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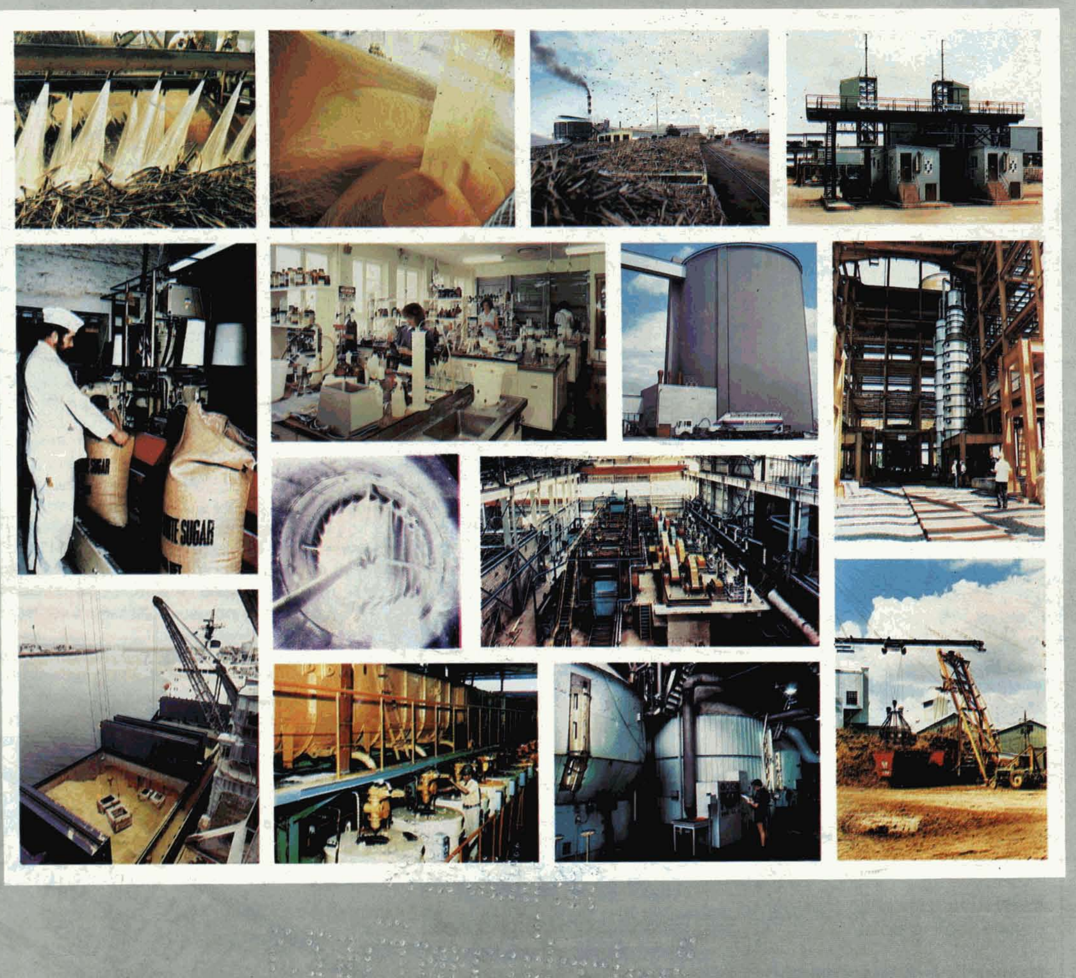

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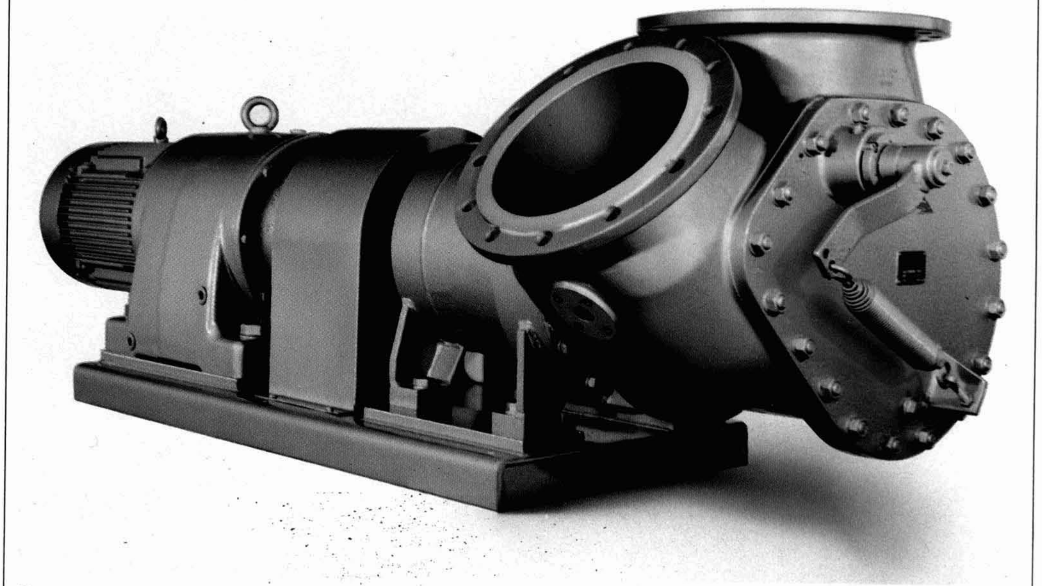

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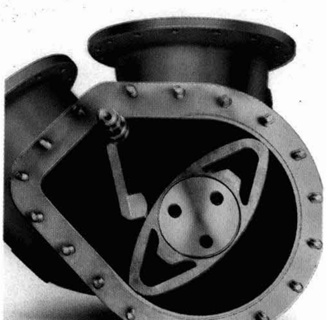

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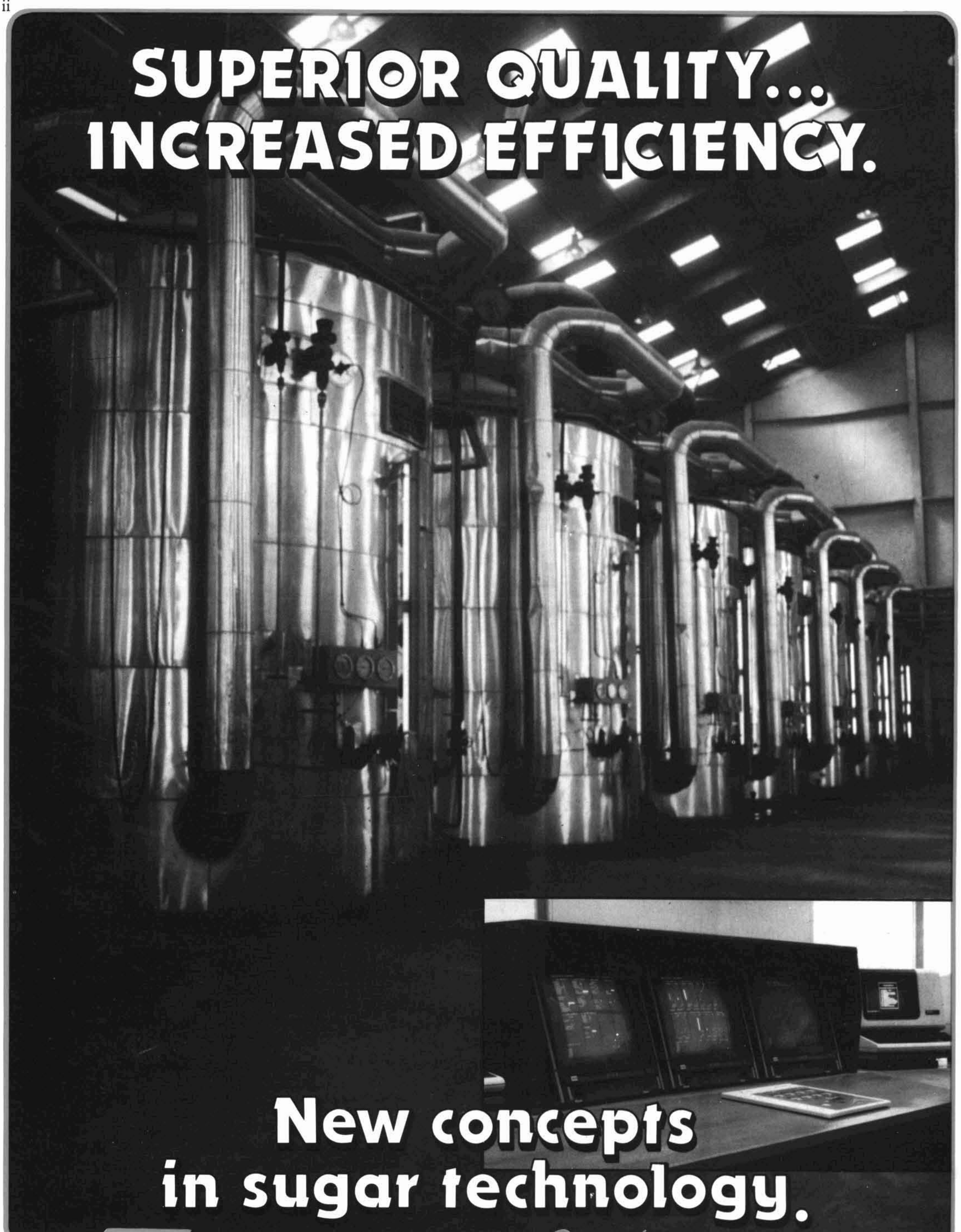
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Notes and comments

World sugar prices

The upward trend of sugar prices of recent weeks continued and from $127 per tonne on September 2, the London Daily Price for raw sugar rose to a peak of $140.50 on September 11. Prices then started to decline as good weather in Europe raised prospects of a higher than previously expected outturn and the LDP sank to $129 on September 13. On that day, the US announced that its supply quota would be about 1.85 million short tons—considerably more than had been expected—and the price surged to $142.50 per tonne. Thereafter, it declined, oscillating between $125.50 and $139, but ended the month at $129.50.

Buoyed by a considerable number of buying tenders for white sugar, the LDP(W), which started September at $163 per tonne, rose in parallel with the raw sugar price and reached $180 per tonne on September 11. Thereafter it too fell but was restored to the same level on September 16, thereafter declining but recovering to a peak of $182 on September 23 and ending the month at $174 per tonne.

Caricom states diversification[1]

Reduction of the US supply quota and current low world market prices have reduced foreign exchange earnings for the Caribbean Community states. Many are accepting World Bank structural adjustment loans and diversifying their economies. Sugar production in the Spring crop in Guyana is set at 114,230 short tons, raw value, which is above the target figure and was achieved thanks to cooperation by the workers and to good weather; nevertheless, Guyana is continuing its program of diversification out of sugar, with increased emphasis on rice, vegetables and aquaculture.

