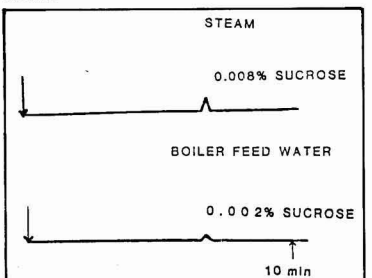


Fig. 6. Traces of sucrose in boiler feed water and steam

HPLC is not yet fast enough nor sufficiently comprehended to be used for routine juice analysis for cane payment, but is an excellent problem-solving tool when juice analyses do not correspond to what happens in the factory, or when juice pol and sucrose yields do not correlate. HPLC does show – and quickly – where and how false pol may become a problem, and can show what is causing false pol. It can show where sugar is being lost; where undesirable non-sugars are being recycled, and where unwanted sucrose is entering the steam cycle.

HPLC use on analysis of the sugars which are present in low-grade syrups in factories is similar to that in refineries, and the latter is discussed in the following section.

Refineries

HPLC was tested for use on incoming raw sugars, affination syrups, clarification and mud washings, sweet waters, low-grade pan syrups, crystallizers, condenser waters, and wash and effluent waters of all kinds. Sucrose loss was one general target: direct loss, as in wash waters, and indirect loss to invert formation. Loss to invert formation was difficult to follow in high purity materials (over 92% purity) by a single direct analysis. Separate analyses, one for sucrose and another, under different conditions, for glucose and fructose as has been shown in earlier work in these laboratories[2] or additional pre- or post-column derivatization reactions, are required[2,3]. The goal in this study was to ascertain the usefulness of the dedicated HPLC in direct, simple analysis. The situation approaching the limiting case is diagrammed, in Figure 7, where run-off syrup from a second boiling shows invert below detectable levels (a) under average HPLC conditions, but shows a result under a different set of conditions where glucose and fructose peaks can be resolved (b).

Invert gain cannot, therefore, be followed satisfactorily through decolorization, or evaporators, by this simple technique, although more complicated HPLC techniques can be used for these studies[23].

Sucrose loss in crystallizers under normal conditions can be seen in Table VII. Results like these can be compared when crystallizers are operated at different temperatures, or with different rates of cooling, or with different additives, and show much more about progressive deterioration in the crystallizers than does simple purity drop.

Dextran contamination in a refinery,

23 Lawson & Russell: *J. Food Sci.*, 1980, **45**, 1256-1258.

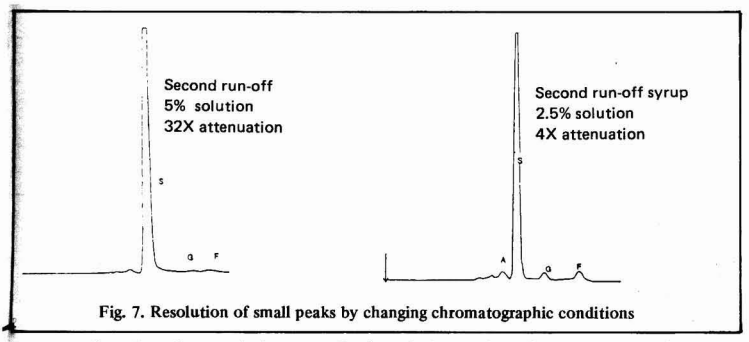


Fig. 7. Resolution of small peaks by changing chromatographic conditions

most often found in the remelt house, will show up quickly on HPLC analysis, as an increase in the polysaccharide peak. No examples are shown here because no contamination was found in the refineries involved in the current study. Build-up of polysaccharides was observed in low-grade syrups, as expected.

Table VII. Changes in crystallizer massecuites

	% Sucrose	Glucose	Fructose
1	62.82	6.65	7.46
2	60.71	6.15	10.29
3	57.64	5.69	9.62
1	55.34	5.59	4.98
2	54.50	7.65	8.16
3	52.00	7.84	6.39

In examination of waters in and out of refineries, some points of interest arose. Table VIII shows results on some spot sampling of condenser waters. None of these samples showed any reaction with α-naphthol but, by HPLC, the samples show definite quantities of sucrose which could amount to considerable losses over some period of time. These sucrose levels are most probably not continuous, but vary as different pans are dropped.

Table VIII. Sucrose content of spot samples of waters

	Day 1	Day 2	Day 3
Condenser 1	0.008%	–	–
Condenser 2	N.S.	0.016%	–
Condenser 3	–	–	–
Incoming	N.S.	0.005%	–
Effluent	–	–	0.028%

In another situation where HPLC figures on condenser waters were compared with those of a colorimetric test, shown in Table IX, the HPLC figures showed whether trace amounts of carbohydrate shown colorimetrically were actually sucrose, or were invert or polysaccharide, an important difference where tracing sucrose losses, although all the same to the environmental control agencies.

HPLC showed that a polysaccharide material and a trace of glucose were in the water-course upstream from the refinery, and that there were neither sugars nor polysaccharides in the final effluent back to the water-course. The guilty party was upstream from the refinery.

In general, HPLC appeared very useful in tracing direct sugar losses, especially in waste waters, and in following degradation and invert gain in low-purity materials.

Product identification

In another area of concern to sugar refiners and manufacturers, HPLC can provide a rapid means to differentiate liquid sweetener products. There have been several cases brought to these laboratories where products sold as cane syrups or liquid sucrose have been suspected to contain the cheaper high fructose corn syrups. Figure 8 shows typical HPLC chromatograms for sucrose syrups, invert syrups and fructose corn syrups, where G represents glucose and F represents fructose. The corn products are readily recognizable by the characteristic double peak eluting before the "sucrose" area.

Table IX. Percent sugar in waste waters

	Colorimetric test	Sucrose	Glucose	Fructose	Polysaccharides
Condensate 1	0.0005	–	0.02	–	–
Condensate 2	0.0010	–	–	–	0.0010
Condensate 3	0.0250	0.0177	–	–	–
Incoming	0.0150	–	–	–	–
Effluent to pond	0.2235	0.2368	0.07	–	–

In another situation concerning water quality, a refinery had been questioned about carbohydrate material showing up (by a colorimetric test) in the water-course dowstream from the refinery. Was the refinery emitting sugars in effluent waters?

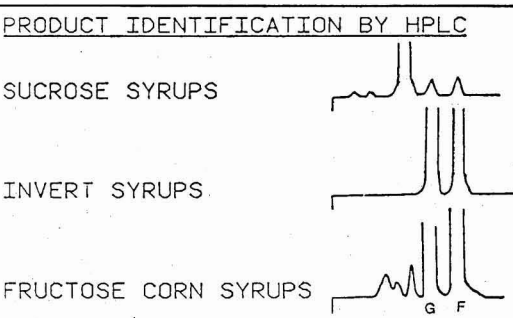


Fig. 8. Identification of composition of liquid sweeteners

(In corn syrups, the disaccharide is maltose, not sucrose.) This double peak in the oligosaccharide region represents maltodextrins, incompletely broken-down starch moieties. All these chromatograms are run on ion exchange systems, as described herein.

Summary

High performance liquid chromatography (HPLC) is well established as an analytical tool in many industries, and has been in use in sugar industry research laboratories for some years. In an assessment of the use of HPLC in plant operations, an HPLC system dedicated to analysis of sugars was taken into sugar factory and refinery laboratories and samples of juices, syrups, process liquors, molasses, waste waters and waters were analysed. With regard to factory operations, HPLC for juice analysis, false pol discovery and routine control are discussed. In the refinery operations, HPLC as a technique for analysis of low-grade syrups and liquors, water monitoring, dextran contamination, invert destruction, and fermentation, are considered. HPLC is particularly useful for investigation of losses, problem solving and maintenance checks in factories and refineries.

La chromatographie en phase liquide à haute performance en sucreries et raffineries

La chromatographie liquide à haute performance (HPLC) est bien établie comme outil analytique dans de nombreuses industries et est utilisée dans les laboratoires de recherche de l'industrie sucrière depuis quelques années. Pour étendre l'utilisation de l'HPLC au processus industriel, un système d'HPLC consacré à l'analyse des sucres a été introduit dans des laboratoires de sucreries et de raffineries pour y analyser des échantillons de jus, de sirops, d'égouts, de mélasses, d'eaux et d'eaux usées. En ce qui concerne la fabrication, on discute de l'utilisation de l'HPLC pour l'analyse des jus, de la découverte de fausse polarisation et du contrôle de routine. En raffinerie, on considère l'HPLC comme technique d'analyse des solutions et des égouts de basse pureté, pour la régulation de l'eau, la contamination par le dextrane, la destruction de l'inverti et la fermentation. L'HPLC est particulièrement utile pour la recherche des pertes, pour résoudre des problèmes et contrôler l'entretien dans les sucreries et raffineries.

Hochdruckflüssigkeitschromatographie in Zuckerfabriken und Raffinerien

Die Hochdruckflüssigkeitschromatographie ist in vielen Industrien eine gut eingeführte analytische Methode und wird auch in Zuckerindustrie-Forschungslaboratorien seit einigen Jahren verwendet. In einer Abschätzung über die Verwendbarkeit von HPLC in der Fabrikation wird ein HPLC-System für die Analyse von Zucker in Zuckerfabriks- und Raffinerielaboratorien beschrieben für Proben von Saft, Sirupen, Klären, Abläufen, Abwässern und Wasser. Diskutiert wird die Verwendung von HPLC in der Zuckerfabrik zur Saftanalyse, Feststellung von Fehlpolwerten und Routine-Kontrolle. Bei der Raffination wurde die HPLC als eine Methode für die Analyse von Nachproduktsirupen und -Klären, Wasserüberwachung, Dextran-Kontamination, Invertzuckerzerstörung und Fermentation betrachtet. HPLC ist besonders nützlich für die Untersuchung von Verlusten, Problemlösungen und Routineuntersuchungen in Fabriken und Raffinerien.

La cromatografía en fase líquida a performakce alto en azucareras y refinerías

La cromatografía en fase líquida a performance alto (HPLC) es bién establecido como un útil de análisis en muchas industrias y se ha empleado en laboratorios experimentales de la industria azucarera durante los unos años pasados. Para asesar el uso de HPLC en operationes industriales, un sistema de HPLC dedicado al análisis de azucares se ha introducido en laboratorios de azucareras y refinerías y se ha empleado para el análisis de muestras de jugos, meladuras, licores del proceso, melazas, efluentes y aguas. Con respect a operaciones industriales, se discute aplicación de la HPLC para análisis de jugo, revelación de pol falso y para control rutinario. En las operaciones de la refinería, se considera HPLC como técnica para análisis de siropes y licores de bajo-grado, supervisión de agua, contaminación con el dextrano, destrucción del invertido, y fermentación. La HPLC es especialmente útil para investigar las pérdidas, solucionar las problemas y controlar entretenimiento en las azucareras y refinerías.

Brevities

US beet sugar company acquisition by refiner[1]

Savannah Foods & Industries, which owns the sugar refinery at Savannah, Georgia, has agreed to buy Michigan Sugar Company for approximately $65 million. Michigan Sugar Company owns four beet sugar factories which, although among the oldest in the US, have had significant investments of capital to modernize operations and reduce costs during the past several decades. Savannah had at one time considered expansion of its business by construction of a new refinery but this was dropped when raw sugar imports were limited by the application of import quotas in May 1982.

New Yugoslavian sugar factory[2]

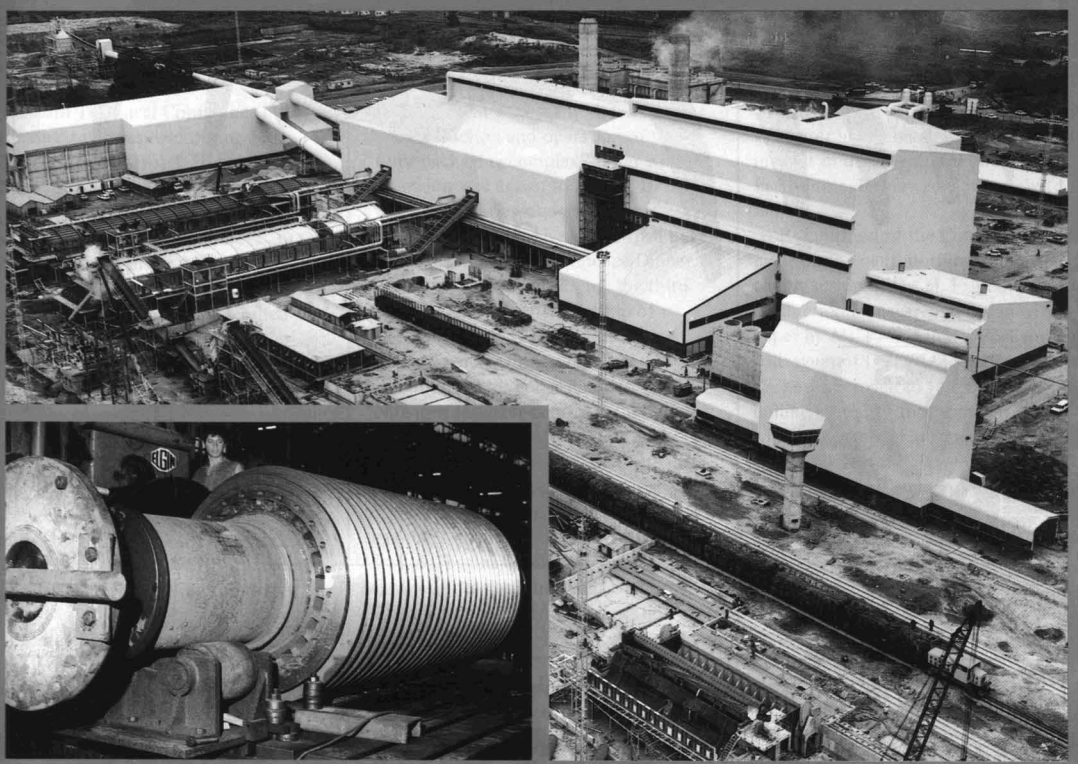
A new sugar factory at Sabac in Serbia was expected to be completed by the end of May. It is to operate with an annual output of 56,000 tonnes of sugar, 24,000 tonnes of beet pulp and 16,000 tonnes of molasses. Equipment has been supplied by local manufacturers as well as imported from Germany and Czechoslovakia.

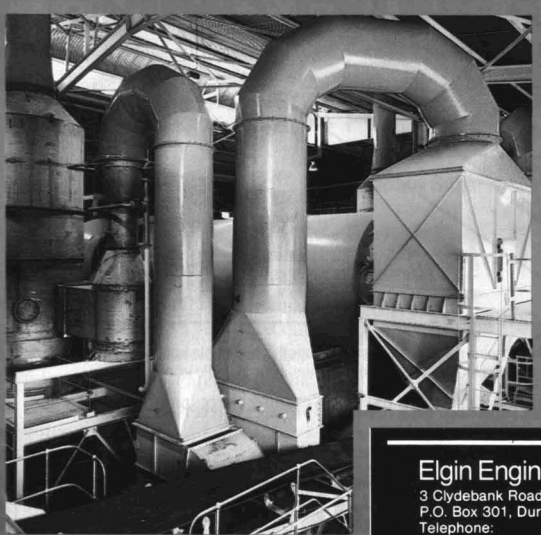
EEC sugar diversion as a chemical feedstock[3]

There has for some years been pressure to permit the utilization of C-sugar at world market prices in the EEC chemical industry which, it has been suggested, might be able to absorb as much as 500,000 tonnes a year. Currently, users pay the full internal price less a rebate adequate to bring the price down to the level of comparable feedstocks. At this price the amount used is thought to be less than 100,000 tonnes. The Commission authorities are understood to be looking again at this possible outlet. A market for this additional quantity of sugar would clearly be advantageous to the sugar sector but it would oust the alternative products and, of course, the Commission authorities can only come to a final decision after having surveyed the position from the point of view of all the commodities concerned.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 243.
2 *World Sugar J.*, 1984, **6**, (11), 38.
3 C. Czarnikow Ltd., *Sugar Review*, 1984, (1701), 89.

WE RECORD OUR SUGAR ACHIEVEMENTS





Elgin Engineering (Pty) Ltd
3 Clydebank Road, Bayhead, Durban 4001
P.O. Box 301, Durban 4000, South Africa
Telephone:
National (031) 251461 International +27 31 251461
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ELGIN

British Sugar plc 27th Technical Conference

The 27th Technical Conference of British Sugar plc was held during June 11-14 at the Grand Hotel, Eastbourne, with the participation of 60 BS personnel, Mr. T. Rodgers, the retired Director and a member of our Panel of Referees, 39 visitors from 14 overseas countries and a representative of this journal. The British Sugar personnel, who included Factory Managers and Technical Executives and Staff from the Central and Group offices, gathered, together with their guests from other sugar companies, etc., during June 11 and the conference was opened the next morning by Mr. R. W. Chappell, Executive Director of British Sugar and Chairman of the Conference. He welcomed all participants before calling on Mr. R. J. Bass, Director of Engineering, who chaired the first session.