Jamaica has turned over a large area on three sugar estates to vegetable farming which are hoping that their products can compete successfully on the US market. Caroni, the state-owned Trinidad company, has concluded that sugar is "dead", although the 92,000 tons produced last year was an improvement on the target of 80,000 tons. Although sugar production has reached the 100,000 tons target in Barbados, officials still have doubts about the future.

Belize is considering the transfer of 82% of the sugar industry to its workers, while St. Vincent has announced plans to scrap its sugar industry; it owes some $15.5 million and FAO experts recommend the substitution of rum manufacture for sugar. Most regional producers have been unable to satisfy their quotas in spite of higher prices obtained on the guaranteed EEC and US markets. Further, the strength of the US dollar has reduced the value of the EEC prices which are quoted in sterling.

Diversification is a bold step for these countries and will have far-reaching ramifications on the social, political and technological structure which has been built around sugar cane cultivation and processing.

European beet area, 1985[2]

The third estimate by F. O. Licht GmbH of the area planted to sugar beet in Europe for the next campaign shows little change from their second estimate but shows a reduction in the total from 7.43 to 7.37 million hectares, which compares with the revised figure of 7,414,000 ha for 1984. The EEC estimate is increased by 6000 ha to 1,717,000 ha, with the same increase for Italy, while the area for Turkey is now estimated at 322,000 ha, a reduction of 31,000 ha instead of the increase of 17,000 ha expected in April. The Yugoslavian beet area estimate is further reduced by 5000 ha to 150,000 ha and that of Spain from 184,000 to 175,000 ha, so that the overall Western Europe total is set 57,000 ha lower at 2,504,000 ha, against 2,586,000 ha in 1984.

In Eastern Europe a reduction of 5000 ha for Hungary and an increase of 10,000 ha for the USSR are the only changes in the beet area estimates, and bring the overall total up from 4,856,000 to 4,870,000 ha.

Weather conditions in most Western European countries have not been particularly favourable and crops in many are late. This, together with the lower area, is likely to affect sugar production which may well be below the 18.2 million tonnes, raw value, of last campaign. In Eastern Europe, the situation so far seems to be normal while some countries even expect above-average yields. In the USSR, much will depend on the effects of the agricultural reforms which, however, are difficult to quantify.

World sugar production and consumption[3]

C. Czarnikow Ltd. have recently published their first estimate of sugar production prospects for 1985/86, much earlier than usual and mindful of their vulnerability to error. Early beet tests seem to bear out their expectations of a drop in EEC output of more than 600,000 tonnes from 1984/85, however, while outside the Community, smaller areas have been planted in Spain and Turkey, and delayed sowings indicate a fall in Soviet beet sugar output. Dissatisfaction last campaign among beet farmers in China have presumably been overcome and output is set at near the 1983/84 level for 1985/86. Despite financial difficulties for some beet sugar producers, US output in 1985/86 is expected to be the same as in 1984/85 while the recovery in Chile's sugar industry is expected to continue.

Recent frosts in Tucumán are likely to reinforce the Argentina government's plan to limit cane sugar production, and Brazil has announced

1 *World Sugar J.*, 1985, **8**, (1), 15.
2 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 419-421.
3 C. Czarnikow Ltd., *Sugar Review*, 1985, (1740), 98-102.

plans to reduce the sugar crop with diversion of cane to alcohol manufacture. Drought in Cuba is likely to cut sugar production and is expected to be a factor in reducing outturn in the Dominican Republic. It is thought that, having achieved self-sufficiency in sugar, further expansion is unlikely in Mexico at present prices, while the new pool system in South Africa is likely to limit production. India is expected to increase sugar outturn a little, as is Indonesia, but a substantial drop is expected in the Philippines. In total world sugar production is set 4.7 million tonnes lower, at 95.8 million tonnes against a consumption level, estimated by statistical means, at 98.4 million tonnes for 1986. As a consequence of differences in control methods, etc., there is generally an unexplained disappearance of about 500,000 tonnes in traded sugar per year and this would bring about a probable drop in the level of overhanging stocks of more than three million tonnes.

Czarnikow's sugar production figures are reproduced elsewhere in this issue.

Pakistan sugar expansion[4]

The sugar industry in Pakistan is an expanding and dynamic one. In 1947/48 there were only two small and very old factories and total production of plantation white sugar amounted to 8000 tonnes. Today there are 39 factories which produced more than 1.31 million tonnes of white sugar in 1984/85. Population has grown in the same period from 34.60 to 94.73 million, however, which has led to an increase in sweetener demand and in 1984/85 white sugar consumption is expected to have reached 13.9 kg per caput against 10.4 kg only a year ago when demand was limited by rationing.

It is believed that the government of Baluchistan, where at the moment no white sugar factories exist, is planning to erect two units with daily cane crushing capacities of 2000 and 4000 tonnes, respectively. The total cost is estimated at 838.2 million rupees ($52 million) with a foreign exchange component of 157 million rupees ($9.7 million). If all goes well the factories could be in operation within five years and produce 100,000 tonnes of white sugar annually. The area under cane in Baluchistan is presently 900 hectares and cane production an estimated 30,400 tonnes. It will require great efforts to raise the crop sufficiently to meet the requirements of the two new units when at full capacity.

The projected demand for total sweetener consumption in Pakistan in five years time is 3,423,000 tonnes of which 2,727,000 tonnes will be white sugar and the balance gur and khandsari. The population will by that time have reached 108 million so that per caput total sweetener requirement is set at 31.63 kg.

US sugar import quota for 1985/86

The US Department of Agriculture announced on September 13 that the import quota for the ten months December 1, 1985 to September 30, 1986 had been set at 1.85 million short tons, raw value. The new quota covers a shorter period than the usual twelve months because the period of the 1984/85 quota was extended to fourteen months instead of cutting the tonnage involved. The 1984/85 quota of 2,677,000 tons, spread over October 1984-September 1985, amounted to 191,215 tons/month, and the new quota is not much lower, at 185,000 tons/month.

The size of the quota was a considerable surprise to the market which had expected something between 0.8 and 1.3 million tons, and it is thought to be some 800,000 tons more than what is required to meet domestic demand. According to B. W. Dyer & Company[5], the larger quota was apparently the result of: (i) a decision to decide the size of the quota based on foreign policy needs rather than merely domestic supply/demand factors, (ii) the policy option chosen for handling the worsening debt crisis in developing countries, specifically the Caribbean and Latin American countries who depend on their sugar exports to the US, and (iii) a signal from the Reagan administration to Congress in the direction of changes in the sugar program, lower loan rates and thus lower price supports for sugar.

One option had been the so-called Savannah proposal[6] for importing non-quota sugar to be turned into an invert syrup comparable with HFS; this is still under consideration, while a similar proposal to limit such imports to Caribbean and Latin American countries was turned down.

The size of the new quota will certainly increase the quantity of sugar forfeited by domestic producers who have obtained loans from the Commodity Credit Corporation using their sugar as security. The stocks to be held by the CCC will create a downward pressure on domestic sugar prices.

European beet sugar production, 1985/86[7]

The first estimate by F. O. Licht GmbH of sugar production in Europe, published near the end of August, shows a fall of 1.3 million tonnes from the 1984/85 outturn, somewhat smaller than the drop forecast earlier in the month by C. Czarnikow Ltd. but reflecting the same influences of reduced areas in some cases as well as the effects of late sowing and poor weather during the growing period. While the smaller outturn in Europe will not on its own eliminate the surplus overhanging the market, Licht notes that cane sugar producers are also starting to react to the current depression and the combination should help to raise prices to more profitable levels in the not too distant future.

4 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 559-560.
5 *Dyergram*, September 16, 1985.
6 *I.S.J.*, 1985, **87**, 22.
7 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 483-486.

The analysis of sugars in beet Part III. HPLC analysis

By A. P. Mulcock, S. Moore, F. Barnes and B. Hickey

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Operating procedure

Equipment

The HPLC system used in our work was built up from commercially available components manufactured by Waters Associates (Milford, Mass., USA) and supplied by Alphatech Systems Ltd, Auckland. The components were: Model 660 solvent programmer; M45 solvent delivery system for methanol; Model 6000A solvent delivery system for water; and a Model U6K universal liquid chromatograph injector. A Waters pre-column filter was used immediately before the Dextropak cartridge which was contained in an RCM-100 radial compression module. An R401 differential refractometer was followed by a Waters data module. The Dextropak cartridge was not able to separate fructose and glucose.

At the commencement of the day's operations, Waters L.C. methanol solvent, which had been degassed in a Branson ultrasonic cleaning bath for ten minutes, was pumped through the system at 1.3 ml/min for ten minutes. By means of the solvent programmer, the methanol was replaced by water over ten minutes at the same flow rate which was maintained throughout the analyses. The water used as the analytical mobile phase was glass-distilled and each day's supply was filtered through an 0.45 µm Oxoid N47/45 membrane filter before being degassed under vacuum by a water pump in the ultrasonic bath for ten minutes. This procedure produced water of 11.5 MΩ resistivity.

Solution preparation

For an internal standard a compound was required that was eluted close to but not overlapping any of the sugars being analysed. After considerable testing α-methyl-d-glucoside (MDG) was found to be satisfactory. It was obtained from Sigma Chemical Co.

The sugar standards were made up from BDH AnalaR-grade sucrose, fructose and glucose. A sample of each was dried at 50°C in a vacuum oven for 24 hr. These samples were stored in screw-top bottles in a desiccator over silica gel granules.

When these sugars were analysed by HPLC no peaks additional to those for the specified compounds were observed on the chromatogram.

Solution (a) Standard sugar solution:
Sucrose (1.0000 g)
fructose (1.0000 g) and
glucose (1.0000 g)
were dissolved in distilled water and made to 100 ml in a standard volumetric flask (B-grade).

Solution (b) Internal standard solution: α-methyl-d-glucoside (1.0000 g) was dissolved in distilled water and made to 100 ml in a standard volumetric flask (B-grade).

Solution (c) Standardizing solution: 1.00 ml of solution (a) mixed with 1.00 ml of solution (b).

Solution (d) Unknown solution: 1.00 ml of beet extract sample mixed with 1.00 ml of solution (b).

Analytical routine

A 10 µl sample of the standardizing solution (c) was injected into the HPLC unit using a Hamilton (No. 802) 25 µl syringe and repeated injections were made until reproducible results and stable retention times for each sugar component were obtained.

Sub-samples (10 µl) of unknown solution (d) were injected for analysis. The standardizing solution (c) was injected after every four unknown samples. This sequence was maintained throughout the period analyses were being made. Each analysis was completed in six min.

Calculation

The solutions for analysis had been obtained by an extraction of known weight of beet and the volumes of the extracts were known[1]. The analytical procedure revealed the quantity of sucrose, fructose and glucose in the solution. This was shown by the area under the peaks on the chromatogram.

A response factor (RF) for each component was calculated during calibration—that is, when the mixed standard solution (c) was injected.

$$\text{RF}(1) = \frac{\text{amount of component (1)}}{\text{area of peak (1)}} \times 1000$$

The area of the internal standard (I.S.) peak was stored in the memory of the module.

After injection of a test sample, the amounts of the components in it were calculated as follows:

$$\text{amount of component (1)} = \frac{\text{RF (1)}}{1000} \times \text{area of peak (1)} \times \frac{\text{area I.S. calibration}}{\text{area I.S. analysis}}$$

This last factor, the ratio of the area of the internal standard peak in calibration to the area of the peak in the sample, was used to adjust the result for any injection of an unknown sample where there was a change in the size of the internal standard peak. This can be caused by a volume more or less than the standard one (10 µl) being injected. Therefore an injection does not have to be exactly 10 µl.

For example, if a volume less than 10 µl were injected, the factor would increase and the mini-computer in the module would adjust the peak areas of the other components.

After the concentrations of sucrose and fructose + glucose in the solution had been obtained the concentration of sugar in the original beet was determined using the following formula:

$$\text{Sugar concentration in wet beet (\%)} = \frac{\text{Sugar concentration in extract solution (\%)} \times \text{volume of filtrate}}{\text{weight of beet sample (g)}}$$

Separation of fructose and glucose

Since separation of fructose and glucose is not achieved with the Waters Dextropak column it was thought that integration results could be inaccurate if samples contained fructose and glucose in proportions other than the 50:50 ratio used in the calibration

1 See *I.S.J.*, 1985, **87**, 172-175.

standard. Therefore standard sugar solutions containing known concentrations of fructose and glucose were prepared and analysed. All the solutions were made up to a total sugar concentration of 1.5%. Results are shown in Table I.

Table I

Standards		Analytical result, % Total fructose + glucose
% Fructose	% Glucose	
—	1.5	1.48
		1.49
1.5	—	1.50
		1.50
0.75	0.75	1.50
		1.50
0.75	0.75	1.51
		1.49
0.75	0.75	1.46
		1.45
1.0	0.5	1.47
		1.47
0.5	1.0	1.49
		1.49

The results all lie within the 3.2% error limit associated with the method used. Thus the column used provided accurate total fructose + glucose concentrations for standard solutions and therefore separation of fructose and glucose was not necessary to achieve an accurate analysis of total sugar concentration.

Errors in HPLC analysis

(1) Calibration:

The HPLC was calibrated using a solution of sucrose, fructose and glucose which was made up as follows:

1.000 g ± 0.001 g fructose
1.000 g ± 0.001 g glucose
1.000 g ± 0.001 g sucrose

A Mettler AC100 balance (Mettler Instruments AG, Zurich) was used for all weighings. The sugars were dissolved in 100 ml ± 0.15 ml water (B-grade volumetric flask). Thus total error in the standard sugar solution equals 3(0.1%) + 0.15% = 0.45%.

The exact concentration of MDG is not important since it was not used in any calculations.

(2) Measurement of volume of solutions:

The 1:1 mixture of MDG and sample was originally made up using 1 ml B-grade pipettes which have a tolerance of ± 1%. Since pipettings from two separate pipettes were required to make up a ratio of 1:1, this gave ± 2% error in the 1:1 solution. To reduce this error, A-grade pipettes which had a tolerance of ± 0.6% were tested; these gave a total error of ± 1.2% in the 1:1 solution.

However, it was observed that when the sugar and MDG solutions were pipetted the difference in surface tension led to erroneous volumes being delivered. To overcome this problem a Socorex 1 ml automatic ejection pipette was tested (Socorex, Renens, Switzerland). Successive ejections were weighed on a Mettler AC 100 balance. Two modes of operation are available on this pipette. The forward mode draws up 1 ml of solution and ejects it all. The reverse mode draws up slightly more than 1 ml but ejects only 1 ml. Both modes were examined (Tables II-IV).

Table II. Mass (g) of water delivered by Socorex pipette set to deliver 1.0 ml

Replicate No.	Forward mode: Eject in mid-air	Forward mode: Eject and touch side of flask after delivery	Reverse mode: Eject in mid-air	Reverse mode: Eject and touch side of flask after delivery
1	1.0064	0.9912	0.9947	0.9708
2	1.0021	0.9851	0.9885	0.9724
3	1.0018	0.9806	0.9927	0.9735
4	1.0005	0.9703	0.9922	0.9737
5	1.0017	0.9780	0.9908	0.9744
6	1.0008	0.9644	0.9867	0.9740
7	0.9998	0.9633	0.9885	0.9742
8	1.0059	0.9742	0.9876	0.9745
9	0.9926	0.9596	0.9879	0.9746
10	0.9943	0.9605	0.9792	0.9747
11	0.9981	0.9605	0.9853	0.9780
12	1.0008	—	0.9831	0.9744
13	—	—	0.9834	0.9768
14	—	—	0.9831	0.9748
15	—	—	0.9799	0.9736
Mean	1.0004	0.9716	0.9869	0.9743
CV	0.4008	1.1312	0.466	0.175

The results set out in Table II showed that the reverse mode of delivery produced less variation, especially when the side of the flask was touched after delivery.

Table IV shows that for a solution of sucrose the variation in mass of a 1 ml aliquot, using a Socorex pipette set to deliver 1.0 ml in the reverse mode, was 0.2%.

(3) Instrument reproducibility:

This was tested by injecting a series

Table III. Mass (g) of water delivered by a Socorex pipette set to deliver 1.0 ml using reverse mode and touching side of flask; results of three trials

Replicate No.	Trial No. A	B	C
1	0.9986	0.9959	0.9946
2	0.9965	0.9963	0.9949
3	0.9957	0.9955	0.9957
4	0.9970	0.9966	0.9943
5	0.9984	0.9967	0.9950
6	0.9979	0.9951	0.9953
7	0.9959	0.9960	0.9954
8	0.9963	0.9957	0.9943
9	0.9955	0.9944	0.9947
10	0.9966	0.9943	0.9954
11	0.9967	0.9941	0.9951
Mean	0.9968	0.9955	0.9950
CV	0.1060	0.0927	0.0465

Table IV. Mass (g) of 1% sucrose delivered by a Socorex pipette set to deliver 1.0 ml using reverse mode and touching side of flask; results of three trials

Replicate No.	Trial No. A	B	C
1	1.0073	1.0036	1.0030
2	1.0052	1.0036	1.0031
3	1.0061	1.0031	1.0033
4	1.0039	1.0031	1.0002
5	0.9998	1.0013	1.0031
6	1.0077	1.0019	1.0041
7	1.0048	1.0027	1.0013
8	1.0034	1.0026	1.0051
9	1.0033	1.0030	1.0058
10	1.0035	1.0030	—
Mean	1.0045	1.0028	1.0032
CV	0.228	0.072	0.172

of sub-samples from one sample of juice mixed with the internal standard (solution d).

The results set out in Table V show a variation of 1.5%.

Table V. Results of HPLC analysis of 10 replicate sub-samples from one sample of beet juice; the sub-samples were injected consecutively

Sample No.	*Sugar %*
1	0.860
2	0.864
3	0.866
4	0.872
5	0.866
6	0.860
7	0.899
8	0.859
9	0.858
Mean	0.867
CV	1.5%

The long term reproducibility of HPLC results was tested by the following experiment. A sample of beet extract, obtained by the blender/ultrasonicator method[2], was sub-sampled into 20 glass vials. The vials were then stored in a freezer at -20°C. Over a period of 3 weeks, at irregular intervals, a vial was taken from the freezer and the sub-sample was analysed. The results of this experiment are set out in Table VI.

Table VI. Results of HPLC analysis of the same beet extract over a three-week period

No. of days frozen	*Sugar concentration (% w/v)*
1	1.306
3	1.295
3	1.290
4	1.281
4	1.298
5	1.307
7	1.341
7	1.347
10	1.286
10	1.295
11	1.350
11	1.286
13	1.362
13	1.342
14	1.341
17	1.347
17	1.357
18	1.304
18	1.337
19	1.326
Mean	1.320
CV	2.08

The variability of the results in Table VI was greater than those in Table V. This was expected as the results in Table VI came from 20 separate sub-samples which each had to be mixed with the internal standard whereas in Table V the same mixture of sample and internal standard was injected repeatedly. There are three main areas contributing to the variability in Table VI; these are machine reproducibility, sample mixing and calibration errors.

To summarise, the errors are:

(1) Error in calibration solution = 0.2%

(2) Errors in pipettes

- B-grade = 2.0%
- A-grade = 1.2%
- Socorex Automatic Pipette = 0.2%

(3) Variation in the HPLC = 1.0%

Effect of long storage on analysis

Analyses described above were all done using samples from beet that had been harvested for not more than a few days. Possible errors due to interference by break-down products in samples from beets that had been stored in clamps for some months and which as a consequence had become dry and woody, were investigated.

Five beets (3 kg) which had been stored outside from February to May were ground and boiled with two litres of water for 1 hr. The water extract was decanted and a 100 ml aliquot was centrifuged at 15,000 rpm for 10 min. After preliminary analysis for sugar content had established the concentration in the extract the supernatant was diluted to one-tenth strength to give a sugar concentration in the operating range of the HPLC. Ten 20 ml sub-samples of the diluted water extract were immediately frozen. These samples are referred to as the water extract.

Another set of samples from freshly harvested beet was obtained using the blender/ultrasonicator extraction method. These samples are referred to as the ethanol extract.

The standard solution (a) above was used as a control. In this solution, fructose and glucose concentrations were equal to 0.95% expressed in equivalent sucrose. This solution is referred to as the standard sugar solution. It was stored at 4°C.

The frozen sub-samples of the water and ethanol extracts were thawed as required. The following solutions were analysed for sugar content. Mixtures were made from equal volumes of each component to determine whether the results were additive.

(1) Water extract
(2) Ethanol extract
(3) Ethanol extract and standard solution
(4) Ethanol extract and water extract
(5) Ethanol extract and water extract and standard solution.