This included a first paper by Mr. D. C. Hogan and colleagues on the "Performance evaluation of a coal-fired fluid bed for pulp drying", which was followed by a contribution by Dr. Ing. K. Austmeyer of the Brunswick Sugar Institute on "The influence of stirrers on heat transfer during the boiling process". The third paper of the morning, by Mr. D. A. G. Brown and colleagues, described "Pulp pressing developments" at British Sugar factories.

The afternoon session was chaired by Mr. M. Shore, Director of Research, and began with a review of crop prospects in the UK by Mr. T. P. J. Dyke. Indications were then given of crop prospects in the countries represented and, apart from a poor crop in Greece and a very good one in Ireland, expectations were much the same as for 1983 in most areas, with the crops somewhat later but easily capable of making this up.

The next paper, by Mr. Shore and his colleagues of the British Sugar Research Laboratories, provided a thorough review of "Factors affecting white sugar colour", after which Mr. J. Tjebbes of Sockerbolaget described "Quality aspects on fodder products from beet pulp" in Sweden.

The next presentation was by Mr. T. A. Field with many slides showing the construction and operation of the "Bury packaging complex", after which the session was drawn to a close. In the evening the conference participants enjoyed a reception given by British Sugar plc and an excellent Conference Dinner.

On the following morning, the third Session, under the chairmanship of Mr. B. M. Piercy, Group Production Manager, began with another paper by Mr. Shore and his colleagues describing "Nitrogen fertilizer control by amino-nitrogen measurements" while Dr. G. Pollach of the Fuchsenbigl Institute in Austria presented a paper afterwards on the "Development and utilization of sugar beet quality criteria in Austria". Mr. I. S. Higgins, Group Production Manager, then took the chair while "The micro applied to beet reception" was discussed by Mr. R. D. Robins and Mr. P. R. Leaton who provided an account of the changes in data processing at this station in British Sugar over the past 27 years.

Dr. Ir. L. H. de Nie and his Dutch colleagues then described the system employed by Suiker Unie and Centrale Suiker Mij. for coping with "Sugar beet and frost damage in the Netherlands". The session was then drawn to a close and conference participants enabled to visit after luncheon a number of places of interest in the neighbourhood of Eastbourne, to play golf or merely to relax.

Resumption of the Conference took place on the next morning, under the chairmanship of Dr. M. F. Branch, Group Production Manager, and began with a paper by Mr. P. W. van der Poel and his colleagues of CSM Suiker which presented "A new approach to full seeding" in the boiling houses of that company, after which "Aspects of automatic sugar boiling at Newark factory" were described by Mr. S. C. H. McCarey and Mr. F. Fearnside. The final paper of the Conference was a discussion by Mr. Ph. Bonnenfant of S.E.R.G.-G. T. S., France, of the "Application of numerical analyses for pan automation", an exercise in the use of a mathematical model for prediction of the results of changes in parameters governing sugar boiling.

Mr. Chappell then resumed the chair and discussed the papers presented and the contributions they had inspired. He thanked those present for their participation and cooperation in helping to make the meetings a success, after which he closed the Conference, the latest in a series which dates back to 1948.

Indian Sugar statistics, 1983[1]

	1983		1982	
		tonnes, raw value		
Initial stocks		3,447,823		1,532,968
Production		8,452,233		9,126,270
		11,900,056		10,659,238
Consumption		7,183,271		6,707,365
Exports				
China	11,885		92,809	
Ecuador	11,061		0	
Egypt	302,570		29,118	
Indonesia	29,172		301,161	
Lebanon	0		327	
Maldives	2,053		1,080	
Morocco	68,931		0	
Sri Lanka	186,266		44,090	
Sudan	38,463		0	
Tunisia	37,924		0	
US	21,716		21,203	
Yemen, North	72,605		0	
		782,646		489,788
Final stocks		3,934,139		3,447,823

1 *I.S.O. Stat. Bull.*, 1984, **43**, (3), 22.

A water-soluble polysaccharide from stand-over cane

Part I. Isolation and structural characterization from the field

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

Introduction

In Queensland, the sugar cane crop is grown and processed on an annual basis. Sometimes cane may be left in the field and "stood-over"until the next crushing season. The reasons for this usually involve production in excess of requirements and, more rarely, unfavourable weather conditions near the end of the harvesting period.

Problems have been experienced with processing some stand-over cane, the symptoms of which are very high syrup viscosities, poor crystallization rates and gumming of heating surfaces. The latter often necessitates frequent cleaning in order to maintain a reasonable factory throughput.

Studies on the nature of the component responsible for these problems are described herein.

Experimental and results

(i) Collection of samples

Fresh and stand-over cane samples were collected from farms in the Burdekin district since this area had experienced some processing problems. The cane was unburnt.

Tops and trash were removed and the stalk-ends were sterilized by dipping in formalin before road transport to Mackay for analysis. Clean whole stalks were weighed, shredded and crushed in a roller mill. After crushing, the bagasse was washed with two juice volumes of boiling water and the extract from a further pass through the mill was combined with the first expressed juice.

The mixed juice was filtered through a 200-mesh sieve and clarified by centrifugation at 1600 *g* (5°C) for 20 minutes. The volume was measured and Brix, pH and pol were determined by standard methods[1]. Three volumes of ethanol were added to precipitate polymeric material. The delay between cutting and ethanol precipitation was 16-18 hours. The precipitate, recovered by centrifugation, was redispersed in water and reprecipitated twice before dialysis against running tap-water for 48 hours. It was finally recovered by lyophilization.

J. D. Blake

J. Littlemore

(ii) Analysis of bulk ethanol-precipitable material

Initially five samples of stand-over cane were selected for study. The ethanol precipitables were analysed for ash content[1], protein as measured by Kjeldahl nitrogen × 6.25 and total carbohydrate as glucose equivalent by the phenol-sulphuric acid assay[2]. The results are shown in Table I.

The relative composition of neutral monosaccharides present in the acid hydrolysate of the ethanol precipitables was determined by gas chromatography of their alditol acetates[3]. The presence of uronic acids was confirmed by paper chromatography of the acidic components of the hydrolysate. The results are shown in Table II.

The nature of the glucan components was studied by separate digestions with dextranase, pullulanase and α-amylase. These enzymes were purchased from Calbiochem and all were of microbial origin. Dextranase and pullulanase were demonstrated to be free of α-amylase activity by the "Phadebas" amylase test[4].

Digestion with dextranase followed the procedure of Richards & Stokie[5] for the enzymic determination of dextran in cane juices and raw sugar. The dialysable portion was concentrated, deionized and chromatographed on paper (2:1:1 *n*-butanol:ethanol:water). Saccharides

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

1 "Laboratory Manual for Queensland Sugar Mills, 5th Edn. (Bureau of Sugar Experiment Stations, Queensland), 1970.
2 Dubois *et al.: Anal. Chem.*, 1956, **28**, 350.
3 Blake & Richards: *Carbohyd. Res.*, 1970, **14**, 375.
4 "Phadebas Amylase Test" (Pharmacia AB, Sweden.)
5 *I.S.J.*, 1974, **76**, 103.

Table I. Composition of ethanol-precipitable material recovered from stand-over cane

Sample code	% Ash	% Protein	% Carbohydrate (glucose)	Precipitate (% on solids)
SN Q80D	25	1.1	35	2.5
AB Q63	15	2.0	28	1.1
DF Q80	7	1.6	70	2.1
AB Q80	10	3.3	23	1.6
SN Q80G	12	3.5	18	1.7

Table II. Relative percentage neutral monosaccharides in samples of stand-over cane

	Sample code				
	SN-Q80D	AB-Q63	DF-Q80	AB-Q80	SN-Q80G
Rhamnose	2	2	1	3	2
Fucose	0.5	0.5	–	2	4
Arabinose	23	15	2	21	16
Xylose	10	3	1	7	3
Mannose	6	5	4	14	15
Galactose	21	21	4	33	37
Glucose	37	53	88	21	23
Uronic acids	+	+	+	+	+

ISJ Abstracts

Cane sugar manufacture

A case study of explosion of a centrifugal basket (its causes, checks and preventive measures)

A. Aziz. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 176-186.

An investigation of possible causes of failure of the basket of a low-grade 1500 rpm batch centrifugal is described in some detail. From examination of the various factors it was concluded that the chief cause was corrosion caused by molasses. Replacement of batch machines with continuous centrifugals was recommended, and suitable BMA machines were subsequently installed. Methods of checking baskets for possible corrosion are indicated.

Failure of mill roller shafts

M. A. Bhatti. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 187-191.

Factors that could lead to failure of mill roller shafts are examined, including overloading, juice penetration, surface defects, too high a trash plate setting, and a faulty hydraulic system. Some advice is offered on preventive measures.

Performance of first installed Unigrator in Pakistan at Fecto Sugar Mills Limited, Darya Khan, Mianwali

S. M. Alam. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 209-222.

See *I.S.J.*, 1979, **81**, 85.

Performance of filter-presses at Kohinoor Sugar Mills Ltd., Jauharabad

M. Aslam. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 204-208.

Poor filter-press performance was due to the unavoidable use of double cotton cloths instead of jute cloths and to corrosion of plates and frames. The problems were overcome by replacing the double cloth with a single cloth having reinforcing bands at the edges, by refacing the edges of the corroded plates and frames and rivetting new plates on the faces of pitted head plates, with juice channels of adequate depth, and by attending to correct fitting of the plates relative to the frames. Of these measures, the replacement of the filter-cloth proved to have the greatest effect on filter performance.

Mill sanitation trial at Fauji Sugar Mills, Khoski

H. H. Khan. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 223-225.

Trials are reported in which Fabcon CMA (Cane Milling Aid) bactericide was applied as a 3% solution to shredded cane and to juice just before the DSM screens at a total of 5 ppm (shock dosing being carried out every ½ hour). Results showed that it was slightly more effective than addition of 24 ppm bleaching powder every 2 hours at the mill in terms of the difference in the reducing sugars:pol ratio between mixed juice and 1st expressed juice (a rise of 0.03). For one out of the four weeks of the trials, the amount of CMA applied was doubled; 2 gal formalin were also added each shift to the last mill juice. The purity drop was the same in both cases.

A brief study on the feasibility for the change of process in carbonatation factories of the Punjab

S. M. Alam. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 233-242.

The potential benefit of replacing conventional carbonatation with the defeco-remelt process in Punjab sugar factories is discussed.

Melt-sulphitation – an ideal process of sugar manufacture in Pakistan

F. Rehman. *Proc. 14th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1977, 243-262.

The advantages and disadvantages of defeco-melt sulphitation compared with the double-carbonatation, double-sulphitation process are listed, and the overall financial benefits of the former technique indicated on the basis of results obtained at Shakarganj Mills Ltd.

A study of molasses exhaustibility at Modern Sugar Mills, its behaviour in storage and means to preserve it

I. Ali. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 181-190.

The boiling house performance and molasses exhaustion at the author's sugar factory are discussed. Tabulated data show a gradual fall in average final molasses purity for each year from 1972 to 1978. Comparison is made with other factories using various processes, and the advantages of the defecation-remelt system are discussed. Molasses degradation during storage and means of preventing it are examined.

Search for a suitable process of clarification in Pakistan

M. Aslam. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 191-204.

On the basis of investigations of the various processes used by Pakistan sugar factories, the author favours the defecation-remelt system with modifications to raise the sugar recovery to the level obtainable in the double-carbonatation, double-sulphitation system which, however, suffers from a mud disposal problem.

Expansion and not conversion

S. M. S. Zaidi. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 205-214.

While the author favours the defecation-remelt process, the advantages of which are listed, he does not advocate conversion of a sugar factory from double-carbonatation, double-sulphitation because of the high investment costs it would entail. On the other hand, expansion of existing factories is considered an economically viable means of increasing cane crushing and hence sugar production while allowing the crushing season to be condensed within a climatically favourable period.

Continuous vacuum pans in cane sugar factories

K. Guyot. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 215-232.

A representative of Fives-Cail Babcock gives an account of the historical background and technological development of the FCB continuous vacuum pan, the design and operation of which he describes. Advantages of the continuous over the batch pan are indicated with the aid of performance data, and an outline is presented of the steps in installation, operation and cleaning of continuous pans. Trends in development and the future outlook are briefly discussed.

Continuous *versus* batch centrifugals at Leiah Sugar Mills

S. H. Ansari. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 233-240.

From examination of data from two seasons, the author draws a number of conclusions on the performance of continuous centrifugals in regard to production of high-purity single-cured C-sugar for use as graining seed. To produce seed of about the same purity in batch centrifugals, double curing was needed, and a considerable quantity of C-light molasses resulted in increased non-sugars recirculation and increased pan boiling. Other advantages of continuous machines are listed.

Pre-flocculation for improved juice clarification

D. M. Villanueva. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 241-248.

Details are given of a pre-flocculation tower developed by Unice Machine Co. and results obtained with use of a polyacrylamide polymer and an inorganic pre-flocculant at El Jiboa factory, Salvador, are reported. These showed that pre-flocculation reduced juice residence time, improved juice clarity and colour, increased mud density and reduced the mud volume.

Dadu Sugar Mills: trial and triumph

S. M. Alam. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 249-257.

Details are given of the 1977-78 trial season at the new factory of Dadu Sugar Mills, and a flow sheet is presented of the defecation-remelt carbonatation process used.

Continuous type centrifugals

R. Conner. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 258-272.

The fundamentals of the design and operation of a conical-basket continuous centrifugal are explained, and the improvements brought about by massecuite reheating in a Konti-10 centrifugal are indicated.

Steam — gold of industry

Z. Ahmad. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 273-280.

Measures for the prevention of heat loss and for reducing steam consumption within a sugar factory are examined.

Development of continuous thickening and rotary vacuum filtration of first carbonatated cane juice

B. M. Rahul. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 281-297.

The Dorr-Oliver clarifier-belt filter arrangement is described and results obtained at Mawana and Daurala sugar factories are reported, demonstrating the advantages of the system.

Why not better milling?

M. A. Qureshi. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 47-59.

Milling results from 28 Pakistan sugar factories are averaged to give a single value for each parameter, which is also the average of three crushing seasons, and the figure compared with results obtained by Australian and South African factories. Among reasons given for the lower Pakistan value for the reduced mill extraction of slightly under 93%, as against about 96% in the other two countries, are: lack of adequate cane preparation, too low an imbibition rate, incorrect mill setting, roller slippage, etc. A number of recommendations are made.

Type of evaporators used in the sugar industry and a modification applied at this station in Modern Sugar Mills

I. Ali. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 60-71.

Descriptions are given of multiple-effect and Kestner evaporators, and details are given of the modification to the quadruple-effect system at Modern Sugar Mills, where an additional vessel converted it to a quintuple-effect evaporator with provision for isolation of the new effect from the others. The alteration was intended to permit increased evaporation capacity when the crushing rate was increased. Parallel operation of the first two effects resulted in a 4.8% net reduction in steam consumption, while the extra heating surface was enough to permit increase in the crushing capacity to 2750 tcd with 200% imbibition % fibre. Other advantages of the modified system are indicated.

Superheater elements in John Thompson boilers at Khoski and Sangla Hill

M. Zahid. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 72-80.

The superheater elements in the John Thompson water-tube boilers at the two title sugar factories started to sag and become distorted after only a few weeks of operation. Possible causes are examined, and a number of precautionary and remedial measures indicated.

Improvement of the quality of feed water at Shakarganj. Its influence on the boiler's life

M. U. Khan. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 81-93.

Problems encountered at Shakarganj sugar factory during the first five seasons of its operation included excessive scale formation and fouling of boiler tubes. Both the water softening plant and internal water treatment were being used

incorrectly; attention to the former improved the situation, whereas incorrect dosage of the chemicals for internal treatment led to greater harm than lack of treatment, which was therefore discontinued. Another remedial measure was installation of an entrainment separator in the 1st evaporator effect, so that condensate could be made available for use as make-up water.

Burning of charcoal as a partial substitute for hard coke in a lime kiln

A. Aziz. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 118-126.

Replacement of 30% of the hard coke for lime kiln firing with charcoal proved to be economically viable (Pakistan has to import hard coke) while giving no increased problems in kiln operation.