The results for 1 and 2 above are set out in Tables VII and VIII. Using these figures theoretical sugar concentrations for the various mixed solutions were calculated and compared with experimental results. These

Table VII. Sugar concentrations (% w/v) in ten replicate sub-samples of ethanol extract; results expressed as equivalent sucrose

Sample No.	*Fructose+glucose*	*Sucrose*
1	0.041	0.574
2	0.055	0.568
3	0.041	0.559
4	0.048	0.576
5	0.063	0.573
6	0.060	0.595
7	0.058	0.578
8	0.054	0.582
9	0.048	0.576
10	0.058	0.578
Mean	0.053	0.576
CV	14.781	1.607

Table VIII. Sugar concentrations (% w/v) in ten replicate sub-samples of water extract; results expressed as equivalent sucrose

Sample No.	*Fructose+glucose*	*Sucrose*
1	0.307	0.380
2	0.308	0.388
3	0.308	0.395
4	0.336	0.400
5	0.296	0.326
6	0.344	0.398
7	0.324	0.395
8	0.308	0.372
9	0.282	0.318
10	0.333	0.387
Mean	0.315	0.376
CV	6.129	7.903

2 *I.S.J.*, 1985, **87**, 188-194.

Table IX. Sugar concentrations (% w/v) in mixtures of ethanol extract and standard sugar solution; results expressed as equivalent sucrose

Sample No.	Fructose+glucose			Sucrose		
	Expected	*Observed*	*% Recovery*	*Expected*	*Observed*	*% Recovery*
1	1.941	1.936	99.74	1.574	1.562	99.24
2	1.956	1.927	98.52	1.568	1.544	98.47
3	1.941	1.906	98.20	1.559	1.557	99.87
4	1.948	1.977	101.49	1.576	1.582	100.38
5	1.963	1.975	100.61	1.573	1.564	99.43
6	1.960	1.969	100.46	1.595	1.600	100.31
7	1.958	1.942	99.18	1.578	1.577	99.94
8	1.954	1.980	101.33	1.582	1.570	99.24
9	1.948	1.969	101.08	1.576	1.582	100.38
10	1.958	2.047	104.55	1.578	1.616	102.41
Mean	1.953	1.963	100.52	1.576	1.575	99.97
CV	0.399	1.971	1.815	0.587	1.339	1.056

Table X. Sugar concentrations (% w/v) in mixtures of ethanol extract and water extract; results expressed as equivalent sucrose

Sample No.	Fructose+glucose			Sucrose		
	Expected	*Observed*	*% Recovery*	*Expected*	*Observed*	*% Recovery*
1	0.348	0.338	97.13	0.961	0.954	99.27
2	0.363	0.366	100.83	0.948	0.955	100.74
3	0.344	0.375	107.45	0.948	0.944	99.68
4	0.384	0.348	90.63	0.976	0.973	99.69
5	0.359	0.385	107.24	0.899	0.905	100.67
6	0.404	0.390	96.53	0.993	0.993	100.00
7	0.382	0.368	96.34	0.973	0.970	99.69
8	0.362	0.327	90.33	0.954	0.976	102.31
9	0.330	0.346	104.85	0.894	0.908	101.57
10	0.392	0.306	78.06	0.965	0.851	88.19
Mean	0.367	0.355	96.4	0.951	0.943	99.18
CV	6.199	7.525	9.321	3.354	4.557	4.010

Table XI. Sugar concentrations (% w/v) in mixtures of ethanol extract, water extract and standard sugar solution; results expressed as equivalent sucrose

Sample No.	Fructose+glucose			Sucrose		
	Expected	*Observed*	*% Recovery*	*Expected*	*Observed*	*% Recovery*
1	2.248	2.131	94.80	1.961	1.945	99.18
2	2.263	2.254	99.60	1.948	1.948	100.00
3	2.249	2.276	101.20	1.947	1.956	100.46
4	2.284	2.306	100.96	1.976	1.972	99.80
5	2.259	2.445	108.23	1.899	2.012	105.95
6	2.304	2.334	101.30	1.993	2.039	102.31
7	2.282	2.431	106.53	1.973	2.022	102.48
8	2.262	2.497	110.39	1.954	2.071	105.99
9	2.230	2.173	97.44	1.894	1.960	103.48
10	2.292	2.211	96.47	1.965	1.893	96.34
Mean	2.267	2.306	101.69	1.951	1.982	101.60
CV	1.004	5.275	5.078	1.635	2.679	3.000

comparisons are shown in Tables IX-XI.

Tables VII and VIII show that results from the ethanol extract samples were not as variable as those obtained with the water extract. The high CV for the fructose + glucose concentration in the ethanol extract was due to the very low levels present (<0.1%).

In analyses of single component samples the errors (calculated as above) were as follows:

Measurement of sample volume	0.6%
Measurement of internal standard volume	0.6%
Total pipetting error	1.2%
HPLC reproducibility	1.5%
Total error	2.7%

When more than one component was present in the sample the extra mixing necessary accounted for a further error of ±3.9%. In calculating the difference between the observed and expected result the errors associated with the mixture must be added to the errors associated with the original analyses of the individual components. Thus in this example the total error was ±5.6%. A summary of the errors for each case is given in Table XII.

Table XII. Errors (%) due to mixing samples

Source of error	Sample 1	2	3	4	5
Analysis of ethanol extract	2.7	—	2.7	2.7	2.7
Analysis of water extract	—	2.7	—	2.7	2.7
Analysis of 2-component mixture	—	—	3.9	3.9	—
Analysis of 3-component mixture	—	—	—	—	5.1
Total error	2.7	2.7	6.6	9.3	10.5

The results set out in Table IX show that recovery was within the errors (Table XII) in all cases. However, experiments involving the water extract (Tables X and XI) gave some results outside the expected error. It could be that substances are present in the old beet which interfere with sugar concentration determinations by eluting at a similar time to the sugars.

Summary of analytical procedure

In order to process a large number of beet samples for analysis of sugar content a method was required which was both fast and reliable. The method set out below is the result of experiments described in this series of papers and is designed to meet these requirements.

1. The beet were harvested from the field.
2. The beet were washed, the leaves removed and the roots were

halved.

3. Half of each root was transferred to a modified soil shredder where the beet were comminuted to produce brei.
4. About 200 g of each sample of brei was packed into a 400 ml plastic container.
5. The containers were placed with as little delay as possible in a freezer and stored at -17°C.
6. When required for analysis the containers were thawed in a water bath at 30-35°C (approximately 15 min).
7. From a thawed container of beet approximately 8 g of shredded beet was weighed accurately on a Mettler AC 100 balance to 3 decimal places and transferred to the 50 ml blender cup of a Sorvall Omnimixer.
8. 50 ml of 80% ethanol was added from a measuring cylinder.
9. The cup was stoppered, and heated in a Branson ultrasonic bath with a Grant SU4 thermostatic control unit for five minutes to achieve a temperature of 55±2°C while being subjected to ultrasonic treatment.
10. The cup was attached to the Omnimixer blender and again lowered into the ultrasonic bath and subject to further ultrasonic treatment and blending at 16,000 rpm for 5 min at 55°C.
11. The contents of the blender cup were transferred with distilled water from a wash-bottle into a 60 mm Buchner funnel, which had a stainless steel gauze (50 µm) attached to the base, and filtered and rinsed with about 20 ml of distilled water under vacuum directly into a B-grade 100 ml volumetric flask. (See Fig. 3.)
12. The filtrate was left to cool to room temperature (20±5°C) before being diluted to 100 ml with distilled water in the flask.
13. A subsample of the filtrate was poured into an 8 ml polycarbonate centrifuge tube and spun at 15,000 rpm for 10 min in the Sorvall RC-2B centrifuge at 0±5°C.
14. 1 ml of the supernatant was mixed 1:1 with the internal standard α-methy-d-glucoside using a Socorex automatic ejection pipette.
15. A Hamilton 802 syringe was used to inject 10 µl of this mixture into a Waters HPLC system containing a Dextropak column.
16. The HPLC reported the concentration of sucrose and combined fructose+glucose in sucrose equivalents as a % w/v in the extract.
17. From this the total amount of sugar as a percentage of the wet weight of the beet brei was calculated.

Table XIII. Summary of determinant errors in analysis by blender/ultrasonicator extraction and HPLC

Source	*Description*	*Absolute error*	*% Error*
Beet weight	7.9 to 8.1 g, read to 0.001 g	0.001 g	0.0125
Solution volume (filtered brei)	100 ml B-grade volumetric flask tolerance 0.15%	0.15 ml	0.15
HPLC calibration standard	Sucrose, glucose, fructose, each 1.000 g in 100 ml vol. flask	0.003 g 0.15 ml	0.3 0.15
Socorex pipette	1:1 mix of sugars/MDG		0.2
HPLC reproducibility			1.5
		Total error	2.3%

In Table XIII the errors that can be expected using this method are set out. From these figures it can be concluded that a beet sample having a sugar content of 15% when analysed could give a result between 14.65% and 15.35% sugar.

Conclusion

The literature on sugar analysis in plant material is sparse and certainly in the analysis of sugar in beet there are many points on which agreement and uniformity have not been reached. From the experiments reported here and from the literature it is clear that the most difficult aspect of sugar analysis of beet from experimental plots is the preparation of a representative sample from the crop in the field. When this problem has been overcome it is important that a suitable extraction procedure which takes account of marc value is used if the sugar content of widely different cultivars from different fertilizer and irrigation trials is to be analysed accurately for comparative purposes.

In order to evaluate the results of field trials the technique by which sugar concentration is assessed must be fully reported as the method can have a considerable effect on the final result. It would appear that the HPLC is a suitable tool for this type of sugar estimation as it gives rapid repeatable results and, what is more important, this technique allows the accurate estimation of the size of the errors that are involved at each step.

Brevities

Cuban sugar crop, 1984/85[1]

President Castro recently said that Cuba produced 8 million tonnes of sugar in 1984/85; he added that the plan was 100% fulfilled, without mentioning that the production target had been reduced during the course of the year. The lower-than-predicted harvest (earlier expected to reach 8.6 million tonnes) was due to the lack of cane in the fields; immature cane for this year's harvest was used last year to meet urgent commitments. Cuba is thought to have bought about a million tonnes of various origin raw sugar so far this year to meet commitments to customers in China and Japan.

1 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 460.

Aspects of automatic sugar boiling at Newark factory

By S. C. H. McCarey and F. Fearnside

Introduction

Newark Factory was completely reconstructed between 1974 and 1978, and, as part of that project, micro-processor controls were installed on all vacuum pans. The original installation and control scheme are described in the first section of this paper. From 1981/82 campaign onwards, Newark factory sugar end strategy changed significantly. The effects of these changes on sugar boiling techniques and the control system are described in the second section of this paper.

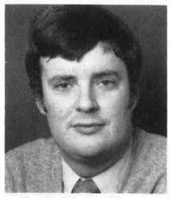
No attempt has been made to discuss the theory behind changes to sugar end techniques since this is well documented elsewhere. The paper is intended to be a practical guide to the logical application of different systems in the sugar end, and the effect of these on the sugar end operation at Newark factory.

Section I

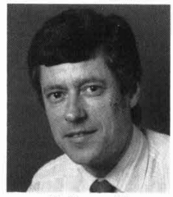
The original micro-processor control system and its development up to the 1981/82 campaign

Five Negretti and Zambra MPC 80 microprocessor controllers were installed at Newark Factory for the 1977/78 campaign. These were to be used to control the operation of all nine pans, four boiling white sugar, two boiling raw sugar, two boiling after-product sugar and one boiling either raw or after-product sugar. Although this last pan was initially used for raw sugar it was subsequently changed to, and remains, an after-product pan. Each MPC 80 was programmed to control two pans.

The MPC 80 is a three-term controller with the facility for sequencing. The three-term control is achieved via algorithms in software. The programs are written in SENZTROL, a high-level interpretive language with process control orientated instructions. 16 sequences and 16 sub-sequences each with up to 64 steps are available. This form of control has proved to be very flexible



S. C. H. McCarey



F. Fearnside

and enables sequences to be altered whilst the MPC 80 is controlling the plant.

Each MPC 80 contains a series of plug-in printed circuit boards comprising: a central processing unit, a real-time clock, three 16K programmable read-only memory (PROM) boards, a 16K random-access memory (RAM) board, two 16-channel digital input boards, three 16-channel digital output boards, two 4- or 8-channel analogue output boards, a 16-channel analogue input board, an analogue-to-digital converter, a dual-channel communications board, and a PROM programming board.

Spare slots are available for additional boards but this configuration has proved adequate for the control of two pans. 16K of PROM memory is available for application programs and 16K of RAM memory for database configuration and on-line sequence editing.

The basic database contains:
8 three-term loops, 8 single-term loops, 64 floating-point variables and 64 integer variables.

The user can expand this to suit his own application to a maximum of 16 three- and single-term loops and 512 floating and integer variables.

This basic hardware was in operation until the 1979/80 campaign when the five MPC 80s were linked to a central MPC 80 microprocessor (see Figure 1).

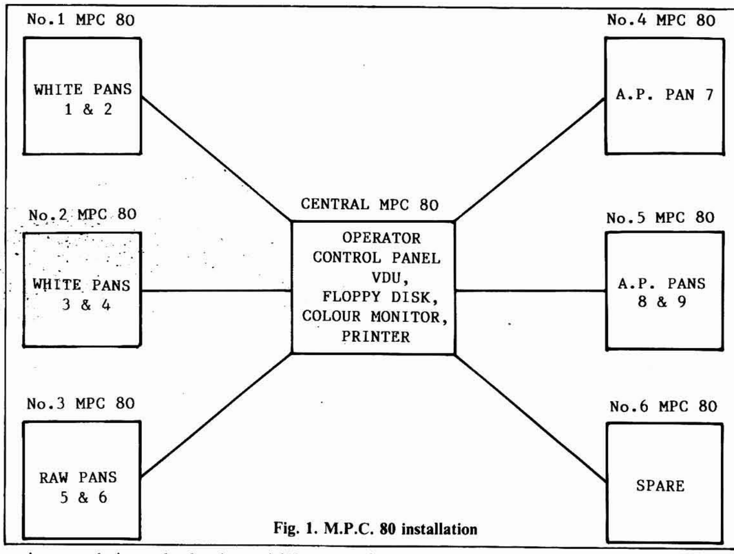


Fig. 1. M.P.C. 80 installation

This central MPC 80 unit has no facilities for plant control but deals with message handling and information storage. It can provide an overall view of the sugar end and be used for pan scheduling. With the central package came an operator's control console with a visual display unit (VDU), a colour monitor, a dual floppy disk and a high-speed printer. The information retrieved from the five front-end MPC 80's by the central units is stored and processed. Pan and sugar end information is stored on disc for pan

Paper presented to the 27th Technical Conference, British Sugar plc, 1984.

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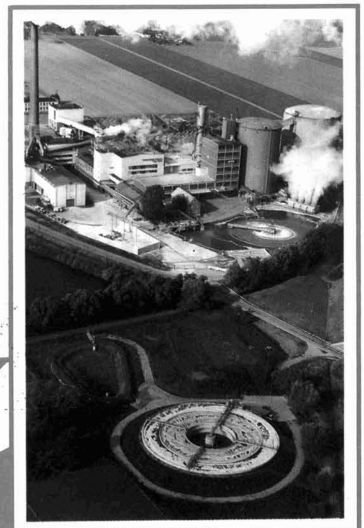

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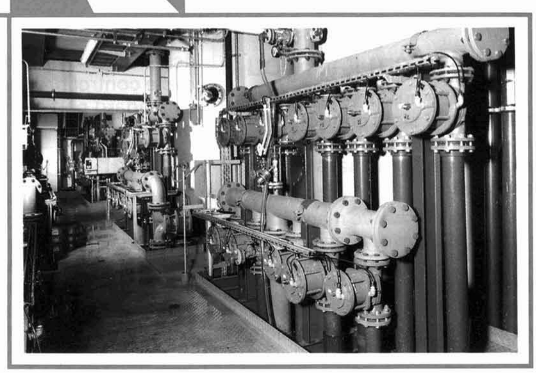

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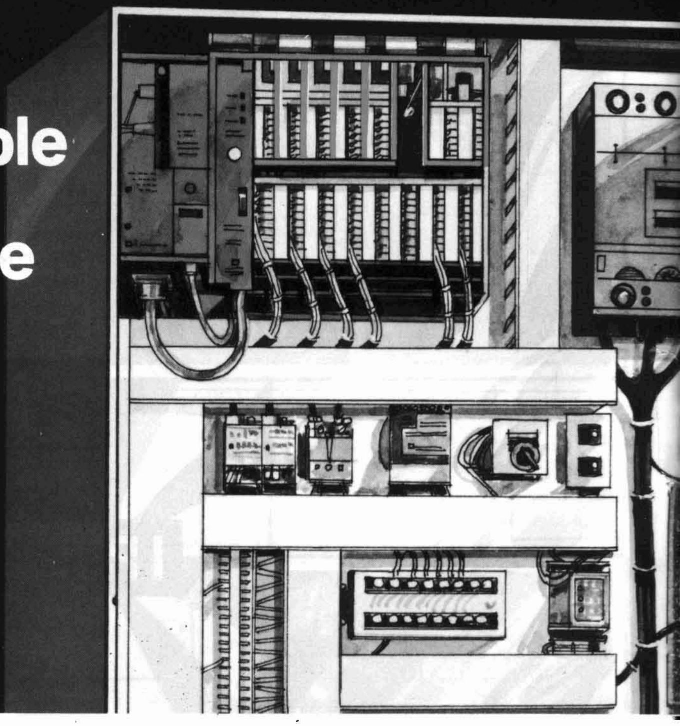

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and shift logs whilst the colour monitor displays the current status of the sugar end. Instructions are sent to the front-end MPC 80s to alter their program flow for scheduling.

Each MPC 80 controls the whole boiling cycle of two pans, opening and closing on/off valves, setting control loops to automatic or manual and changing set-points, ratios and control constants. Each pan has its own mimic display situated in the sugar end control room, consisting of the pan outline with associated pipework and valves (see Figure 2). Stage lights in the centre of the mimic illuminate as the pan cycle progresses and valve lights illuminate as the on/off valves open. Indicators show the position of the control valves. Digi-switches are available to allow the operator to set end charge levels and seed points.

The flow chart splits at the feed cycle to show the white sugar cycle and the raw and AP sugar cycle.

Figure 4 illustrates the shock-seeded white pan cycle in use up to 1981. The principal stages of this cycle are:

Charge—to volume determined by the operator.

Boil down—to an operator-determined seeding temperature.

Shock seed—using a small amount of sugar dust.

Establish grain—during which time the pan temperature is allowed to rise to an internally-set point.

Open out—to an operator-determined temperature.

Feed.

Brix up.

Drop.

Pan supersaturation for the whole cycle is controlled by temperature.

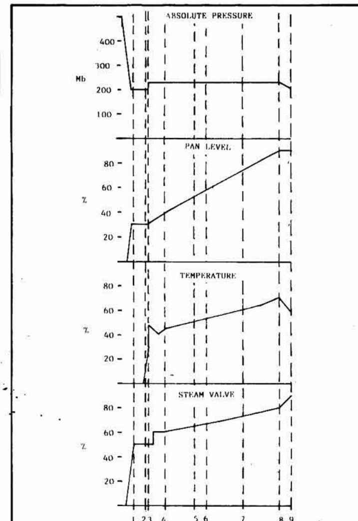

Fig. 4. White pans — shock seeding: 1. End charge; 2. Seed; 3. Start feed; 4. 1st ratio change; 5. 2nd ratio change; 6. 3rd ratio change; 7. High level; 8. Pan tight

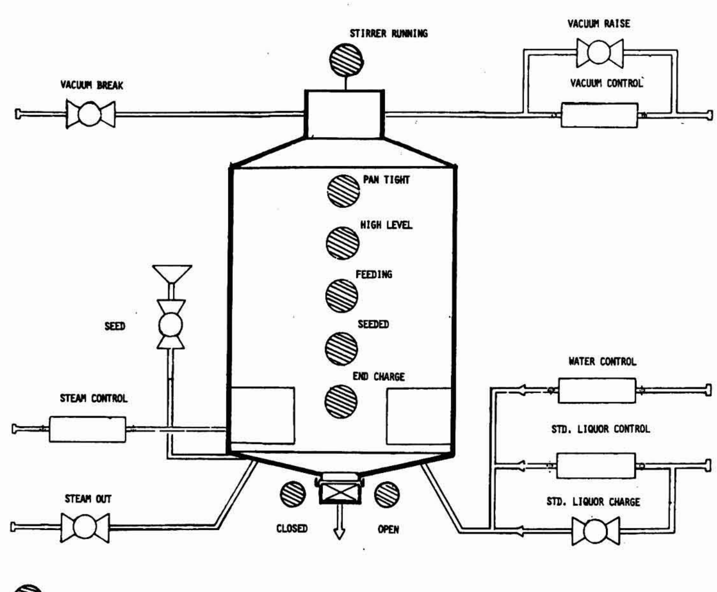

Fig. 2. White vacuum pan

The flow-chart (Figure 3) indicates very simply the program flow. Up to "seed," and after "pan tight," the sequence of events is similar for each type of boiling.