Computers in the sugar industry

A. Crawford. *J.A.S.T.J.*, 1978-80, **39-41**, 93-97.

The author considers the practicalities of four outline schemes involving the use of computers for sugar estate management and control. The two simplest schemes, (i) where an estate has its own computer, and (ii) where an estate uses data processing facilities located elsewhere, are considered usually adequate. On the other hand, a more complex system, in which a number of estates have their own individual computers but are grouped together for exchange of information via a central body, is considered too expensive (because of considerable under-utilization of each computer) and difficult to control (because of a tendency towards individual accounting procedures). A scheme in which the estates in a group use a central computer is regarded as more logical; although information is exchanged via a central control body, there is a tendency towards standardization of accounting and reporting procedures and towards centralization of operations, thus reducing the need for inter-company exchange of information, while the greater utilization of the computer leads to a considerable reduction in overall costs.

Bagasse boiler efficiency at Worthy Park

B. G. Smith. *J.A.S.T.J.*, 1978-80, **39-41**, 138-143.

Modifications to the Thomson Eisner bagasse furnaces at Worthy Park sugar factory are described, covering bagasse feed, air control, hearth construction and damper settings. The benefits brought about by the changes are indicated.

Pipe computations for sugar engineers

M. Biddlestone and L. R. Johnson. *J.A.S.T.J.*, 1978-80, **39-41**, 144-153.

Two methods are described for calculating the pressure drop-flow profile of a pipe carrying compressible material (air or steam) or incompressible fluids such as water, juice, syrup, molasses or fuel oil. Worked examples are presented.

Boiling house operations at Appleton Estate

M. McA. D. Dilworth. *J.A.S.T.J.*, 1978-80, **39-41**, 153-157.

The Toca system of granulation introduced at Appleton in 1979 involves graining with a mixture of syrup and *A*-molasses at 78 purity, developing the grains with a small quantity of syrup, and completing the process with *A*-molasses to 68-70 purity. Half of the crystals are dropped in the seed box, while the remainder is developed with *A*- and *B*-molasses to 63-65 purity; half of the material is dropped in another seed box, and the remainder used as first footing of *C*-massecuite of 57-59 purity. Advantages of the system include improvement in magma purity and raw sugar quality as well as exhaustion, and increased boiling house throughput. Calculations of the massecuite parameters are given together with Cobenz diagrams.

An approach to feedwater control at Innswood Estate

E. Callinder. *J.A.S.T.J.*, 1978-80, **39-41**, 157-160.

The boiler feedwater automatic level control system at Innswood is described. Prior to its introduction, the factory had had a history of boiler failures resulting from insufficient water. Apart from the pneumatic control system, a number of other measures were adopted, including provision of increased condensate storage, installation of water softening facilities, modifications to the feedline so as to ensure a maximum supply of water when required, re-designing of the feedwater system to provide optimum conditions at the pump inlet, and installation of a new feed pump. The advantages and disadvantages of the new system are indicated.

The approach to energy conservation at Appleton Estate sugar factory

G. A. Morris. *J.A.S.T.J.*, 1978-80, **39-41**, 161-169.

The phases in development of a scheme for energy saving at Appleton sugar factory and distillery are described. Most of the measures include installation and replacement of steam-generating and -consuming equipment, with emphasis on use of vapour (as in the case of a new pan) and back-pressure steam (as with converted column stills) as well as condensate recycling and the use of appropriate instrumentation to monitor and control boiler operation. Air heaters were also to be installed to reduce heat losses, particularly in the boiler chimney.

Milling and diffusion

J. L. Carbonell. *Sugar J.*, 1983, **46**, (6), 19-21.

An account is presented of the history and development of cane diffusers, with information on systems and performances in South Africa and Australia, and details of the DDS diffuser installed at Ingenio Cruz Alta in Argentina. The author concludes by stressing the benefits of a combined diffusion-milling system as a method of increasing extraction.

Beet sugar manufacture

Evaluation of the performance of foam depressants in beet sugar manufacture

V. G. Yarmilko, B. N. Valovoi, N. V. Kulinich, I. I. Barikova, A. E. Lekhter and M. K. Petrova. *Sakhar. Prom.*, 1983, (12), 11-15 *(Russian).*

A laboratory procedure for determining the efficiency of anti-foam agents is described, and results of tests are reported in which Antispumin 7517 proved more effective in reducing foam formation in raw juice than did spent soap stock or fatty soap stock.

Change in the processing properties of thick juice removed for storage

R. L. Kashchenko, I. S. Naumchenko and I. P. Orobinskii. *Sakhar. Prom.*, 1983, (12), 15-16 *(Russian).*

Thick juice samples were stored in 250 and 500 ml flasks for up to 30 days at 4°, 10° and 20°C; results showed that sugar content, purity and pH_{20} fell with temperature rise and with storage period, while colour increased. Samples stored for 60 days at 10°C and pH_{20} 8.5, 9.5 and 10.5 underwent a sugar loss and increase in colour that were greater the higher the pH_{20}, while numbers of mesophiles and slime-forming bacteria showed a marked fall with increase in pH_{20}, as did the thermophile count but to a lesser extent. Addition of formalin to a concentration in the range 0.02-0.2% was effective in reducing the numbers of bacteria, 0.1% formalin completely eliminating the mesophiles and slime-formers after 7 days and the thermophiles after 60 days. It is recommended to store thick juice at a temperature in the region of 0°C and pH_{20} 8.5-9.5 in the presence of 0.1% formalin.

A pectin flocculant from pulp press water

M. I. Daishev and A. R. Kubaisi. *Sakhar. Prom.*, 1983, (12), 16-18 *(Russian).*

In tests at Timashevo sugar factory, press water was treated with a 10% NaOH solution (0.5% by volume) followed by addition of 10% aluminium sulphate solution (1% by volume). Addition of 10% NaOH (1% on volume of water) to the resultant mud suspension yielded a flocculant which, in experiments with 1st carbonatation juice, increased the settling rate (by comparison with no additive) and reduced turbidity and mud volume. The flocculant also proved successful in treatment of 2nd carbonatation juice, where carbonatation was preceded by liming and the mud was intended for recycling to raw juice before preliming. While problems had arisen in mud separation by filtration or settling, use of the flocculant gave a clear, sparkling juice and a granular mud of reduced volume; lime salts were also reduced as a result of calcium pectate precipitation.

Transfer of pectins from beet cossettes to raw juice

G. V. Koshchieva, N. P. Shelukhina and V. P. Usikova. *Sakhar. Prom.*, 1983, (12), 19-20 *(Russian).*

Laboratory tests are reported in which the effects of double superphosphate (unammoniated) and of aluminium sulphate on pectin solubility were determined. In one test, a 12 % aqueous sugar solution (10 ml) was treated with 0.02-0.10% reagent after addition of 1% w/v of polygalacturonic acid that had been 40% esterified with methanol. The mixture was heated on a water bath for 70 min at 70°C and pH 3.5-4.5. Aluminium sulphate proved more effective than the double superphosphate in reducing the pectin content, e.g. relative to the control, 0.06% sulphate gave a 32% reduction and 0.06% superphosphate gave a 17% reduction; the difference is attributed to formation of insoluble aluminium pectate at pH approx. 4.5. On the other hand, in tests in which the reagents were added, separately, to 100 g of cossettes and the pH maintained at 6.2-6.5 during the 70 minutes' heating, 0.06% superphosphate reduced the pectin content by 44% compared wih only 6% using aluminium sulphate.

Hydrodynamic cavitation activation of lime suspension in beet sugar manufacture

A. F. Nemchin, O. A. Savchenko, Yu. V. Anikeev and V. A. Anistratenko. *Sakhar. Prom.*, 1983, (12), 22-24 *(Russian).*

The use of cavitation as basis for increasing the activity of milk-of-lime, and thus reducing the amount of limestone required, is discussed, and details are given of an experimental unit in which milk-of-lime was subjected to accelerated flow before encountering cavitation blades, the angle of which was adjustable to provide an optimum length of cavity and hence appropriate number and size of bubbles formed. Tests at Tbilisi showed that the unit was effective in raising the activity from 74-76% to 85-97% when the cavitation blades were at a suitable angle.

Automation of condensate tanks

Z. S. Voloshin, Yu. N. Kiyanitsa and A. G. Storozhenko. *Sakhar. Prom.*, 1983, (12), 34-35 *(Russian).*

Details are given of a system of automatic level control in condensate tanks based on use of float-type level indicators and pneumatic valves. The system was tested on evaporator condensate at a sugar factory and found to maintain stable conditions, with a pressure difference no greater than ± 0.5 kPa across the control valve.

Experience in the operation of R3-PUB rotary catchers for heavy impurities

N. D. Khomenko. *Sakhar. Prom.*, 1983, (12), 35-36 *(Russian).*

The poor performance of R3-PUB (3-scoop) and R3-PUB-6 (4-scoop) rotary catchers for separation of sand, stones and other heavy impurities from beet is blamed on a low level of maintenance, incorrect adjustment and bad operation at Soviet sugar factories where they are used in large numbers. By comparison, the same type of catcher used in factories outside the USSR is rated at a removal efficiency of 95-99%. Suitable advice is offered.

Sugar refining

Simulation of the influence of hydrodynamic conditions and of temperature during drying of sugar cubes

O. Mikus. J. Nemec and M. Marek. *Ind. Alim. Agric.*, 1983, **100**, 491-495 *(French)*.

See *I.S.J.*, 1983, **85**, 55.

Control and regulation tasks of the automatic process control system at the Mantulin refinery, Krasnopresnensk

V. S. Pavlenko *et al. Sakhar. Prom.*, 1983, (11), 28-33 *(Russian)*.

Details are given of the centralized control system used at the title refinery in Moscow for regulation of 234 parameters. Particular mention is made of the pressed sugar/drying station, and photographs illustrate the display terminals for this section, for liquor filtration (using candle filters) and for refined sugar output.

Premiums for raw sugars above 96-degree polarization

J. V. López-Oña. *Sugar y Azúcar*, 1983, **78**, (9), 48, 50, 54.

Comments are made on the question of premiums for raw sugar having a pol greater than 96. While it is shown that refined sugar yields increase with increasing raw sugar pol, cane sugar refiners in the USA pay for the raw sugar on the basis of a scale of declining premiums as originally established by the Sugar Institute Inc. in 1928. Because of this, raw sugar producers feel that there is no incentive to increase pol beyond 96 and that the U.S. Bulk Raw Sugars Contract should be revised.

Performance of a mechanical circulator in boiling of refined massecuites

S. M. Alam, A. Kazi and A. W. Qureshi. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 267-273.

Tests on boiling of refined sugar massecuite using pan stirrers are reported with the aid of tabulated data. Although the results showed no significant effect of the stirrers on boiling time, crystal yield was increased by about 5%, while crystal quality and uniformity were also improved.

Evaluation of the hygienic properties of decolorizing resins

E. V. Ivanova and G. A. Chikin. *Sakhar. Prom.*, 1984, (1), 25-27 *(Russian)*.

Assessments were made of the possible effect of the resin on the organoleptic properties of decolorized syrup, of the migration of chemical components from the resin to the syrup and of the potential effect of the resin on living organs in the case of AV-16GS polycondensation anion exchange resin and AV-17-2P polymeric, macroporous anion exchange resin. Results showed that the former had a number of adverse properties of sufficient magnitude to justify banning of its use where syrup was to be used directly for food purposes. AV-17-2P resin had no undesirable or toxic effects and its mass production is recommended.

A complex scheme for mechanization of raw sugar unloading, storage and feeding to process

N. N. Guminskii. *Sakhar. Prom.*, 1984, (1), 31-33 *(Russian)*.

Details are given of the system used at Znamenka for unloading of bulk raw sugar from rail trucks followed by its transfer by underground belt conveyors to storage, and reclaiming from storage to the melter.

Studies on the application of ultrafiltration to the process of sugar refining. I. Production of liquid sugar from molasses by use of ultrafiltration. II. Modification of the sugar refining process by the application of ultrafiltration to the recovery process

J. Shimizu *et al. Shokuhin Sangyo Senta Gijutsu Kenkyu Hokoku*, 1981, (5), 1-17, 18-28; through *S.I.A.*, 1984, **46**, Abs. 84-100, 84-101.

I. Pilot-plant experiments are described in which refinery molasses was diluted and subjected to ultrafiltration in order to remove colloids and other large molecules. The ultrafiltration unit was equipped with tubular modules, and the cut-off point of the membranes was a M.W. of 20,000. Optimum conditions were: molasses at 35°Bx maintained at 35-40°C, pumped at an average pressure of 7 kg/cm^2 to flow through the modules at 1.3 m/sec. Ultrafiltration was continued until 75% of the solids had passed into the permeate; at this point, 65% of the colouring matter was in the retentate, and average permeation capacity of the membrane was 2 kg solids/m^2/hr. Capacity decreased only slightly during 168 hours of operation. The permeate was treated with activated carbon and partially demineralized by electrodialysis, for which optimum operating conditions were 33°Bx, 43 ± 2°C, with application of 1 V/pair of membranes. To prevent fouling of the membranes, the current had to be reversed for each successive operation. The solution was then passed through ion-exchange resins in a mixed bed, and evaporated under vacuum. A partially inverted liquid sugar, containing 94.9% sugars on solids, was obtained.

II. Affination syrup was treated by a new process comprising ultrafiltration followed by electrodialysis. A pleasant-tasting syrup was obtained, free from astringent and bitter tastes which are found in affination syrup. For ultrafiltration, the same operating conditions could be used as in the treatment of molasses (see preceding abstract). The improvement in taste was greatest when electrodialysis was carried out after partial demineralization. The treated syrup could be mixed with run-off syrups from refinery boilings, and dried to produce a special product ("golden sugar") containing 91% sucrose and 4.1% reducing sugars on solids. Use of such a process in a refinery would increase the recovery of solids from 96.1 to 98.6%, and decrease the steam and electricity consumption by 17% and 30% respectively.

Laboratory studies

Investigation of the structure of sugar solutions by NMR

L. A. Sapronova, A. B. Luk'yanov, V. S. Shterman, V. F. Andronov and G. I. Burkov. *Sakhar. Prom.*, 1983, (12), 24-26 *(Russian)*.

The application of nuclear magnetic resonance to a study of the structure of sucrose solutions as a function of concentration is described. Results showed that one of two structures predominated, according to concentration range. In dilute solutions of up to 30% sucrose the dominant structure was that of hydration equilibrium, whereby individual sucrose molecules were weakly bound to one another; in solutions having a concentration greater than 40% there was a sharp increase in the interaction between the molecules, which formed association structures, evidence of which was an increase in viscosity.

Adsorption of glucoamylase on DEAE-cellulose

M. Jach and H. Sugier. *Starch/Stärke*, 1983, **35**, 427-429.

In recent years, glucoamylase (GA) has been widely used for starch saccharification because of its ability to hydrolyse the glucoside bonds almost completely into glucose. However, the high costs of the enzyme made the process costly, but various immobilization techniques developed in recent times have been shown to be applicable in continuous or cyclic processes, thus lowering costs and simplifying the technology. Investigations were conducted on immobilization of GA by adsorption on DEAE-cellulose. Graphed results are discussed, including the pH stability of soluble and immobilized forms of the enzyme in the pH range 3-8. The immobilized form hydrolysed a 1% starch solution more slowly than the soluble form, but the maximum degree of hydrolysis achieved by the two forms was about the same. While the temperature stability of the immobilized GA was lower than that of the soluble form, it can be improved by the presence of a substrate. At lower temperatures ($\leqslant 55^{\circ}C$) the activity of the immobilized GA increased afer incubation with 5% starch solution and was fully retained after 21 cycles.

Evaluation of the DNS method for analysing lignocellulosic hydrolysates

W. L. Marsden, P. P. Gray, G. J. Nippard and M. R. Quinlan. *J. Chem. Technol. Biotechnol.*, 1982, **32**, (11), 1016-1022; through *S.I.A.*, 1983, **45**, Abs. 83-1536.

The 3,5-dinitrosalicylic acid (DNS) method gives a rapid and simple estimation of the degree of saccharification of lignocellulosic materials, by measuring the total amount of reducing sugars in the hydrolysate. However, it is subject to interference by other reducing substances and by the differing reactivities of the various reducing sugars. These interferences become more apparent for complex substrates such as bagasse. In a sample of bagasse hydrolysed by QM9414 cellulase, *total (glucose + xylose + cellobiose)* determined by HPLC was only 89% of reducing suars determined by DNS. The difference may be due to other pentoses, glucose oligomers and perhaps soluble derivatives of lignin.