Figure 5 illustrates the magma-seeded raw pan cycle in use up to 1982. The principal stages of this cycle are:

Charge—with magma and high green, to volume determined by the

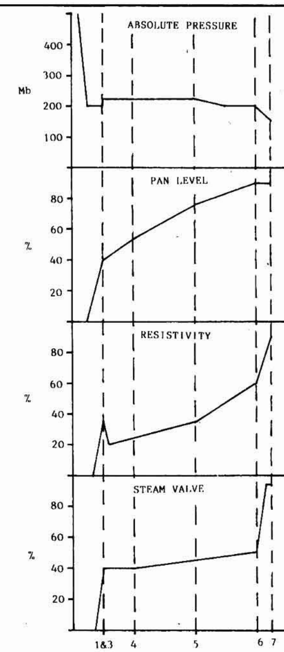

Fig. 5. Raw pans — Magma: 1. End charge; 3. Start feed; 4. 1st ratio change; 5. 2nd ratio change; 6. High level; 7. Pan tight

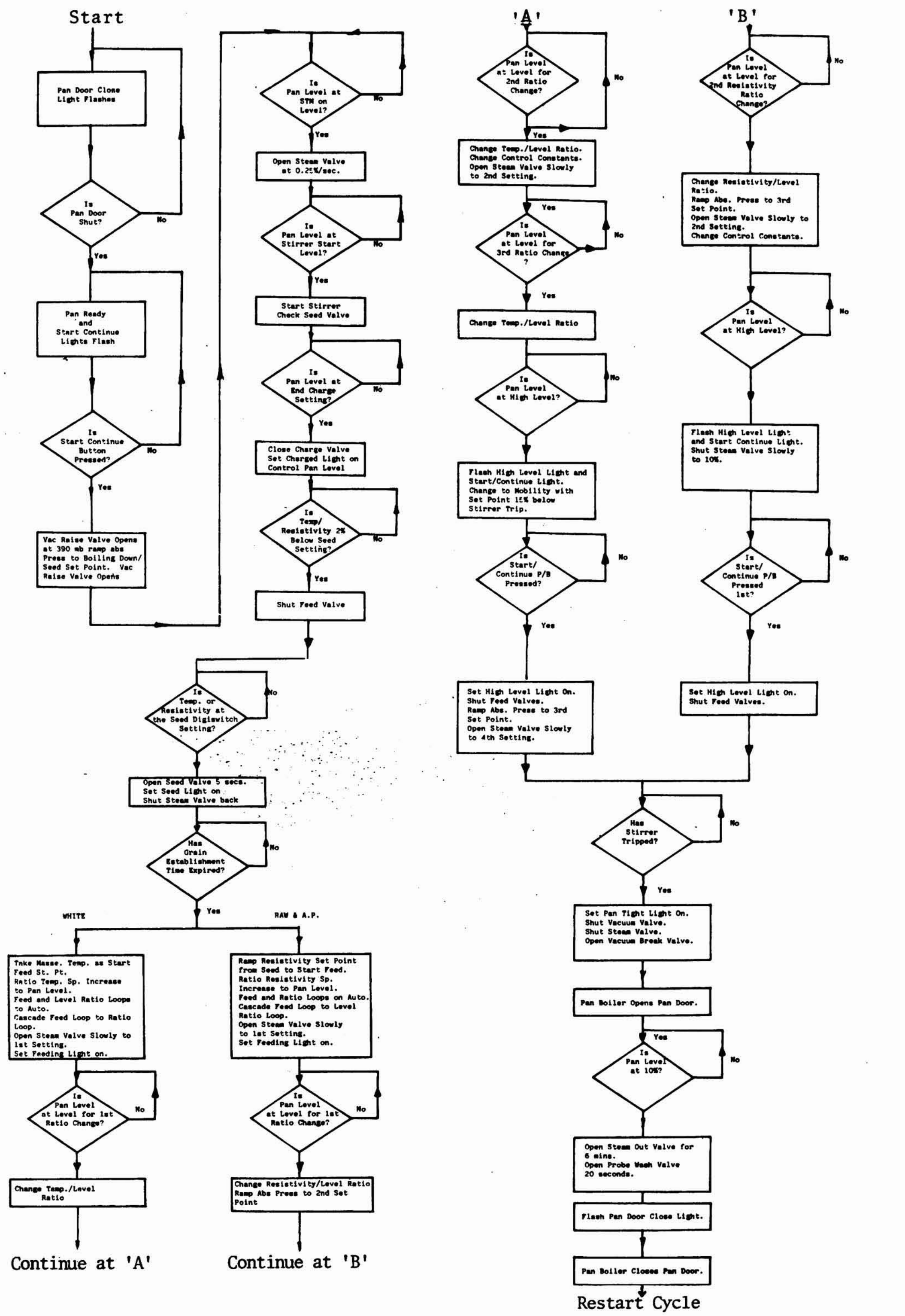
Start
Pan Door Close Light Flashes
Is Pan Door Shut?
No
Yes
Pan Ready and Start Continue Lights Flash
Is Start Continue Button Pressed?
No
Yes
Vac Raise Valve Opens at 390 mb ramp abs Press to Boiling Down/ Seed Set Point. Vac Raise Valve Opens
Is Pan Level at STM on Level?
No
Yes
Open Steam Valve at 0.25%/sec.
Is Pan Level at Stirrer Start Level?
No
Yes
Start Stirrer Check Seed Valve
Is Pan Level at End Charge Setting?
No
Yes
Close Charge Valve Set Charged Light on Control Pan Level
Is Temp/ Resistivity 2% Below Seed Setting?
No
Yes
Shut Feed Valve
Is Temp. or Resistivity at the Seed Digiswitch Setting?
No
Open Seed Valve 5 secs. Set Seed Light on Shut Steam Valve back
Has Grain Establishment Time Expired?
No
Yes
WHITE
RAW & A.P.
Take Masse. Temp. as Start Feed St. Pt. Ratio Temp. Sp. Increase to Pan Level. Feed and Level Ratio Loops to Auto. Cascade Feed Loop to Ratio Loop. Open Steam Valve Slowly to 1st Setting. Set Feeding Light on.
Ramp Resistivity Set Point from Seed to Start Feed. Ratio Resistivity Sp. Increase to Pan Level. Feed and Ratio Loops on Auto. Cascade Feed Loop to Level Ratio Loop. Open Steam Valve Slowly to 1st Setting. Set Feeding Light on.
Is Pan Level at Level for 1st Ratio Change?
No
Is Pan Level at Level for 1st Ratio Change?
No
Change Temp./Level Ratio
Change Resistivity/Level Ratio Ramp Abs Press to 2nd Set Point
Continue at 'A'
Continue at 'B'
'A'
Is Pan Level at Level for 2nd Ratio Change?
No
Yes
Change Temp./Level Ratio. Change Control Constants. Open Steam Valve Slowly to 2nd Setting.
Yes
Is Pan Level at Level for 3rd Ratio Change ?
No
Yes
Change Temp./Level Ratio
Is Pan Level at High Level?
No
Flash High Level Light and Start/Continue Light. Change to Mobility with Set Point 15% below Stirrer Trip.
Is Start/ Continue P/B Pressed?
No
Yes
Set High Level Light On. Shut Feed Valves. Ramp Abs. Press to 3rd Set Point. Open Steam Valve Slowly to 4th Setting.
'B'
Is Pan Level at Level for 2nd Resistivity Ratio Change?
No
Change Resistivity/Level Ratio. Ramp Abs. Press to 3rd Set Point. Open Steam Valve Slowly to 2nd Setting. Change Control Constants.
Is Pan Level at High Level?
No
Flash High Level Light and Start Continue Light. Shut Steam Valve Slowly to 10%.
Is Start/ Continue P/B Pressed 1st?
No
Yes
Set High Level Light On. Shut Feed Valves.
Has Stirrer Tripped?
No
Yes
Set Pan Tight Light On. Shut Vacuum Valve. Shut Steam Valve. Open Vacuum Break Valve.
Pan Boiler Opens Pan Door.
Yes
Is Pan Level at 10%?
No
Open Steam Out Valve for 6 mins. Open Probe Wash Valve 20 seconds.
Flash Pan Door Close Light.
Pan Boiler Closes Pan Door.
Restart Cycle

Fig. 3

ISJ Abstracts

Cane sugar manufacture

Preventive maintenance at HC & S: application of non-destructive testing techniques

J. C. Holliday. *Rpts. 42nd Ann. Conf. Hawaiian Sugar Tech.*, 1983, 178-180.

Types of non-destructive testing used by Hawaiian Commercial & Sugar Co. at their raw sugar factories as part of the preventive maintenance program are described, with indications of typical applications, limitations, cost of equipment or individual inspection, and (in two cases) with general comments on the technique. The four methods are: magnetic particle inspection, liquid penetrant testing, ultrasonic testing and vibration monitoring and analysis.

Maintaining production by avoiding gear failure in sugar mill drives

T. J. Putnam. *Rpts. 42nd Ann. Conf. Hawaiian Sugar Tech.*, 1983, 181-186.

The kinematics of gear meshing are explained as a preamble to a discussion of surface fatigue (the most prominent type of gear failure) and pitting of the gear tooth flanks with which it is usually identified. Three types of pitting are described: initial pitting, destructive pitting and spalling. The mechanics of pitting, which can occur in one of two ways, are examined, followed by a survey of causes of pitting and remedial measures.

Equipment for cane sugar mills

F. Komon. *Skoda Review*, 1985, (1), 61-63.

A brief account is given of cane sugar factory equipment manufactured by Skoda, the Czechoslovakian concern, for supply to various countries.

Modifications to the Zanini-Farrel 'A' tandem, Usina Santa Elisa S.A., Brazil, 1984/85 crop

M. Biagi and W. A. Manfrin. *Sugar y Azúcar*, 1985, **80**, (1), 30-31.

In the first part of a two-stage modernization program, a Zanini-Tongaat shredder with a straight knife set replaced the second set of knives, and a rubber conveyor belt was installed in place of the last section of the cane carrier between the shredder and the Donnelly chute feeding the first mill of the 6-mill tandem, which was converted to a 4-roller mill by addition of a press roller. The second stage consisted of removing the 4th mill to the 'B' tandem where it became the 1st mill, while a 4th (press) roller was installed on all the remaining mills of the now 5-mill 'A' tandem. A Zanini-Tongaat shredder with a quick-release knife set was also installed for the 'B' tandem, all five mills of which also received a 4th roller. Comparison of data for 1981 and 1984 show that, despite a rise in cane fibre content from 12.20 to 13.06%, the modifications to the 'A' tandem led to increase in the crushing rate from 400 to 503 tch, in the % open cells from 70 to 92.5 and in pol extraction from 92.98 to 96.80%, while bagasse pol fell from 3.00 to 1.60%. Details are also given of the automatic cane feeding system and of the cane conveyor and turbine speed controls.