Characterization of volatile constituents of sugar cane juice during processing and storage

P. O. Jimenez. *Crystallizer*, 1983, **6**, (4), 11.

The effects of thermal processing and storage on cane juice were investigated. Results showed that significant changes occurred in pH, % titratable acidity, colour and reducing sugars but not in % soluble solids; pH and % titratable acidity attained stability only after the 46th day of storage. The pH dependence of colour in the early half of storage time suggested the presence of low-molecular, pH-sensitive colorants derived mainly from flavonoids, and the change in reducing sugars content led to the speculation that this contributed to juice colour formation. Counts of yeasts and moulds showed that considerable quantities of those originally present in the fresh juice were destroyed by heating. Gas-liquid chromatography of the volatile extracts revealed eight peaks, only four of which appeared in most of the samples; of these four, two were present in unprocessed juice while the other two appeared after processing and in storage; the remaining four appeared in deteriorated samples.

Molasses desugaring by ion exclusion (chromatographic method)

M. Asadi. *Listy Cukr.*, 1983, **99**, 275-284 *(Czech)*.

Laboratory experiments were conducted on ion exclusion fractionation of molasses. Preliminary investigations carried out on four resins, all having a sulphonate function group, showed two to be suitable, and the subsequent experiments involved Dowex 50 WX2 resin in Na^{+} form. Optimum values were established for column height, flow rate, temperature and quantities of molasses and water as feed. The effect of the $(Ca^{++} + Mg^{++})$ content of the molasses on the number of cycles before resin regeneration was determined for three types of sample: molasses that had been only filtered and contained 1.1% (Ca + Mg) on dry solids limited the number of cycles to 28; molasses that had been delimed to 0.7% (Ca + Mg) allowed 60 cycles before regeneration, while there was no need for regeneration after as many as 100 cycles when the molasses feed had been delimed to a (Ca + Mg) content of 0.15% on dry solids. Results showed that up to 95% of the initial molasses sugar was recoverable in a sugar-rich fraction (15-17% sugar of > 90 purity), although evaporation and boiling would reduce the recovery (as white sugar) to 80%. The process is suitable for both beet and cane molasses treatment.

Laboratory sugar figures

V. V. Elliott. *J.A.S.T.J.*, 1978-80, **39-41**, 170-172.

The author explains some of the parameters used as indicators of cane quality and factory performance.

By-products

Effect of different combinations of rice polishings and molasses-manure on diets of low molasses levels for fattening pigs

C. P. Díaz and A. Elías. *Cuban J. Agric. Sci.*, 1983, **17**, 163-168.

Inclusion of 20% (on dry matter) cattle manure-molasses silage in the rations of castrated pigs, which also contained 41% final molasses and 17% rice polishings, gave a much higher daily weight gain than 10% or 30% molasses-manure silage but a lower value than when no silage was included, but it was the most economical of the four treatments per weight unit increase.

Production of ethanol by immobilized yeast cells

C. J. Chiou. *J. Chinese Agr. Chem. Soc.*, 1981, **19**, (3-4), 151-159; through *FSTA*, 1983, **15**, (9), 9H1171.

The use of immobilized yeast to ferment cane juice without prior steam sterilization was assessed. Among five high-ethanol-producing yeasts isolated from bagasse and preserves samples, *Saccharomyces cerevisiae* 4B was able to produce 11% of ethanol from cane juice containing 22.4% sugar. Of salts added, only $(NH_4)_2SO_4$ had slight effects on ethanol production. Fermentation under reduced pressure (50 mm Hg at 35°C) was no better than under atmospheric pressure. A new process for continuous ethanol fermentation was developed: yeast cells were absorbed on celite and sand and packed in a steel pipe reactor, giving a long-life packed bed (over 100 hours of fermentation without contamination); cane juice containing 14% sugar was fermented to produce 7% ethanol in a residence time of 10 hours at 30°C; when this juice was supplied with 600 ppm Na_2SO_3, the hourly ethanol productivity was 7 g/litre.

Contributions to explanation of microbiological and chemical relationships in pressed pulp ensilage. II. Investigations on the causes of loss of structure in ensilaged pressed pulp under the effect of prolonged heat

W. Braunsteiner, N. Kubadinow and F. Hollaus. *Zuckerind.*, 1983, **108**, 1138-1144 *(German)*.

The major causes of loss of structure (protopectin decomposition) in plant material, including thermal and chemical degradation, are surveyed, and investigations on fresh beet pulp and pulp silage reported. The decomposition rate was found to be a function of pH, temperature and reaction time. Whereas at 50°C the rate with typical ensilage periods is so great that there is marked loss of structure, at 35°C this is no longer the case. However, uncontrolled microbial processes such as caused by yeast contamination of pulp can have a greater effect than temperature on protopectin decomposition.

The use of sugar cane stillage for single-cell protein production

G. Cabib, H. J. Silva, A. Giulietti and R. Ertola. *J. Chem. Technol. Biotechnol.*, 1983, **33B**, (1), 21-28: through *S.I.A.*, 1983, **45**, Abs. 83-1597.

Two strains of *Candida* sp. were grown on vinasse from a cane molasses distillery, with or without supplementation with N (as NH_4 salts) and molasses. Tests were made on a laboratory scale and in an air lift-type fermenter containing 9000 litres of medium. Biomass production ranged from 14 to 25 g/litre; its composition was satisfactory for use as SCP, the protein content being 41%. The decrease in COD of the vinasse was only 40-47%. Another organism, *Paecilomyces variotti*, gave satisfactory results only if the medium was sterilized.

Fluidized bed reactor for the production of methane from sugar cane bagasse

F. Sineriz, H. F. Diaz and P. R. Cordoba. *Advances in Biotechnology*, 1981, **1**, 657-662; through *S.I.A.*, 1983, **45**, Abs. 83-1600.

Methanogenic organisms were obtained from bagasse dumps and cane sugar factory effluents, and cultured on a mineral medium containing bagasse as the only carbon and energy source. Initial tests were carried out in batch digesters. The productivity was greatly enhanced when a fluidized bed reactor was used; its average output of methane was 0.24-0.39 litres/litre per day, according to the feed concentration, with conversions of more than 1 g solids/litre per day.

Role of pH in the hypochlorite bleaching of bagasse sulphate pulp

M. A. Abou-State, N. A. Darwish, F. F. Abd El-Megeid and M. A. Omar. *Ann. di Chimica*, 1982, **72**, (9-10), 483-490; through *S.I.A.*, 1983, **45**, Abs. 83-1617.

A chlorinated and alkali-extracted sulphate pulp from Egyptian bagasse was submitted to hypochlorite bleaching at various pH values in the range 2.8-11.3. Properties of the bleached pulps and paper sheets prepared from them are tabulated. In general, the mechanical properties improved with increasing pH up to 5, then became worse as the pH approached neutrality, above which they improved again. The brightness was maximum at pH 6-8, but the loss in brightness on ageing was maximum at pH about 7.

Activating pulp toward acetylation by chemical or mechanical means

S. O. Heikal and S. F. El-Kalyoubi. *J. Appl. Polymer Sci.*, 1982, **27**, (8), 2833-2844; through *S.I.A.*, 1983, **45**, Abs. 83-1618.

The acetylation rate of bagasse pulp increased with increasing degree of beating up to 50°SR, above which it decreased. Grafting of acrylonitrile onto the pulp increased the acetylation rate; however, it had less effect than prior beating did. The mechanical, rather than the chemical, method of activation resulted in higher strength properties of paper sheets prepared from the acetylated bagasse pulps.

Graft copolymerization of acrylonitrile onto bagasse and wood

pulps

S. O. Heikal and S. F. El-Kalyoubi. *J. Appl. Polymer Sci.*, 1982, **27**, (8), 3027-3041; through *S.I.A.*, 1983, **45**, Abs. 83-1619.

In the above reaction ceric ammonium nitrate was used as initiator. More polymer was grafted if the pulp was added to a mixture of monomer and initiator than if the materials were mixed in a different order. Graft yields were better at 50° than at 30° or 40°C, and increased substantially with increasing monomer or initiator concentration. Reaction rate depended more on concentration of initiator than of monomer. The amount of grafting could best be controlled by reaction time. Water swelling of the pulp affected the grafting rate and the ceric consumption; the latter was also influenced by several other factors.

Grafting of some vinyl monomers onto lignocellulose and cellulose in the presence of lignin

O. Y. Mansour, A. Nagaty and A. F. Beshay. *ACS Symp. Series*, 1982, **187**, 253-268; through *S.I.A.*, 1983, **45**, Abs. 83-1620.

Samples tested were bagasse ground to 40 mesh and extracted with methanol-benzene, alkali-treated bagasse, bagasse semichemical pulp and cotton linter. Grafting reactions using ceric ammonium sulphate (CAS), sodium bisulphite + soda lime glass or + china clay as initiator were inhibited or retarded if soda lignin was added to the grafting medium. Lignin present *in situ* (in the ground bagasse) caused inhibition only if CAS was used as initiator. Possible mechanisms of these effects are discussed.

Bagasse hemicellulose acid hydrolysis and residue treatment prior to enzymatic hydrolysis of cellulose

R. C. Trickett and F. G. Neytzell-De Wilde. *S. Afr. Food Rev.*, 1982, **9**, (2), S95-S101; through *S.I.A.*, 1983, **45**, Abs. 83-1624.

Acetic acid is liberated from lignocelluloses by steaming at elevated temperatures. Auto-hydrolysis tests on whole bagasse indicated that, above 140°C, this would cause significant hydrolysis of pentosans; however, hydrolysis with dilute mineral acid would still be needed to convert the pentose oligomers to monosaccharides. Whole bagasse hemicellulose was hydrolysed with 0.5-4.0% sulphuric acid by weight at a liquid:solid ratio of 15:1 at 80-150°C. Hydrolysis mainly to xylose was readily achieved under this range of conditions, the maximum yield being 220 mg/g dry bagasse. Of possible pretreatments to improve enzymatic digestibility of the cellulose in prehydrolysed bagasse, soda pulping was more effective than ammonia, acid sulphite or organosolv pulping. Attritor milling was extremely effective.

Ethyl alcohol impurities and their removal during rectification. A review

V. F. Sukhodol and L. N. Prikhod'ko. *Izv. Vuzov, Pishch. Tekh.*, 1983, (5), 23-29 *(Russian)*.

The literature (26 references) on impurities in methyl and ethyl alcohol manufactured by fermentation is reviewed. Molasses contains acids having carbon atom numbers in the range C_3-C_7, while the wort formed from it has C_4-C_{10} acids which, when diluted, give off an unpleasant, rancid smell. Volatile nitrogenous substances present in molasses are considerably reduced in quantity during rectification, and typical contents are 0.4-0.5 mg/litre absolute alcohol. While molasses contains a marked quantity of SO_2 (as a result of juice and syrup sulphitation during sugar manufacture), rectified alcohol contains only trace quantities of S compounds.

Brigg pulp plant gets up steam

Anon. *British Sugar News*, 1984, (59), 3.

Trials at Brigg sugar factory have demonstrated the feasibility of using fluidized bed technology to produce hot gas for beet pulp drying. Air blown through a bed of sand on the floor of the generator fluidizes the bed; once this has been preheated using oil heaters, coal is dropped onto the bed and burns efficiently in the constantly moving mixture. The temperature of the gas leaving the bed and passing to the pulp dryer is regulated by the flow of air around the system under the control of a microprocessor. The generator is capable of raising the temperature of the gas to more than 100°C above the requisite 950°C. It is important to ensure that the bed of sand does not become too hot, otherwise it would melt and turn to glass. Use of a hot gas generator, which takes up less space than a conventional travelling-grate stoker has been encouraged by the high costs of oil and gas as fuels. The new system is to be introduced at four UK sugar factories, including Brigg.

The possibility of ensilage and feeding of pulp sprayed with brine effluent from decolorizing resins

I. Januszewicz, J. Marczynski, E. Walerianczyk, P. Rucinski and G. Kulasek. *Gaz. Cukr.*, 1983, **91**, 191-175 *(Polish)*.

Experiments are reported in which NaCl effluent from decolorizing resins was sprayed onto wet beet pulp at 2.17% on dry solids (18 dm^3 per tonne) before ensilage. The brine, containing 13% NaCl, did not affect the positive action of *Lactobacillus* spp. injected into the pulp, nor did it influence the quality of the silage. Fattening bullocks fed on the silage showed the same weight gains as with untreated silage, while the brine effectively replaced salt-licks. A major advantage was the reduction in the amount of NaCl (non-biodegradable and non-mineralizable) in sugar factory effluent.

Study on removal of coloured compounds from raw molasses

M. Ohashi, T. Saeki, T. Ishikawa and T. Karasawa. *Shokuhin Sangyo Senta Gijutsu Kenkyu Hokoku*, 1981, (5), 117-130; through *S.I.A.*, 1984, **46**, Abs. 84-192.

Cane molasses to be used for the production of baker's yeast was clarified by treatment with ethanol, centrifuging

and two-stage evaporation of the liquid, with recycling of the ethanol distilled-off. Optimum concentrations of added ethanol and sugar in the molasses were 85% and 35%, respectively. These enabled complete separation of the supernatant from the precipitate and gave 65% decolorization and 90% sugar recovery in the supernatant. Decolorization increased with pH, from 60% at pH 2.5 to 95% at pH 12, but sugar recovery decreased gradually above pH 6 and considerably above pH 9. Tests showed that, with regard to the yield and quality of baker's yeast, there was little difference between the clarified and the raw molasses. The effluent after yeast production had a lower COD when clarified molasses was used.

Preparation of laevulic acid from molasses

M. A. Razzaque, M. Rahman and M. Kiamuddin. *Bangladesh J. Sci. Ind. Res.*, 1981, **16**, (1-4), 171-173; through *S.I.A.*, 1984, **46**, Abs. 84-193.

Molasses was reacted with dilute HCl; a compound extracted from the residue after distillation was identified as laevulic acid. The yield was a maximum (28 g) when 500 ml (680 g) molasses was reacted with 100 ml HCl + 100 ml water.

A new process of continuous fermentation

Div. Ind. Copersucar. *Boletim Tecn. Copersucar*, 1980, (12-80), 6-8; through *S.I.A.*, 1984, **46**, Abs. 84-198.

The Guillaume-Egrot method of continuous alcoholic fermentation has been used for more than 40 years; it has recently been improved by incorporating the Melle-Boinot system of yeast recovery and new flow schemes. Advantages and disadvantages are indicated, and Brazilian experience in 1979-80 is outlined. Recommended techniques and optimized parameters are suggested. In particular: the head (initial fermentation) vessels should be few and large (60-70% of total volume) and should have a high population of yeast, e.g. 2.5-6.0%; the tail vessels (30-40% of total volume) should be numerous and small (10-20% as large as head vessels); pH should be 3.8-4.0 for high-purity musts, 4.3-4.6 for musts based on inferior molasses.

Continuous production of ethanol by yeast cells immobilized in sugar cane bagasse pith

A. R. Navarro, M. E. Lucca and D. A. S. Callieri. *Acta Cientifica Venezolana*, 1982, **33**, (3), 214-218; through *S.I.A.*, 1984, **46**, Abs. 84-199.

A glucose-based medium was fermented to ethanol in a single-stage open fermenter. The yeast cells had been immobilized on bagasse pith by recycling a yeast culture through the pith, resulting in the cells being adsorbed and entrapped by a filtration effect. A high cell loading was achieved (27.7-44.5% by weight on pith). The effects of dilution rate during fermentation on glucose conversion to ethanol and on productivity were investigated. The system showed good operating stability to abrupt changes and even interruptions of several hours in the supply of medium.

Simultaneous saccharification and fermentation of cellulose to ethanol using *Penicillium funiculosum* cellulase and free or immobilized *Saccharomyces uvarum* cells

V. Deshpande, H. S. Raman and M. Rao. *Biotechnol. Bioeng.*, 1983, **25**, 1679-1684; through *S.I.A.*, 1984, **46**, Abs. 84-226.

Tests were carried out using pure cellulose or bagasse as substrate. Although bagasse hydrolysis in 48 hr at 37°C was 70%, conversion of bagasse to ethanol using either free or gelatin-immobilized yeast was only 50-55%. This low yield may have been due to inhibition of yeast fermentation by the bagasse hydrolysate or to the inability of the yeast to convert all the reducing sugars formed to ethanol.

Effect of pretreatment on the hydrolysis of cellulose by *Penicillium funiculosum* cellulase and recovery of enzyme

M. Rao, R. Seeta and V. Deshpande. *Biotechnol. Bioeng.*, 1983, **25**, 1863-1871; through *S.I.A.*, 1984, **46**, Abs. 84-227.

P. funiculosum enzymes were used for saccharification of bagasse pretreated with NaOH or with steam under pressure; in 48 hr, saccharification was 63% and 59%, respectively. From a 30% slurry of steam-treated bagasse, a semi-solid mass containing 14% sugar was obtained. Under suitable conditions it was possible to recovery 90% of the enzyme.

Pressed sugar beet pulp for sows in pregnancy

Anon. *British Sugar Beet Rev.*, 1984, **52**, (1), 33-34.

Pressed pulp was fed to pregnant sows as an energy replacement for barley in a trial covering an average of 11 weeks before parturition. Replacement of 1.1 kg of the barley of 86.5% dry matter in the standard concentrate diet of 2.2 kg with 4.75 kg of pressed pulp of 20% dry matter gave the same sow weight before and after parturition, while piglet numbers and weights were also similar. The pulp ration was consumed more slowly than the conventional feed, which could be of advantage where pregnant sows are fed in groups, since it might allow greater uniformity of intake by the individual animals; however, under the trial conditions feeding weighed amounts of pulp from buckets took longer than with the free-flowing standard ration, and it would be more difficult to ensure an accurately controlled feeding rate under normal farm conditions. Moreover, one problem was the sticky consistency of the faeces.

Effects of methods of pulping, bleaching and blending on the physico-chemical properties of sugar cane bagasse for newsprint

H. A. Naqvi. *Proc. 16th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1979, 94-117.

See Naqvi *et al.*: *I.S.J.*, 1974, **76**, 317.

Beet pulp on the hills

E. Hart. *British Sugar Beet Rev.*, 1984, **52**, (1), 77-78.

Mention is made of the feeding of beet pulp nuts, which are simply scattered on dry heather, to hill-grazing lambing ewes in the north of England. The pulp supplies energy to the ewes and thus enables them to forage more actively for the succulent heather shoots.

Economical utilization of waste molasses

S. H. Ansari. *Proc. 15th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1978, 170-180.

The potential of cane molasses as animal fodder or as feedstock for alcohol manufacture is discussed, and the economics of a typical distillery scheme producing 4000 gal of alcohol per day are calculated.

The economics of bagasse utilization

W. Keenliside. *J.A.S.T.J.*, 1979-80, **39-41**, 26-30.

The total heat energy required for the Jamaican sugar industry, including rum and alcohol manufacture, is discussed with tabulated data given for the years 1975-77, and the amount of oil that would be needed to produce the heat is calculated. The possible use of bagasse that would be made available (assuming none of it were used as fuel) for paper production is discussed, together with an estimate of the capital investment required as well as the projected foreign exchange earnings. The costs of transporting the bagasse have not been included in the analysis.

The energy crises, by-products development and an alternative energy source.

N. G. Osbourne. *J.A.S.T.J.*, 1979-80, **39-41**, 32-35.

It is stated that the survival of the Jamaican sugar industry rests on increased production, improved sugar factory efficiency and the development of by-product industries. The author calculates that, assuming 33% bagasse availability on cane, a sugar factory should be able to cover all of its fuel requirements and still have a 10% bagasse surplus, which would possibly be sufficient for the viable operation of a particle board plant manufacturing 100 tons per day; but a major constraint is the scattered location of sugar factories and the associated costs of transportation, handling, etc., which would make the operation uneconomical unless the amount of bagasse needed (100,000 tons or 10% of annual production) could be obtained from just one location (or from two factories relatively close to each other). However, this would entail major changes in the fuel situation in the sugar industry, since oil to replace the bagasse would be too costly. One possible answer is to burn leafy trash, and the various factors to be considered in this are examined.

Lime and bagacillo as cheap lagging material

W. A. Kennedy. *J.A.S.T.J.*, 1978-80, **39-41**, 36.

A bagacillo:lime mixture of 60:40 approximate proportions having a mortar-like consistency was found to be a good alternative to asbestos meal for lagging of a pot still in a distillery and able to withstand temperatures of up to 300°F. A molasses:lime mixture of varying proportions was unsuccessful.

The potential of sugar cane-derived alcohol as a fuel in Jamaica

I. Sangster. *J.A.S.T.J.*, 1978-80, **39-41**, 83-89.

From an examination of the potential of a molasses-based fuel alcohol industry in Jamaica, it is concluded that rum manufactured from the molasses for export would be economically more viable in terms of foreign exchange, as would the direct export of molasses. Production of fuel alcohol from cane juice would also be economically unjustifiable if it entailed the establishment of a new cane milling/fermentation-distillation facility, although the high capital costs could be reduced if surplus existing sugar factory/distillery capacities were used. Projections are made of the rate of increase in gasoline prices necessary to make fuel alcohol manufacture in Jamaica economically viable.

Preliminary investigations into the effect of nitrogen and potassium on cane yield and quality at New Yarmouth

J. G. Plummer. *J.A.S.T.J.*, 1978-80, **39-41**, 107-110.

After filter-cake transportation by truck became too costly, New Yarmouth started to deposit it in irrigation water, but it was thought possible that the additional N, P and K in it were creating a nutrient imbalance, since the quality of cane irrigated with the water containing the filter-cake was found to be lower than that of cane irrigated with ordinary water, although cane yield was higher where filter-cake was applied. Experiments were conducted in three small plots; the cane in one plot was irrigated with clean water, and in the other two plots with irrigation water to which filter-cake and vinasse had been added. All the plots received varying amounts of urea and KCl. Foliar levels of N, P and K were determined, as was cane yield. Results showed that, although the treated irrigation water increased cane yield, it led to unsatisfactory results in terms of tons of cane per ton of sugar, while urea and KCl failed to correct the nutrient imbalance. Further trials were to be conducted.

Filter press mud

M. S. Rao. *J.A.S.T.J.*, 1978-80, **39-41**, 223-237.

Research conducted in Jamaica and elsewhere on the use of filter-cake as fertilizer is reviewed. Since its value lies mainly in the phosphate content, soils that respond to P applications will be the ones to benefit most from filter-cake. Plant cane derives greater benefit than ratoon cane, although both increase yield as a

result of the treatment, while even high levels of filter-cake will increase sugar yield despite a drop in juice quality. Filter-cake proved slightly superior to triple superphosphate in plant cane, but neither source of P had any residual effect. A list is presented of cane soils in Jamaica that would best benefit from filter-cake application.

Solidifying of final molasses for quick and easy transportation to cattle owners

A. Aziz. *Proc. 17th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1981, 118-122.

The potential of a solidified 21:4 molasses:lime mixture (w/w) as cattle feed in Pakistan is discussed. Tests showed that a mixture containing 90°Bx molasses (taken from a storage tank) and finely powdered lime took only 1½ days to solidify when spread over a glazed floor; it could then be cut into cakes for direct supply.

Utilization of CO_2, a distillery waste: its technical and economic feasibility in Pakistan

A. N. Ansari. *Proc. 18th Ann. Conv. Pakistan Soc. Sugar Tech.*, 1982, 275-286.

Recovery, treatment and liquefaction of CO_2 occurring as a fermentation by-product in alcohol manufacture from molasses are described and the economics of a daily production of 25 tonnes of liquid CO_2 calculated. Details are also given of a scheme for regeneration of ammonia that is used as coolant.

Pulp treatment and energy

P. Wertan. *Cukoripar*, 1983, **36**, 154-157 *(Hungarian)*.

The author briefly discusses the basic reasons for extracting moisture from beet pulp, and then examines the results (as reported in the literature) achieved in pressing under given temperature conditions. The contribution made by additives to pulp pressing quality is discussed, and the overall effect of reduction in fuel consumption and drying costs evaluated.

Development of a rapid and continuous-flow biogas digester for alcohol distillery slops

C. R. Barril, C. S. Abrigo and E. J. del Rosario. *Crystallizer*, 1983, **6**, (4), 10 *(Abstract only)*.

The optimum conditions for biogas production from vinasse were determined in a gallon-bottle digester and used to evaluate the performance of two digester designs, namely a cylindrical-plate and a tubular type. The optimal conditions for the gallon-bottle digester were a pH of 7.0, temperature 39 ± 2°C, 80% (by volume) starter and 1:3 substrate:water ratio. The starter must be from a stabilized stock activated for 5-7 days. Under optimum conditions, the digester performed as well as the two designs tested. However, under non-optimum conditions, particularly non-optimum temperature and pH, the two designs performed better than the conventional bottle, giving average yields of 13.6 litres biogas per litre of vinasse, compared with 7.4 litres per litre with the bottle digester. The reduction in BOD could be as high as 60-70%.

Dewaxing and utilization of press mud as a source of phosphorus

S. P. Kale and O. P. Vimal. *Indian Sugar*, 1983, **33**, 325-329.

Despite a high availability of filter-cake as fertilizer, its value as a nutrient is reduced by its low rate of mineralization. Since the problem could be partly caused by the presence of wax, investigations were carried out in which hexane was used to remove the wax, and the treated filter-cake then applied to pots together with varying quantities of superphosphate and constant amounts of urea and KCl. The effects of P uptake by paddy in two types of soil were determined. In both alluvial and black soil, dewaxing increased uptake by comparison with the use of untreated filter-cake; in alluvial soil, the uptake with 21 g dewaxed filter-cake added to 5 kg soil without any superphosphate was the highest of 10 different treatments, while in black soil (21 g filter-cake added per 3.5 kg) the P uptake was almost the same as given by 60 g superphosphate, whereas non-dewaxed filter-cake gave the poorest result of all the treatments.

Practical solutions to prevent pollution from distillery effluent (vinasses)

P. J. M. Rao. *Indian Sugar*, 1983, **33**, 247-254.

See *I.S.J.*, 1984, **86**, 158.

Contributions to explanation of microbiological and chemical relationships in pressed pulp ensilage. III. Changes in the chemical composition of pressed pulp during the ensilage process

N. Kubadinow, F. Hollaus and W. Braunsteiner. *Zuckerind.*, 1984, **109**, 38-45 *(German)*.

Investigations using HPLC and GC are reported on conditions favouring optimum conversion of carbohydrates in pressed pulp to lactic acid, particularly in the presence of yeasts as contaminants. The effects of disinfectants used in diffusion on ensilage, and conditions favouring undesirable reactions, such as the formation of butyric acid, were also studied. Results are tabulated.

were detected with alkaline silver nitrate[6] and the separations recorded by reflective densitometry. Samples coded AB-Q63 and DF-Q80, richest in glucan, showed little change in glucose composition. Densitometry profiles are shown in Fig. 1.

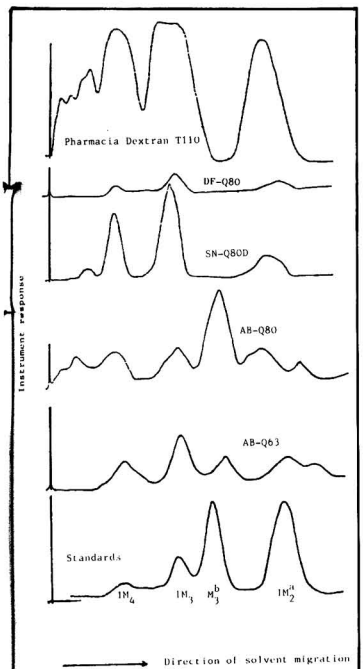


Fig. 1. Densitometer response of the oligosaccharides separated by paper chromatography and produced by digestion with dextranase enzyme; (a) IM, isomaltose-series dextrins, (b) M_3, maltotriose

Pullulanase digestion was effected in 0.02M sodium acetate, at pH 5.0, and at a sample concentration of 2% (w/v). Three enzyme additions were made over a 26-hour period before chromatography on paper using similar conditions to those outlined above. The profiles are shown in Fig. 2.

Digestion by α-amylase was effected in the above acetate buffer at pH 5.5. Two additions of enzyme were made over a 22-hour period before chromatographic analysis. Densitometry profiles are shown in Fig. 3.

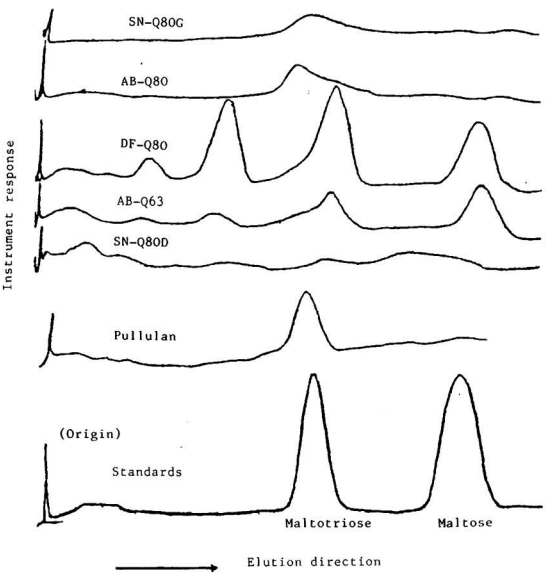


Fig. 2. Densitometer response of the oligosaccharides separated by paper chromatography and produced by digestion with pullulanase enzyme

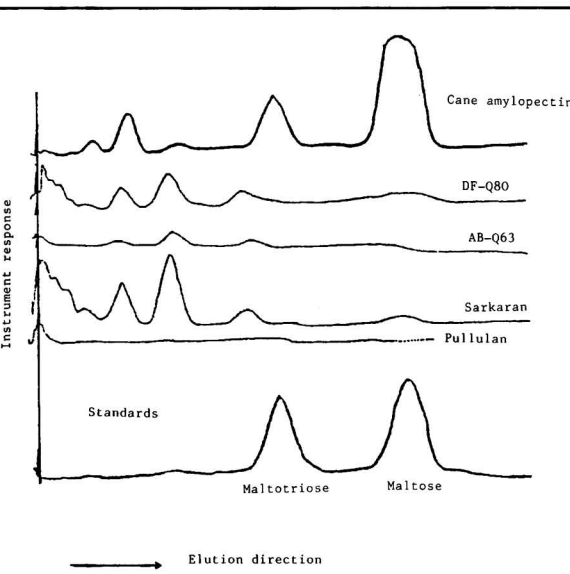


Fig. 3. Densitometer response of the oligosaccharides separated by paper chromatography and produced by digestion with α-amylase enzyme

6 Trevelyan *et al.: Nature*, 1950, **166**, 444.

In each digest an enzyme blank was used to check for the presence of stabilizer (e.g. starch, dextran) in the enzyme preparations.

(iii) Isolation and purification of polysaccharides

Sample DF-Q80 was chromatographed on a column of Sepharose CL-4B in 7M urea to give an elution peak with gaussian symmetry and a composition showing 96% glucose. Traces of mannose and arabinose were observed. It was found that the bulk of the material could be chromatographed under similar conditions on Sepharose CL-6B with only a small portion excluded by this less porous gel.

(iv) Structural characterization of the glucan coded DF-Q80

(a) Specific optical rotation was +167° (C = 1, water).

(b) Periodate oxidation[7] consumed 1.27 moles of periodate per anhydro unit and produced 0.37 moles of formic acid per anhydro unit.

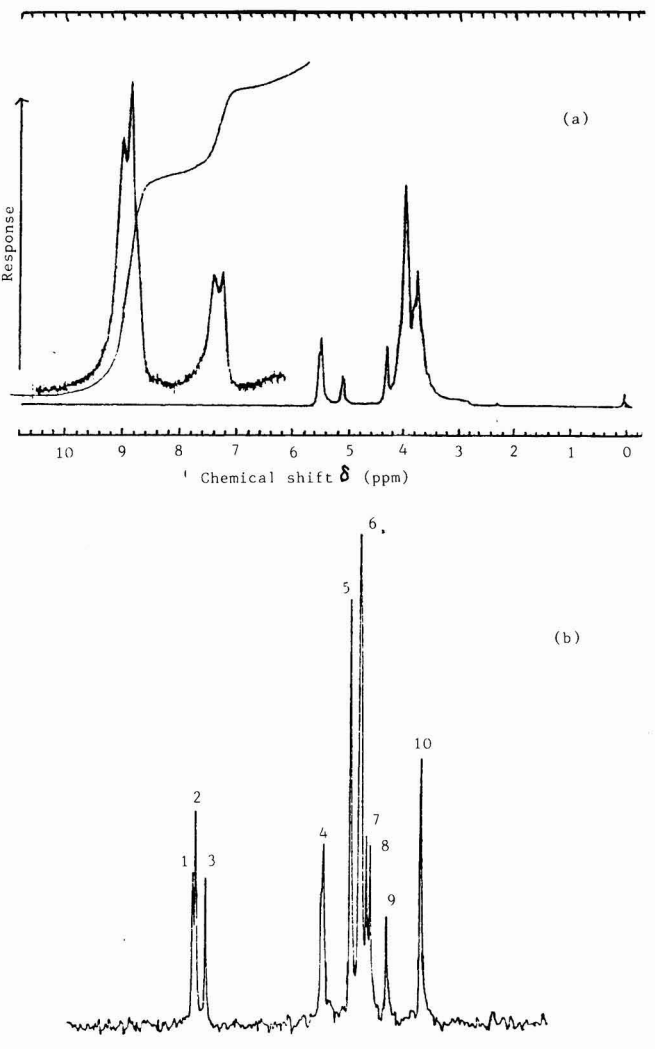
(c) N.m.r. spectra using both ^{1}H n.m.r. and ^{13}C n.m.r. spectroscopy were obtained for the purified polysaccharide and authentic pullulan and sarkaran controls.