Utilization of a computer system in the control and increase in productivity of industrial units

M. M. Silva, L. M. Silva and R. A. Cardoso. *Brasil Açuc.*, 1984, **102**, (1), 8-10, 12-13; (2), 16, 18 *(Portuguese)*.

Application of microcomputers to process control in Brazilian sugar factory/distilleries has given an increase of 12.3% in cane crushed and 2.7% in extraction. In South Africa their application to crystallization has been given a 50% increase in sugar production in 10% less time. Open- and closed-loop systems of automatic control are illustrated and basic characteristics of a closed-loop system described. A diagram illustrates the hierarchical levels of a process control and automation system, and the advantages of the DDCS (Distributed Digital Control System) in industrial processes — particularly in the sugar and alcohol industries — are discussed. As the first of a series to be published, an illustrated account is given of a system of mill feeding.

The varietal solution to milling and clarification problems

J. T. Rao and K. C. Rao. *SISSTA Sugar J.*, 1984, **10**, (3), 4 pp.

The lack of attention to the processing quality of cane varieties in India is indicated, and references are made to the literature on cane fibre content and its effect on mill performance and to the effects of cane juice constituents on clarification. The authors call for greater attention on the part of the breeder to the needs of the processor so as to overcome problems encountered in Indian sugar factories.

Modern milling technology

R. Nandagopal. *SISSTA Sugar J.*, 1984, **10**, (3), 4 pp.

The Chief Sugar Engineer of Tamil Nadu Sugar Corporation discusses various aspects of cane milling and indicates a number of modifications that have led to increased extraction and throughput and reduced both power consumption and bagasse sugar.

The condensation system in a sugar factory

R. B. Khare. *Indian Sugar*, 1984, **34**, 657-660.

A vacuum system for the evaporator and pan stations is described which is based on rain-type condensers with individual or common water pumps. Advice is given on suitable arrangement of the system components, and the rated horsepower of the motors for the pumps and cooling tower fans is indicated.

Beet sugar manufacture

Yugoslavian models of continuous crystallization vessels for 1st massecuite boiling

S. Susic and V. Sinobad. *Zuckerind.*, 1985, **110**, 115-122 (*German*).

The design principles of a continuous boiling system developed in Yugoslavia are explained and a model described in which standard liquor, pre-evaporated in a single vessel from 65 to 80°Bx and in a slightly supersaturated state, is concentrated to a required Brix at 80°C in five compartments in series, and is then crystallized in the last three compartments at 80°C; the use of rotary calandrias in these last three permits a reduction in the space occupied by the calandrias and hence a greater space available for crystallization. Since the same amount of water is evaporated in each of the first five compartments, vacuum control as a function of Brix is possible. Four possible variants of the system are suggested: one in which the overall height and length of all eight compartments are the same but the widths of the first five compartments differ (and hence their working volumes), while the dimensions of the last three compartments are identical, and three forms of a cascade arrangement. All the dimensions are calculated on the basis of 1000 tonnes of 65°Bx standard liquor per day.

Juice purification with supplementary aeration during main liming under factory conditions

B. Wnuk. *Gaz. Cukr.*, 1984, **92**, 151-155 (*Polish*).

Experimental injection of air into juice undergoing main liming at three sugar factories reduced the invert and colour content of thin and thick juice substantially and gave a white sugar of lower colour than with conventional juice purification. Best results were given by 0.9 m^3 of air per m^3 of juice, typically reducing the juice invert by 40% and colour by 20%.

Modernization of the heat economy at Chelmza sugar factory

H. Cyrklaff, W. Ciechonski, W. Lekawski and K. Urbaniec. *Gaz. Cukr.*, 1984, **92**, 156-157 (*Polish*).

The fuel and steam consumption and capital costs of five variants of an evaporator scheme are discussed, and some modifications made to the quadruple-effect evaporator at Chelmza are described, including increase in the total heating surface area and changes to the steam line and juice feed arrangements. As a result of the changes, juice could be evaporated to a 5-8° higher Brix and the evaporator steam consumption reduced, while the fuel consumption throughout the factory was reduced from 55.2 to 50.7 kg per 100 kg sugar produced.

An outline scheme for improving the current waste water disposal at sugar factories

Z. Zareba. *Gaz. Cukr.*, 1984, **92**, 157-159 (*Polish*).

In recent years there has been a noticeable increase in surface water pollution in Poland. Since the sugar industry is regarded as one of the main culprits, measures to improve effluent disposal are needed, and some suggested means are described.

Assumptions and project guidelines for model industrial storage of sugar beet

J. Malec. *Gaz. Cukr.*, 1984, **92**, 164-166 (*Polish*).

Advice on beet storage at factories includes ensuring that there are sufficient beets at any one time to guarantee 20-30 days' processing, and maintaining forced ventilation of the piles with approx. 40 m^3 of air per tonne of beet/hr at a temperature that will keep the R.H. within the pile at 95-96%. The air flow between individual beets should be in the range 0.08-0.25 m/sec.

The principles of correct filtration of carbonatation juice as a function of the type of equipment used. I. Tray-type settler and vacuum filter arrangement. II. Batch thickeners with vacuum filters. III. Continuous thickeners with vacuum filters

I. Oglaza and E. Walerianczyk. *Gaz. Cukr.*, 1984, **92**, 175-176, 176-177, 177-178 (*Polish*).

I. Measures to improve juice settling and reduce the quantity of mud in clear juice so as to avoid filtration problems are discussed, and a scheme is recommended in which flocculant is added to the 1st carbonatation juice before the settler, the clear juice from which goes to an intermediate tank where it is continuously mixed with 2nd carbonatation mud suspension and filtrate from the 1st carbonatation mud filters. From the tank, the mixture passes to a supplementary precoat filter, the mud from which is added to that from the settler and treated by vacuum filters. The main advantage of the system is elimination of colloids which would otherwise cause a rise in the lime salts content in 2nd carbonatation juice and in the colour of thin juice and white sugar.
II. The advantages of filter-thickeners over settlers are indicated, and reference is made to the failure of the first thickeners used in Poland to achieve the same mud consistency as in settlers. A scheme is described, with the aid of a diagram, in which 1st carbonatation juice is fed via a heater to a header tank where flocculant is added before the batch filter-thickeners. Check rings on the clear juice outlet pipe help to maintain a mud concentration similar to that from a settler, reduce filter cloth wear and the frequency of cloth washing, regulate

the work of the filter station and increase the specific filtration efficiency.
III. The benefits of continuous filter-thickeners are listed, and the main problem of inadequate juice flow through the elements is examined; the use of check rings between each element and the juice collector is suggested. The positive effect of these on the performances of 2nd carbonatation juice thickeners is indicated.

Improved means of filtering dense fluids

I. Oglaza and E. Walerianczyk. *Gaz. Cukr.*, 1984, **92**, 178-179 (*Polish*).

Problems encountered with low-pressure bag filters used hitherto for thick juice and syrups are listed, and difficulties in developing the right type of filter to handle high-density solutions indicated. The advantages of plate-type filters, particularly for mud sweetening-off, are set out, and a cycle for 2nd carbonatation juice treatment is described with the aid of a diagram.

Notes from a visit to Swedish sugar factories

K. Duffek and M. Svejka. *Listy Cukr.*, 1985, **101**, 38-45 (*Czech*).

An outline is presented of the Swedish sugar industry, beet agronomy and operations and equipment at Örtofta sugar factory.

Thick juice storage as an economically effective alternative for the sugar factory as verified in practice

E. Walerianczyk. *Gaz. Cukr.*, 1984, **92**, 181-185 *(Polish)*.

Although investigations of thick juice storage conducted some years ago in Poland had shown that the practice was not economically beneficial, one new factory (Ropczyce) was built with provision for it, and did show that it could be of advantage. With subsequent radical changes within the Polish sugar industry, the need was felt to re-examine thick juice storage as a means of stabilizing factory operation and sugar production. The results achieved in various countries using thick juice storage are used to demonstrate its advantages, and investigations at three Polish sugar factories and the results obtained are used as basis for a number of recommendations.

Thick juice storage at Ropczyce sugar factory

J. Cieslak and E. Walerianczyk. *Gaz. Cukr.*, 1984, **92**, 186-189 *(Polish)*.

Details are given of experience at Ropczyce in storage and processing of thick juice over four campaigns. Changes made to the scheme for pre- and post-storage treatment of the juice in 1982/83 are indicated, and the campaign performance of the factory processing beet followed by thick juice in 1982/83 and 1983/84 is discussed. During the last campaign, there were practically no major problems in the treatment of over 35,000 tonnes of thick juice, but omission of precise adjustment of the juice pH on the alkaline side before storage led to crystallization of some of the juice in the tanks. A brief outline is given of laboratory and microbiological control parameters that are regularly checked.

Temporary thick juice storage as a factor stimulating greater use of the capacity of the beet end and boiling house

E. Walerianczyk and J. Cieslak. *Gaz. Cukr.*, 1984, **92**, 189-192 *(Polish)*.

Where a factory processes beet at an approximately constant daily rate, increase in juice purity can lead to increase in the load on the boiling house with attendant problems. However, as the authors indicate, short-term storage of thick juice can be of value in acting as a buffer, and experience at Ropczyce factory is used as basis for advice on both storage and processing of the juice.

A test to evaluate the potential economic benefits obtainable by a sugar factory storing some of its thick juice

E. Walerianczyk, I. Oglaza and J. Cieslak. *Gaz. Cukr.*, 1984, **92**, 192-194 *(Polish)*.

Results obtained in the 1982/83 and 1983/84 campaigns at two neighbouring factories are compared. Whereas one (factory P) operated for a total of 115 and 131 days in the two campaigns without use of thick juice storage, it processed only approx. 301,500 and 356,000 tonnes of beet compared with 402,000 and 508,000 tonnes at the other factory (Ropczyce), which stored some of its thick juice and processed beet during a campaign of 75 and 83 days; moreover, sugar yield at factory P was lower (because of higher losses) than at Ropczyce. The authors calculate the extra amount of sugar that could have been produced at factory P if it too had stored thick juice, assuming the same level of losses as at Ropczyce. Despite the fact that the climatic conditions during the 1983/84 campaign were relatively favourable, the results highlight the need to shorten campaigns by storing thick juice for later processing.