Hydroxyl protons were exchanged by repeated dissolution in deuterium oxide and freeze-drying, and sodium 4,4-dimethyl-4-silapentane-1-sulphonate was used as internal standard.

The ^{1}H n.m.r. spectra were obtained on a JEOL-JNM 100 MHz spectrometer at a probe temperature of 90°C to sharpen peak signals and minimize interference from the H-O-D signal. ^{13}C n.m.r. spectra were obtained on a JEOL-FX-60 spectrometer using a 10 mm probe at 84°C. Spectra incorporated 4096 data points with a sweep width of 2500 Hz.

The integrals of the signals at 5.05 and 5.60 ppm are recorded in Table III while relevant spectra are shown in Figs. 4, 5 and 6.

(d) The polysaccharide was methylated using the procedure of Jansson and coworkers[8]. The identity of the alditol acetates of 2,3,6- and 2,3,4-tri-O-methylglucopyranoses was established by combined gas chromatography-mass spectrometry using a Hewlett Packard system, model 5992. Separation was effected on a 17 m fused silica capillary column



Chemical shifts (ppm): 1 - 102.9; 2 - 102.4; 3 - 100.7; 4 - 80.8; 5 - 76.0; 6 - 74.3; 7 - 73.3; 8 - 72.6; 9 - 69.6; 10 - 63.5

Fig. 4. N.m.r. spectra from stand-over cane polysaccharide; (a) ^{1}H-n.m.r. (b) ^{13}C-n.m.r.

7 Hay *et al.: Methods Carbohyd. Chem.*, 1965, **5**, 357.

8 *Chem. Commun. Univ. Stockholm*, 1976, **8**, 1-75.

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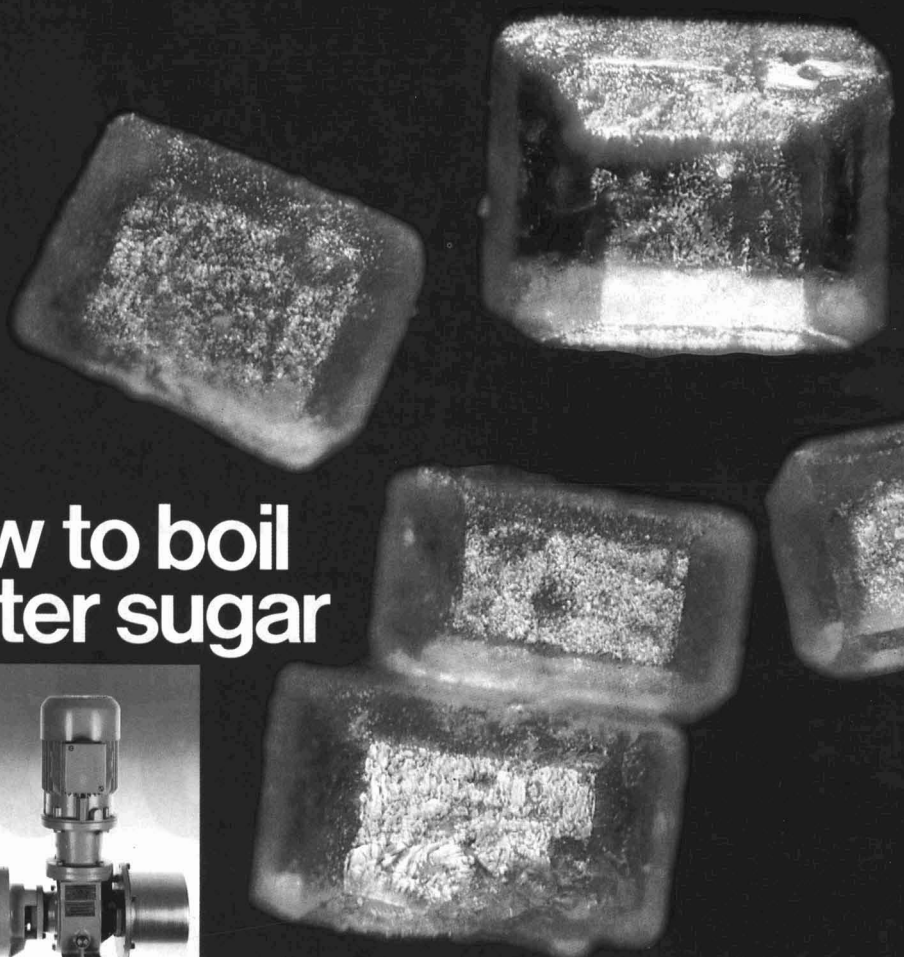

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Table III. ^{1}H n.m.r. integrals for the anomeric carbon atoms in stand-over cane glucan, pullulan and sarkaran

Sample	Signal chemical shift and % of total anomeric area*
Cane glucan	5.05 (25.5): 5.60 (74.5)
Sakaran	5.05 (25.0); 5.60 (75.0)
Pullulan	5.05 (34.0); 5.60 (66.0)

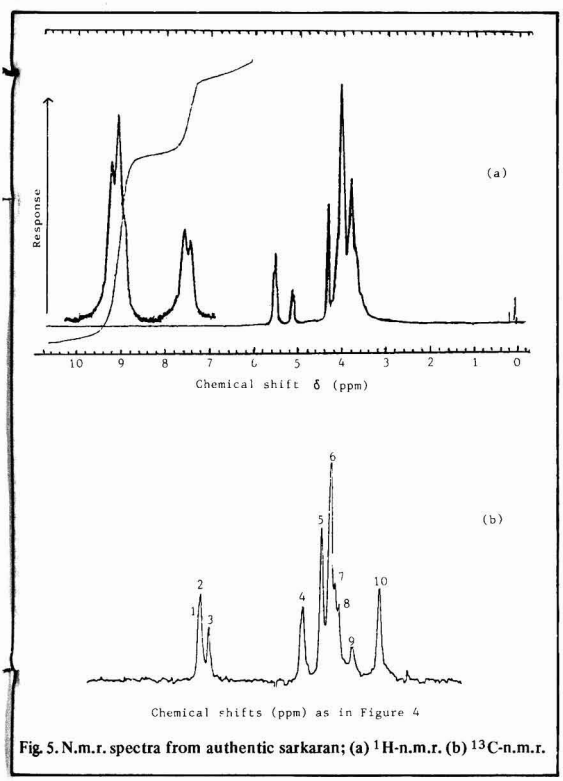


Fig. 5. N.m.r. spectra from authentic sarkaran; (a) ^{1}H-n.m.r. (b) ^{13}C-n.m.r.

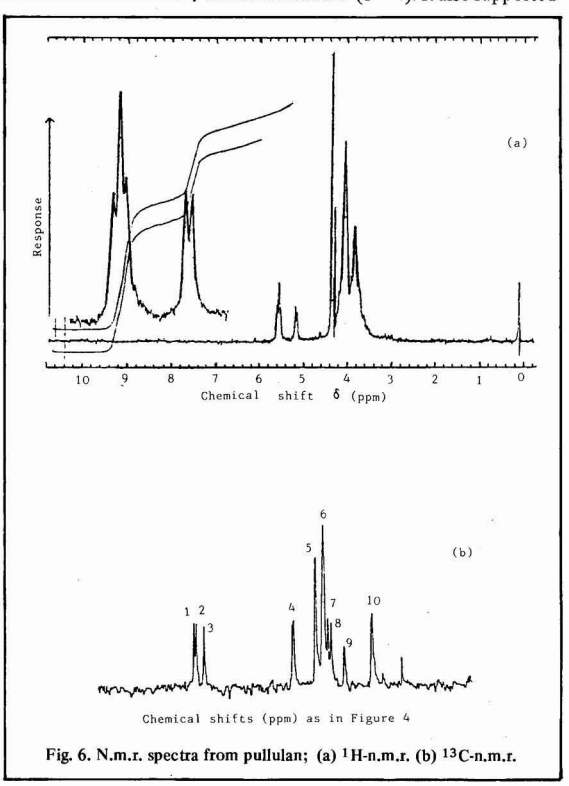


Fig. 6. N.m.r. spectra from pullulan; (a) ^{1}H-n.m.r. (b) ^{13}C-n.m.r.

(0.32 mm i.d.) of OV.225 (Chrompack, Holland) at 196°C at a linear gas velocity of 26 cm/sec and split ratio of 60:1.

Discussion

Data from Table I show that the sample coded DF-Q80 was particularly rich in carbohydrate while Table II reveals that this is glucan in nature. Juice pol and pH failed to reveal any noteworthy differences between samples while no obvious relationship exists between ash content, total carbohydrate and yield.

In addition to the glucan component revealed by composition analysis in Table II, the relatively large concentrations of arabinose and galactose reflect the presence of the arabinogalactan component of sugar cane. This has been named indigenous sugar cane polysaccharide[9] and has been classified as an arabinogalactan of the 3,6-type[10].

Digestion of the crude precipitates with specific enzymes showed that samples coded DF-Q80 and AB-Q63 contained material degradable by pullulanase and, to a lesser extent, by α-amylase (Figs. 2 and 3). This is consistent with the properties of sarkaran, a glucan isolated by Bruijn[11–13] from deteriorated whole-stick cane. He found it to be a linear glucan containing 25% of residues linked (1 → 6) and the remainder linked (1 → 4). It also supported a claim by Fulcher & Inkerman[14] that milling problems experienced with stand-over canes may be due to the presence of this polysaccharide.

Characterization of the glucan was facilitated by use of a sample of authentic

9 Roberts *et al.: I.S.J.*, 1976, **78**, 163.
10 Blake *et al.: Carbohyd. Res.*, 1983, **113**, 265.
11 *I.S.J.*, 1966, **68**, 331.
12 *ibid.*, 356.
13 *ibid.*, 1967, **69**, 195.
14 *Proc. Queensland Soc. Sugar Cane Tech.*, 1976, 295.

sarkaran generously supplied by Dr. Bruijn.

The glucan was chromatographically pure by gel permeation chromatography. Its specific rotation of +167° indicated an α-linked glucan of comparable rotation to that reported by Bruijn[13] (160°). The consumption of periodate is consistent with an average composition of 27% (1 → 6) linkages. A glucan comprising equal proportions of maltotetraose and maltotriose would possess 28.6% (1 → 6) linkages.

Further support for the structure follows from n.m.r. studies. Integration of the anomeric proton signals is consistent with the periodate results while the spectra themselves are essentially identical. The slight differences between spectra for sarkaran and pullulan occur in the distortion of signals of the anomeric (1 → 4) protons at 5.60 ppm. In pullulan, a linear glucan in which maltotriose residues are linked α(1 → 6), the (1 → 4) anomeric protons experience slightly different environments depending on their attachment to a glucose residue which is either linked 1 → 4 or 1 → 6. The doublets arising from splitting on C_2 interact to give an apparent triplet. In sarkaran the number of anomeric (1 → 4) protons experiencing slightly different environments increases and the composite doublets give a more distorted "triplet".

Methylation further confirmed the nature of the linkages.

In conclusion, these data, together with the results of specific enzymic degradation, establish that sarkaran can be present as a quite significant impurity in stand-over cane. As such its distribution is more widely spread than was to be inferred from the definitive studies of Bruijn who found it as a component of cane subjected to long cut-to-crush delays.

Acknowledgements

The authors gratefully acknowledge the assistance of Dr. J. T. Baker and Dr. R. J. Wells of the Roche Research Institute of Marine Pharmacology for the use of facilities and production of n.m.r. spectra. We thank Professor G. N. Richards, James Cook University of North Queensland, for valuable discussion in preparation of an M.Sc. thesis (J. Littlemore) based on these studies. Finally, we thank Dr. J. Bruijn, Sugar Milling Research Institute, Durban, for a generous sample of sarkaran which made these studies so much easier.

Summary

Stand-over cane left in the field from the end of one season to the next can give rise to problems in the manufacture of sugar and it has been established that polymeric material isolated from the juice of such cane contains sarkaran, previously noted as present in deteriorated whole-stalk cane.

Un polysaccharide hydrosoluble provenant de canne laissée en champs. Partie I. Isolement et caractérisation structurale à partir du champs

La canne laissée en champs à la fin d'une saison et passée dans les moulins au cours de la saison suivante peut donner naissance à des problèmes dans le travail. En isolant des polymères du jus d'une telle canne on a observé qu'il renfermait du sarkaran, dont on avait précédemment signalé la présence dans des tiges de canne deteriorée.

Wasserlösliches Polysaccharid aus "Stand-over"-Rohr. Teil I: Isolierung und strukturelle Charakterisierung in Rohr auf dem Feld

Das zum Ende der Saison auf dem Feld stehengebliebene und erst in der nächsten Kampagne gemahlene Rohr ("Stand-over"-Rohr) kann Verarbeitungsprobleme verursachen, und es zeigte sich, daß in der Polymerfraktion des aus diesem Rohr gewonnen Saftes Sarkaran enhalten war, das auch in alterierten ganzen Zuckerrohrstengeln gefunden wurde, wie bereits berichtet.

Un polisacarido soluble en agua encontrado en caña restante de la zafra anterior. Parte I. Aislamiento y caracterización estructural en material proveniente del campo

Caña restante en el campo al cabo de una zafra y molida en la zafra subsecuente puede dar origen a problemas en la elaboración del azúcar, y se ha establecido que el material polimerico aislado de jugo de tal caña contiene sarkaran, previamente señalado como presente en caña deteriorada de tallo entero.

Cuba sugar exports, 1983[1]

	1983	1982	1981
	tonnes, raw value		
Albania	15,698	15,946	12,143
Algeria	99,005	207,896	253,259
Angola	40,633	52,028	57,641
Bulgaria	331,485	277,678	249,853
Canada	190,490	160,299	375,985
China	771,717	915,311	573,246
Czechoslovakia	144,648	134,892	99,871
Djibouti	0	0	150
Dutch Antilles	3,413	2,346	977
Egypt	229,779	190,269	162,415
Finland	64,870	38,816	173,261
Germany, East	280,922	213,461	254,770
Guinea Bissau	0	2,096	2,131
Hungary	0	72,903	76,216
Indonesia	0	14,236	13,646
Iran	61,595	0	0
Iraq	158,217	133,783	178,184
Jamaica	0	1,626	8,872
Japan	354,532	294,986	354,593
Kampuchea	529	0	1,626
Korea, North	22,511	17,079	27,559
Libya	90,191	45,055	54,729
Malaysia	60,463	26,269	107,749
Mexico	62,732	139,702	138,126
Mongolia	4,699	4,701	4,697
New Zealand	0	15,662	0
Peru	25,037	0	0
Poland	0	0	70,154
Portugal	15,086	70,814	154,405
Rumania	221,454	89,663	138,820
Senegal	0	0	27,560
Spain	0	21,588	22,746
Surinam	3,307	4,558	1,080
Sweden	5,196	0	24,647
Switzerland	2,232	3,089	3,072
Syria	109,323	109,274	108,714
Tunisia	12,114	0	14,354
USSR	3,315,035	4,425,519	3,204,475
Vietnam	77,134	24,155	102,613
Yemen, South	2,096	0	0
Yugoslavia	9,397	0	10,389
Other C. America	2,897	3,167	2,097
Other Africa	0	2,707	1,950
Unknown	2,706	2,709	2,717
	6,791,143	7,734,283	7,071,445

New Pakistan sugar complex[2]

Heavy Mechanical Complex, of Taxila, and Dewan Sugar Mills Ltd. have signed an agreement for installation of a sugar factory at Ghulamullah in Thatta District. Total investment will be 350 million rupees and the factory is expected to come on stream in 1985/86.

1 *I.S.O. Stat. Bull.*, 1984, 43, (3), 10-11.
2 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 247.

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**

Introduction

Sugar beet processing is one of the most energy-intensive processes in the food industry. In order to save energy, much work has been done on the application of low-energy techniques in sugar processing. One such technique is the ultrafiltration of raw juice[1,2]. In addition to its potential for saving energy, this technique has an added advantage in that it minimizes the handling and disposal of carbonatation sludge.

The greatest problem in ultrafiltration is the fouling of membranes[3,4]. This could cause serious disruption in the sugar campaign and limit the economic viability of the process. However, industrial experience with heavily fouled streams in the potato starch industry has shown that this problem can be overcome[5,6]. This was achieved mainly by the use of tubular membranes and by creating high Reynolds numbers to reduce the concentration polarization. Other systems, such as plate and frame, spiral wound and hollow-fibre filter systems, were unsuitable because of the risk of blockage and the necessity for pretreating the feed.

In the light of the experience gained in the potato starch industry, orientation studies with tubular membranes were started on a bench scale to investigate the possibility of ultrafiltering raw beet juice. Following the success of this work, pilot plant studies were carried out at the Suiker Unie factory in Roosendaal during the 1981 and 1982 campaigns.

In this paper some of the problems encountered with the ultrafiltration of raw juice are discussed, together with an economic evaluation of the process.

T. R. Hanssens J. G. M. van Nispen

K. Koerts L. H. de Nie

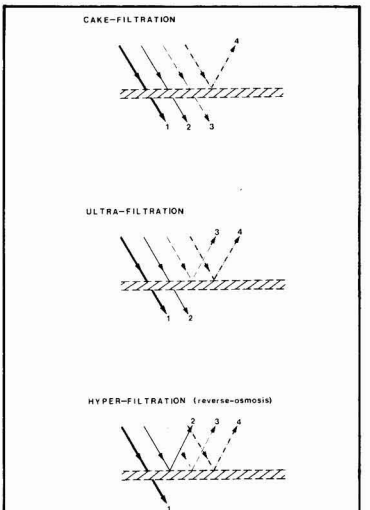


Fig. 1. Principles of the different filtration systems. (1) Water; (2) Small molecules, ions; (3) Macro molecules, colloids; (4) precipitates.

Ultrafiltration

Ultrafiltration is a molecular separation method in which molecules are separated from a solution without phase segregation. The membrane is only permeable to molecules smaller than a certain "cut-off" size and the process requires a minimum pressure differential as the driving force. This is in contrast to cake filtration where almost everything except the precipitate passes through the membrane. In hyperfiltration (reverse osmosis) only water and a limited number of small ionic and non-ionic species will pass through the membrane (Figs. 1 and 2).

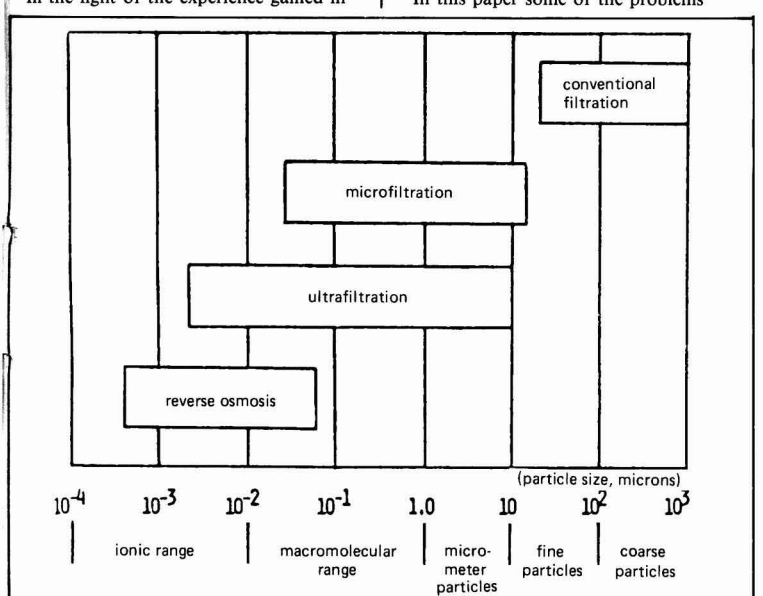


Fig. 2. Ranges of the different filtration systems

* Suiker Unie Research.
** Coöperatieve Vereniging Suiker Unie U.A.

Paper presented to 17th Gen. Assembly CITS, 1983.

1 Madsen: "Hyperfiltration and ultrafiltration in plate-and-frame systems," (Elsevier, Amsterdam) 1977.
2 Kofod Nielsen *et al.: Sugar Technol. Rev.,* 1982, **9**, (1), 59-117.
3 Matthiason & Sivik: *Desalination,* 1980, **35**, 59-103.
4 Bruin *et al.: ibid.,* 223-242.
5 Oosten: *Starch/Stärke,* 1976, **28**, 135.
6 Meindersma: *ibid.,* 1980, **32**, 329.

The membranes are manufactured by different techniques and from different kinds of material to suit process parameters like pH, temperature and cleaning conditions[7]. Since some of the sugar passes through the ultrafiltration membranes, special measures have to be taken to minimize the sugar loss. These include multiple stage ultrafiltration and diafiltration. Each stage of the multiple stage unit consists of a group of modules in series and a circulation pump.

Recirculation over the modules is important to keep the system pressure within certain limits and to reduce concentration polarization to an acceptable level.

An alternative to the circulation system is the single-pass system. In this system, only one feed pump is necessary, but there are disadvantages with a high pressure drop and sensitivity to feed variations. This is especially noticeable downstream where the higher concentrations and lower pressures cause a reduction in the flux. Both the recirculation and single-pass system are shown in Fig. 3.

In every successive stage of the multistage unit, the concentration of macromolecules increases and, in consequence, the flux in the succeeding stages decreases. Because of the high concentrations in the last stage the sugar loss becomes appreciable and it is necessary to apply diafiltration.

Diafiltration involves the injection of fresh water into the system. It has the effect of lowering the concentration of impurities and thereby increasing the filtration rate. A complete system is shown as an example in Fig. 4.

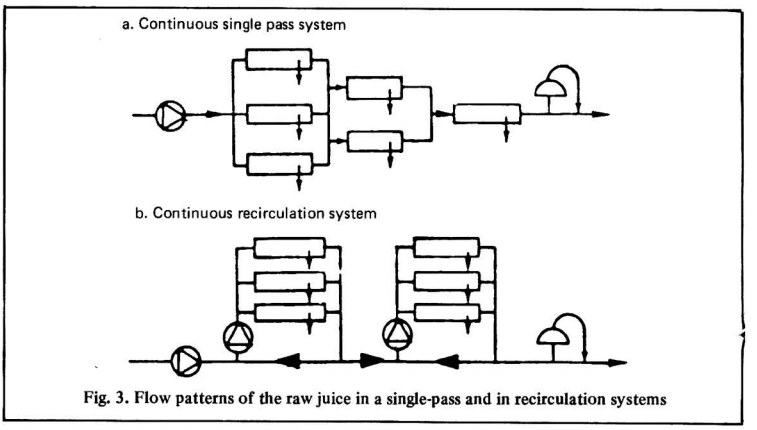


Fig. 3. Flow patterns of the raw juice in a single-pass and in recirculation systems

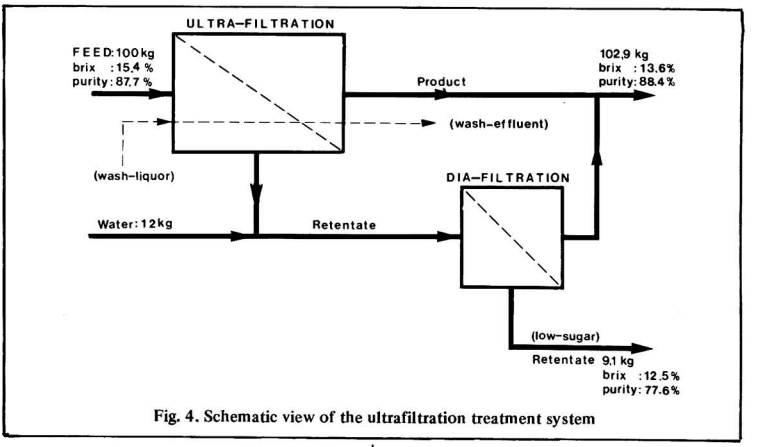


Fig. 4. Schematic view of the ultrafiltration treatment system

Experimental work

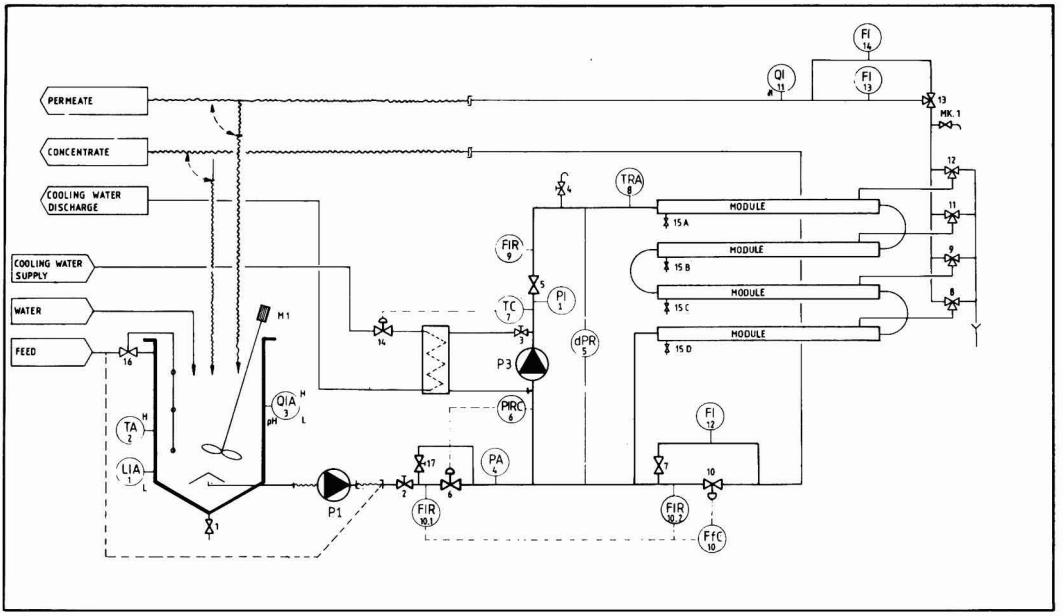
Several ultrafiltration systems from different manufacturers were used for the experiments. They included a small laboratory unit from P.C.I. (Paterson Candy International, Whitchurch, Hampshire, England) and pilot-units from Abcor (Wilmington, MA, U.S.A.) and Wafilin (Hardenberg, Holland).

The system from P.C.I. and Abcor were used only in the batch-mode to observe the overall performance and to study the quality of the permeate. Details of the different experimental systems are summarized in Table I.

7 Pusch & Walch: *Desalination*, 1980, **35**, (1/2/3), 5-20.

Table I

	Wafilin	P.C.I.	Abcor
Type of membrane	WFS 8010 WFA 5010	T 6/8	HFM 251
Surface area (m^2)	4 X 1.9	0.9	1.2
Linear velocity (m/s) along membrane	∿4	1.5	3.6
Working pressure (kPa)	600	600	360
Temperature (°C)	85 (WFS) 55 (WFA)	60	50
pH	2-11	2-11	1-12
Active chlorine (ppm) (short periods)	1500	150	500



(by courtesy of WAFILIN)

Fig. 5. Process scheme of a fully instrumented ultrafiltration plant

During the 1981 and 1982 campaigns, trials were carried out with the Wafilin pilot unit (Fig. 5) with raw juice direct from the Roosendaal factory. These trials were carried out in the continuous mode, because this mode matched the factory operation more closely, and because it limited the activity of micro-organisms which would otherwise develop during the long holding time of the batch process. One feed pump was used to control the pressure head of all stages, so that the average system pressure was the sum of the average feed pump pressure plus half of the pressure differential of the circulation pump.

The membranes comprised an area of 7.6 m^2 which was subdivided into 4 modules, each 6 m long and having a membrane area of 1.9 m^2. The membranes tested were the types WFS 8010 and WFA 5010 from Wafilin. The centrifugal feed pump had a maximum head of 400 kPa while the centrifugal circulation pump had a capacity of 16 m^3/hr and a head of 390 kPa at a viscosity of about 5 mPa/sec.

(to be continued)

Previties

Bagasse board plant for Thailand

Khon Kaen MDF Board Co. Ltd., a newly formed subsidiary of Khon Kaen Sugar Company, has contracted to build an MDF (medium density fibreboard) plant using depithed bagasse as the sole raw material. Equipment and engineering will be supplied by Sunds Defibrator AB. of Sweden and start-up is planned for summer 1985. The plant, rated at 66 t.p.d., will have a production capacity of 27,000 m^3 per year and the product will primarily be used in Thailand's furniture and joinery industry. The plant is the first to use bagasse for MDF manufacture.

Pakistan HFS plant[1]

Starcosa GmbH, a subsidiary of the West German company BMA, has won a contract to erect a HFS plant in Hub-Chowki, in the Province of Baluchistan, 50 km west of Karachi. The plant will have a daily production capacity of 85 tonnes of 42% HFS, using broken rice as raw material. The plant is expected to come on stream at the end of 1985.

Jamaican sugar factory closures[2]

The Jamaican government is to close three of the six sugar factories it owns – Duckenfield, Gray's Inn and Long Pond[3] – at the end of the 1984 harvest. The state-owned National Sugar Company said that the closures resulted from continued losses by the factories which have accumulated to $24 million. The closures will cause the loss of 1700 jobs. Industry sources in Kingston say the decision suggested that the government had failed to sell or lease the factories to private operators. The closures will make unlikely any significant improvement in Jamaica's sugar production which has fallen in the past 15 years from 450,000 tonnes a year to just under 200,000 tonnes.

New Egyptian sugar factory[4]

West Germany is to extend a loan of $100 million to establish a new cane sugar factory at Sohag in Upper Egypt, with an output of 100,000 tonnes of sugar per year, which is scheduled to start production in 1986.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 247.
2 *Financial Times*, April 17, 1984.
3 *World Sugar J.*, 1984, **6**, (11), 37.
4 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 282.

Brevities

Higher quality raw sugar contracts for US refiners[1]

Savannah Food & Industries Inc. instituted a new raw sugar purchasing contract on April 1 which calls for raw sugar of 98 pol against the former industry standard of 96 pol; a system of premiums and penalties were included to encourage suppliers to meet the new requirements. Shortly after, Amstar Corporation also introduced a new, similar contract to take effect on July 1 and it is thought that the rest of the industry will follow suit. The New York Coffee, Sugar and Cocoa Exchange is studying the new contracts and how they relate to the Exchange's No. 12 contract which may have to be reviewed.

Turkish sugar consultancy contract

Against strong international competition, BSD Limited – the consultancy subsidiary of British Sugar plc – has won a US $1,000,000 contract to reorganize the state-owned Turkish sugar industry. Funded by the World Bank, the consultancy assignment covers the technical, financial and management organization of the Turkish Sugar Corporation's 22 factories and workshops. The contract was ratified at the beginning of July by the World Bank and work commenced the same month. The investigation will take twelve months to complete, during which the 42-man study team will scrutinize and make appropriate recommendations on personnel management and training, financial and accounting systems, preventive maintenance and repairs procedures, energy use, quality control and preventive maintenance in machine factories, distillery pollution control and the purchase price of sugar beet. BSD Ltd. considers the project attractive because of the similarities between the UK and Turkish beet sugar industries which both produce about the same amount of sugar. The Turkish government has announced its intention to privatize some of the country's nationalized industries and the sugar industry wants to improve its own efficiency before any changes take effect.

Senegal sugar expansion[2]

Senegal plans to extend the sugar cane area to 8000 hectares for the 1985/86 crop, when domestic output is expected to be sufficient to meet demand and thus obviate the need for sugar imports.

Mexico sugar imports increase[3]

Mexico will import 300,000 tonnes of sugar this year to meet domestic demand, according to the Union of Sugar Producers; earlier this year it had been estimated that 250,000 tonnes would be required. Further, there are indications that production may turn out to be higher than the earlier estimate of just over 3 million tonnes. Consumption is very difficult to estimate as there are illegal exports to the US; it is apparently very profitable to purchase Mexican sugar and sell it in the US at more than double the price.

Finland sugar imports and exports, 1983[4]

	1983	1982
	tonnes, raw value	
Imports		
Argentina	26,655	0
Australia	26,690	14,593
Brazil	35,439	48,975
Colombia	12,263	0
Cuba	76,931	73,468
Mauritius	0	12,893
Swaziland	0	41,579
Zimbabwe	0	12,592
	177,978	204,100
Exports		
Algeria	17,468	73,912
Norway	30,869	12,199
USSR	26,089	4,356
Other countries	7,554	3,390
	81,980	93,856

Guyana ISO quota shortfall[5]

In addition to shortfalls declared earlier against their ISO quotas-in-effect by member countries[6], Guyana has made a shortfall declaration amounting to 40,480 tonnes, raw value. This reduces that country's 1984 quota to 85,000 tonnes and adjusts the totals of shortfalls and quotas-in-effect to 914,740 and 16,063,395 tonnes, respectively.

CSR Limited Annual Report, 1984

Profit made to end-March 1984 by the Sugar Division of CSR Ltd. amounted to A$ 25.7 million, A$ 14.2 million more than the previous year owing to a temporary rise in world sugar prices in the first half of the financial year. The company's seven factories crushed 6,244,000 tonnes of cane (6,366,000 tonnes in 1982/83) to produce 839,000 tonnes of raw sugar (915,000 tonnes). The drought in CSR's mill areas delayed cane growth and reduced output but the adverse effect of lower output on unit costs was offset by economies in overhead and maintenance costs. Capital expenditure at the mills (A$ 8.2 million) was concentrated on essential replacements and items providing a quick return through cost savings. Refined sugar sales in Australia were down at 658,000 tonnes vs. 685,000 tonnes while those in New Zealand were unchanged at 156,000 tonnes. Refined sugar exports fell from 22,000 to 5000 tonnes when Papua-New Guinea established its own sugar industry. Capital expenditure in the six refineries amounted to A$ 6.6 million.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 299.
2 *World Sugar J.*, 1984, **6**, (10), 35.
3 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 264.
4 *I.S.O. Stat. Bull.*, 1984, **43**, (2), 18-19.
5 C. Czarnikow Ltd., *Sugar Review*, 1984, (1703), 102.
6 See *I.S.J.*, 1984, **86**, 193.

Sugar Processing Research Conference

The 1984 Conference on Sugar Processing Research will be held on October 16-18, 1984, at the Maison Dupuy Hotel in New Orleans and will be followed on October 19 by the International Dextran Workshop at the same location (see *I.S.J.*, 1984, **86**, 84).

Among papers to be presented to the S.P.R. Conference will be "Performance characteristics of the CTI-501 Dark Solution Polarimeter" by S. E. Bichsel; "Laboratory filtrability test methods" by N. Nenadkevich; "Analytical methods of measurement – a need for correspondence" by S. A. Brooks; "The chemistry of iron in the sugar industry" by R. Riffer; "Effect of different impurities on filtration rate of carbonatated raw sugar solutions" by P. Hidi; "Sugar liquor clarification using diatomite filter aid" by C. W. Cain; "Fermentable sugars from starches and cellulosic materials" by M. R. Ladisch; "*Leuconostoc* spp. in sugar cane processing samples" by E. B. Lillehoj; "Recent observations on starch and sugar cane products" by F. W. Parrish; "Colour tests and other indicators of raw sugar refining characteristics" by M. A. Clarke; "Observations on filtration impedance in raw sugar" by J. A. Devereux; "Sensory analysis of brown sugars and correlation to chemical measurements" by M. A. Godshall; "Electrostatic methods to separate bone char from granular carbon: Preliminary report" by M. A. Godshall; "A glucan from sugar cane" by E. J. Roberts; "Current application of HPLC in sugar technology" by W. S. C. Tsang; "Application of GLC analysis in the South African sugar industry" by P. Morel du Boil; "The performance of ion exchange resins in decolorizing carbonatated liquor; an analysis of performance data" by J. C. Williams; and "Composition of sugar cane juice as affected by post-freeze deterioration in Louisiana" by B. Legendre. For further information, readers should write to Sugar Processing Research Inc. at P. O. Box 19687, New Orleans, LA 70179, U.S.A.

Trade notices

Microprocessor technology in sugar weighing

Richard Simon & Sons, Park Lane, Basford, Nottingham NG6 0DT, England.

Most of the recent developments in Richard Simon equipment has been to further improve productivity on high-speed packing lines, whilst enhancing the accuracy of weighing. Among these advances is a second-generation microprocessor controller for high-speed bagging weighers, an automatic bag placer with self-advancing auto-indexing magazine for several stacks of empty bags and a computerized system for batch blending of multiple ingredients.

Dust-proof bulk bag filler

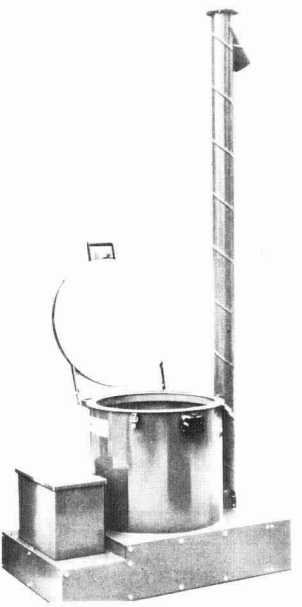
Paxall Ltd., Icknield Way, Letchworth, Herts. SG6 1JR, England.

A new, dust-proof, semi-automatic machine for handling sugar or other fine- to coarse-grained dry materials to fill 10-25 kg flexible sacks or rigid containers has been introduced by Paxall Ltd. The machine below will fill with an accuracy of ± 0.5% at a rate exceeding three 25-kg sacks per minute. Operation is by foot and hand control, the latter providing the final trickle-feed and positive cut-off at the end of the fill. A load-cell ensures accuracy and tares any spillage at the beginning of each filling cycle. A control panel indicates target and actual fills and can be equipped with a recorder/printer.

Elevator for caking material

Helix Conveyors Ltd., Braughing, Ware, Herts. SG11 2PB, England.

The need to break down, screen and elevate caked, hygroscopic materials such as filter cake, icing sugar, etc. has led to the introduction of a single unit capable of performing all three functions. The

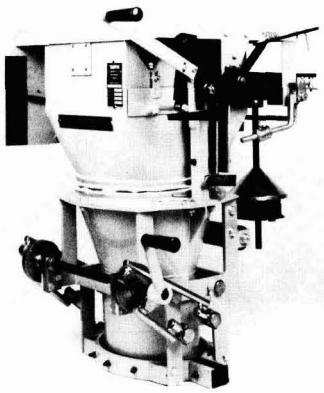


"Siftalifter" comprises a circular hopper with vertical sides and a lid, containing a rotating paddle and shear bars to disintegrate the hardened product and restore it to free-flowing consistency. The action of the breaker arm sweeps the product through a screened panel into the vertical screw elevator for conveying to the required height. Capacity depends on the product being handled. The machine can be built in mild or stainless steel, with fixed or variable speed and length, diameter and type of elevator to match the application and subsequent process.

Semi-automatic sack filling/weighing machine

T. A. Shore Co. Ltd., Pelham Road, Nottingham NG5 1AP, England.

Improvements to the T.33 sack filler include a new mechanism to actuate the closing of the catch gate more precisely, which results in less topping-up and an increased throughput. The machine illustrated is the gravity-fed model for free-flowing materials such as sugar; alternatively a



screw type or belt feeder can be provided. The dust-proof sack holder is of 70 cm diameter and up to three sacks per minute can be filled.

Vibrating bin dischargers

Mogensen Sizers Ltd., Fernie Road, Market Harborough, Leics. LE16 7PH, England.

A new 12-page publication in colour illustrates the Mogensen Carman gyrated and whirlpool drive two-stage vibrating bin dischargers. Available in diameters from 2 to 15 feet and featuring a two-stage 30°/60° cone design, the equipment has applications throughout industry on almost every form of stored material, including sugar, lime and limestone or other chemicals, etc.

Continuous water filtration

Carter Industrial Products., Bedford Road, Birmingham B11 1AY, England.

A new leaflet is obtainable from the manufacturers which describes the range of Carter Doucet automatic and continuously operating filters/strainers/hydrocyclones for water treatment.

OCV control valves

OCV Control Valves, 7400 East 42 Place, Tulsa, OK 74145, U.S.A.

The range of valves described in a leaflet entitled "An overview" are all hydraulically-operated diaphragm globe or angle valves which operate automatically from either line pressure or an independent power source and may be designed for solenoid control, float control, pressure reducing, relief or differential control, etc. The leaflet includes a chart of flow rates for water and a table of basic specifications and materials.

Steam turbo-alternator order for Ethiopia

ASEA STAL of Finspong, Sweden, has received an order from the state-owned Ethiopian Sugar Corporation for two TGB 8 back-pressure steam turbines for the Wonji cane sugar factory. The contract, which is worth about £900,000, includes all the electrical and installation work on site as well as the turbines, generators and control equipment. Each set is skid-mounted on a base-plate ready to drop into place in one piece. They are rated at 1700 kW each, delivering 400V 50 Hz current. The inlet steam is at 13.7 bar absolute pressure and 320°C, while the exhaust pressure is 2.2 bar absolute. Switchgear and control gear is supplied by ASEA who are supervising the electrical installation. The two units are to be operational before the next season which starts in October 1984, while further turbines of the same size are to be purchased by the Corporation during the year.

New sugar factory for Egypt

In February, Braunschweigische Maschinenbauanstalt AG signed with the General Organization for Industrialization and Société des Sucreries et de Distillerie d'Egypte a contract covering the supply and erection of a cane sugar factory capable of processing 6000 t.c.d. The factory will be built at Guirga and is scheduled to be commissioned in 1987. The project will be financed with capital aids and financial loans from the Federal Republic of Germany.

Zanini sugar factory equipment sales

Zanini is to supply Tongaat shredders to two cane sugar factories in Brazil, in one case with the addition of a fourth roller on each unit of the milling tandem. A third Brazilian factory is to be supplied with Zanini's own design of shredder. Export orders have also been received for mill gearing to go to Ingenio La Cabana in Colombia, mill spares for Ingenio Consuelo in the Dominican Republic, mill gearings for Ingenio Taboga in Costa Rica and cane knives for Gulf & Western Okeelanta Division in Florida.

Boiler controls for two British Sugar plants

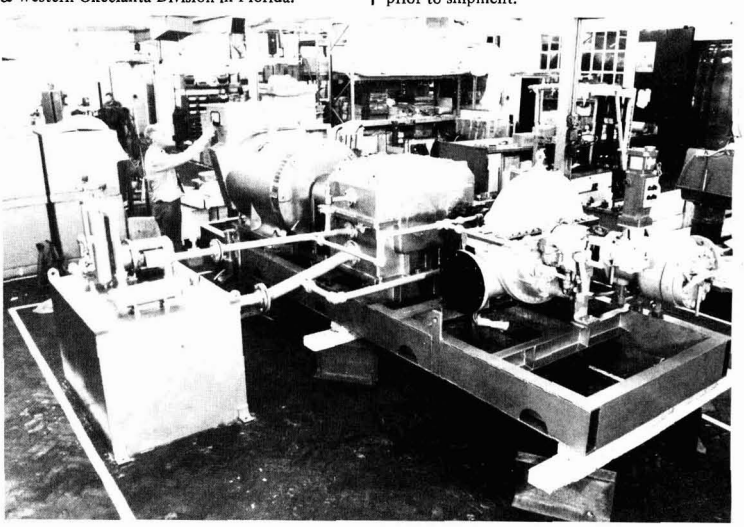
The Croydon Division of Babcock-Bristol Ltd., a member of the Babcock Industrial and Electrical Products Group, has supplied British Sugar plc with complete instrumentation and pneumatic controls for boiler equipment at the Kings Lynn and Bardney sugar factories. The contracts total in excess of £600,000 and include installation and commissioning of the equipment on one new and two refurbished boilers at each factory. The pneumatic controls are a combination of Babcock-Bristol's own long-established Miniline units and its advanced design H-range high density pneumatic control system.

Glucose syrup filtration plant

CPC (UK) Ltd. have ordered a second multiple filtration system from Albany International Engineered Systems Division, of Slough. It is for continuous filtering of glucose syrup at a flow rate of 27 $m^3.hr^{-1}$ at 5.5 bar operating pressure and the Albany system has been chosen for removal of contaminants in the 12 micron range. The Albany Model 5000H6 stainless steel filter has four operational barrels on stream, while an automatic valve arrangement allows backwashing with filtrate in an operation that takes only 5 seconds.

Steam turbo-alternator for St. Vincent

The St. Vincent Sugar Corporation recently took delivery of an 800 kW Coppus steam turbo-alternator designed and assembled by George Meller Ltd., of London., of London. Replacing an out-dated steam engine the generator is run at optimum speed for maximum efficiency; surges in power demand are coped with by stand-by diesel generators running in parallel. The illustration shows the generator prior to shipment.



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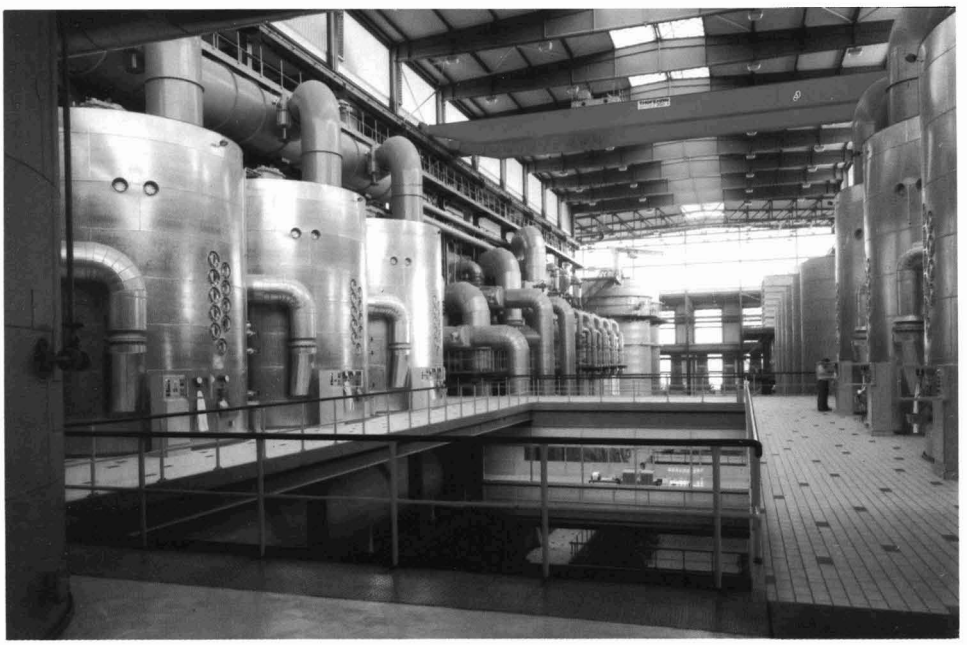

Partial view of sugar boiling house and front end of modernised beet sugar factory "Uelzen Aktiengesellschaft".
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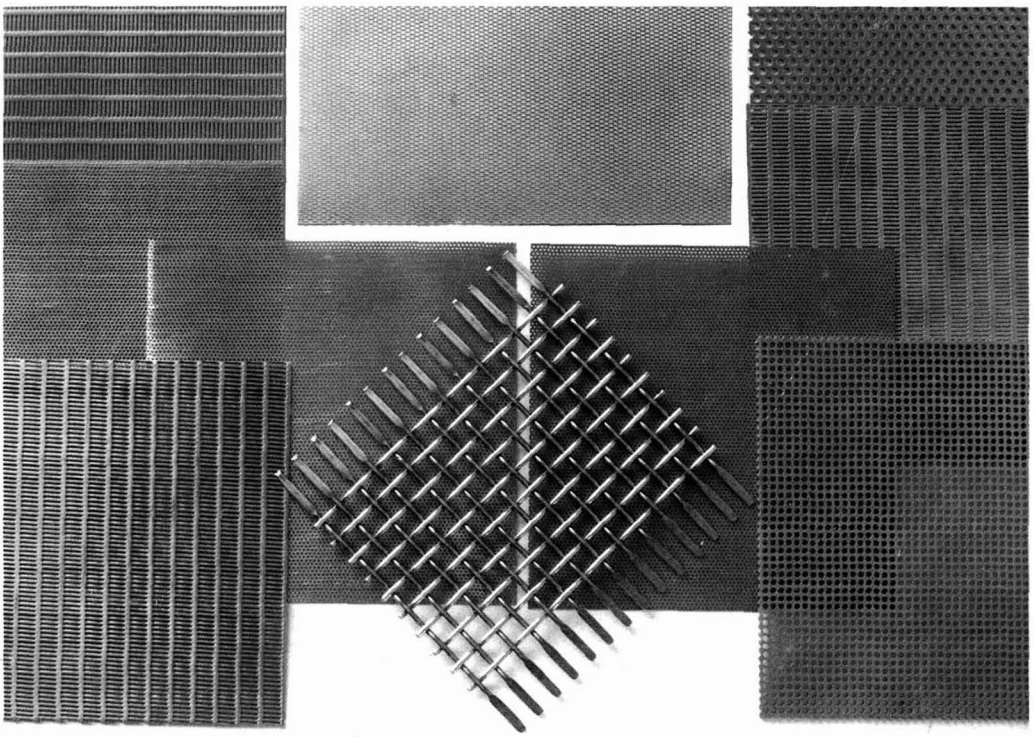

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