Microbiological problems occurring during thick juice storage and processing

E. Walerianczyk. *Gaz. Cukr.*, 1984, **92**, 194-201 *(Polish)*.

Detailed accounts are given of the bacteriological conditions in thick juice storage and processing at Ropczyce, where the technique was introduced in 1980/81. Tabulated data referring to 1981/82, 1982/83 and 1983/84 campaigns show the numbers of mesophiles, osmophiles and sporulating aerobic and anaerobic thermophiles as well as the Brix and pH as determined on specific dates, and some indication is also given of the average ash content and reducing matter in juice fed to each of the four tanks in 1982/83. Each tank was sprayed with formalin before receiving the juice, and this treatment was also carried out whenever the bacterial counts justified it. In some cases mould was discovered. The worst conditions in 1983/84 were found in the last of the four tanks to be filled with juice; the presence of considerable amounts of mould was attributed to failure to disinfect the tank and to seepage and ingress of air through the bottom manhole. The juice from the other tanks was in a very good state of preservation when reclaimed. A number of recommendations are made, including suitable pre-treatment of tanks and piping and of the juice to be stored, as well as installation of air filters on the tanks.

Plant for anaerobic treatment of waste water at the Offstein sugar factory of Süddeutsche Zucker-AG

C. Nähle, R. Nicol and W. M. Haver. *Sucr. Franç.*, 1985, **126**, 83-87 *(French).*

Details are given of the Degrémont system for anaerobic treatment of waste water at Offstein factory in West Germany which started operations in the 1983/84 campaign. Besides processing beet, the factory also manufactures liquid sugar throughout the year; the waste water plant is intended to treat a 10:1 flume-wash water:liquid sugar waste water mixture during the campaign, and a 5:1 mixture during the post-campaign period at hourly rates of 160 and 50 m^3, respectively. The unit consists of a digestion tank and a settling tank/thickener, with a degasser (equipped with stirrer) between the two tanks. Results showed an average 95% reduction in COD (compared with a guaranteed reduction of 90%) despite a nominal daily load of 11 kg COD/m^3 which was 20% higher than usual for this type of digester; gas production was 0.4 m^3/kg COD eliminated, at a methane content of 76-81%. The calcium carbonate content of the untreated waste water rose from approx. 500 to 1350 mg/litre as the campaign progressed (liming of wash water being a typical practice in West Germany). A continuous counter-current cylindro-conical centrifuge was tested on separation of the $CaCO_3$ precipitate from the settled mud; results showed an organic matter loss in the sediment of only 16-17%, the balance remaining in the liquid fraction recycled to the digester.

Experience in preparing milk-of-lime at Teofipol'skii sugar factory

M. P. Spivak, V. F. Bereznii and Yu. V. Anikeev. *Sakhar. Prom.*, 1985, (3), 22-23 *(Russian).*

A description and diagram are given of the milk-of-lime preparation and purification system; the efficiency of mechanical impurities removal is such that there is no need for stoppages to clean the screens in the 1st and 2nd carbonatation vessels.

Raising the raw juice purification efficiency with pre-carbonatation

O. V. Moroz, A. A. Lipets and D. M. Korilkevich. *Sakhar. Prom.*, 1985, (3), 23-25 *(Russian).*

Pre-carbonatation of raw juice mixed with filter cake utilizes the adsorptive properties of the $CaCO_3$ to form conglomerates with non-sugars; tabulated data demonstrate the benefits in the form of reductions in sulphitation juice and thick juice lime salts, colloids, nitrogen and reducing matter and a rise in purity by comparison with the system previously used at Ivanichevskii factory. Optimum pre-carbonatation conditions are 55-60°C and pH 11.2-11.6. The juice and filter cake are mixed in the feedline before the pre-carbonatation vessel to pH_{20} 8.5-9.0; a warning is given about the risk to flow of conglomerates formed in the feedline from colloids, compounds of high M.W. and $CaCO_3$ at this pH level.

Coagulation of albumins and their degradation products in preliming

L. P. Reva, G. A. Simakhina and V. M. Logvin. *Sakhar. Prom.*, 1985, (3), 25-27 *(Russian).*

Investigations showed that coagulation of albumins and their degradation products during preliming at 60°C occurred at a maximum rate in the first minute, after which it decelerated and became almost constant after 6 minutes. Only about 50% of the degradation products was coagulated, compared with 80-83% of the non-degraded albumins, molecular weight being the chief determinant. While some authors describe the coagulation as a single-stage, monomolecular first-order reaction, others consider the process as a series of reactions following different paths at different stages.

Dissolving *C*-sugar in the basket of a centrifugal

A. I. Gromkovskii and N. P. Mazaev. *Sakhar. Prom.*, 1985, (3), 27-31 *(Russian).*

Increasing remelt concentration reduces the amount of steam needed to evaporate the water in juice normally used for melting *C*-sugar, but makes the process unduly long. Increasing the rate of movement of the juice or syrup relative to the crystals would solve the problem. After laboratory investigations of the dissolution of sugar in a stationary layer in a special unit simulating a centrifugal, the results were statistically evaluated and an equation obtained for calculation of the rate of solution as a function of temperature and solvent concentration, and the spinning time required for a basket charge of 650 and 1000 kg was calculated. Factory tests were then carried out, results of which were in satisfactory agreement with the calculated values and which demonstrated the advantages of using a centrifugal as melter.

The effectiveness of microwave heating of low-grade massecuite

L. I. Trebin, V. V. Mank, L. A. Kupchik, V. Ya. Adamenko and A. P. Lapin. *Sakhar. Prom.*, 1985, (3), 31-33 *(Russian).*

Experimental microwave reheating of artificial massecuite of 30% crystal content is reported. Results showed that raising the temperature from 40° to 65°C at a rate controlled by voltage regulation during a period up to 9 minutes was accompanied by such a slow rate of dissolution of the crystals (in the size range 0.16-0.25 mm) that there was no change in Brix or purity, while there was a drop in viscosity from 4.45 to 1.02 Pa/sec and a marked increase in centrifugal productivity. There was also an increase in sugar yield as a result of increased molasses exhaustion, and the value of the extra sugar outweighed the costs of the electricity involved in reheating. Increase in the heating time to 16 or 20 minutes caused a slight rise in mother liquor purity, while reheating to a temperature above 65°C was less effective (at 70°C foaming took place and adversely affected centrifugal performance).

Rational use of secondary resources at a sugar factory

Z. S. Voloshin, A. I. Kochubei and A. N. Nikolaenko. *Sakhar. Prom.*, 1985, (3), 33-35 *(Russian).*

Details are given of a proposed scheme for recovery of CO_2 and SO_2 from boiler flue gases for use in carbonatation and sulphitation, and of preparation of milk-of-lime from kiln waste.

Treatment of floto-condensate from waste water flotation at beet sugar factories

V. V. Sakhnenko and V. V. Stetsenko. *Sakhar. Prom.*, 1985, (3), 35-37 *(Russian).*

Laboratory and factory-scale experiments are reported in which the foam resulting from waste water flotation was quenched and the mineral and organic impurities (including surfactants such as saponin) removed by precipitation with milk-of-lime added at the rate of 1660-2300 mg CaO/litre. Precipitation was fastest during the first 30 minutes, and coagulation was best at pH 10.8-12.8. The treatment caused a marked fall in BOD_{20}, COD, saponin and suspended matter, the pH rose from 7.8 to 11.9 and the water changed from black to colourless.

Holly Sugar Corporation's capital improvement program

L. L. Neville. *Sugar y Azúcar,* 1985, **80,** (2), 49, 52.

Details are given of projects undertaken over three years at beet sugar factories of Holly Sugar Corporation, including upgrading of evaporators to quintuple-effect systems (resulting in 18% reduction in boiler fuel consumption apart from increase in evaporation capacity), installation of more efficient horizontal pulp presses (leading to a 36% reduction in dryer fuel consumption), various other fuel conservation measures, solar drying of pressed pulp, conversion of boilers from natural gas to coal firing, installation of stirrers in vacuum pans and of prelimers (giving exceptionally good colour removal and permitting much higher daily sugar production), installation of additional crystallizers, and construction of a larger lime kiln at one factory.

Pre-cooling and deep-freezing sugar beets

S. Bass. *Sugar y Azúcar,* 1985, **80,** (2), 53, 55.

American Crystal Sugar Co. operates five beet sugar factories in Minnesota and North Dakota, where the winters are long and cold, so that harvesting must be carried out in October and much of the crop stored for relatively long periods. After favourable results were obtained with forced ventilation using above-ground ducts, these were installed at four factories; fans are run periodically to cool the beet piles whenever ambient temperatures are below the pile temperature but above freezing. In early December, when the ambient temperature has dropped to zero degrees or lower, the fans operate continuously until the entire pile is frozen; these beets are the last to be processed. Permanent covered storage facilities with underground ducting is now planned for all five factories, and already Moorhead factory has been provided with two, each having a capacity of 50,000 short tons of beet. The facilities, intended for long-term storage of beets from a crop of above-normal yield, is provided with means for more precise control of air mixtures and with automatic controls for timing of ventilation periods. Concrete side walls 18 ft high support an insulated ceiling, and louvres in the end walls allow warm air to escape from the piles. The beets are piled to a height of 30 ft in the centre of the building. Beets piled at 50°F in mid-October in 1984 were completely frozen by December.

Application of the Enviro-Clear clarifier for Steffen heated cold filtrate

O. Bonney and J. Thomas. *J. Amer. Soc. Sugar Beet Tech.*, 1983, **22,** 155-169.

Details are given of the Enviro-Clear bottom-feed clarifier installed at the Woodland factory of Spreckels Sugar Division to treat heated Steffen filtrate. Preliminary results showed that the suspended solids content in the underflow was much greater and that in the overflow lower than obtained with the 3-tray Dorr clarifier which the system replaced, although the sugar content of the overflow was also slightly lower. Settling aid was added at about 0.5 ppm on clarifier feed. Other advantages include easier and less costly maintenance as well as improved filtration of the underflow, allowing a reduction in the number of filters in operation. Scale formation is a problem, but modifications already made are expected to extend the time between clarifier cleanings, and minor modifications to be made will minimize scaling of the overflow weir and overflow box.

Determination of pressure loss due to friction during water flow in a smooth pipeline—pipeline dimensioning

P. Hoffman. *Listy Cukr.*, 1985, **101**, 51-57 *(Czech).*

Equations and nomograms are presented for calculation of pressure loss due to friction in the case of water flowing in a pipeline system including a pump. The nomograms are valid for pipelines of 10-1600 mm i.d., a delivery of 0.1-10,000 m^3/hr, a temperature up to 100°C, a flow velocity of 0.1-10.0 m/sec and a relative pipe roughness up to 0.06 mm per mm pipe diameter.

A line for invert syrup at the experimental sugar factory of the Sugar Industry Research & Development Foundation, Praha Modrany

I. Havránek and D. Lingerová. *Listy Cukr.*, 1985, **101**, 62-72 *(Czech).*

Details are given of the equipment and batch process used for the experimental manufacture of invert syrup at the rate of 2 tonnes/hr.

Selected manufacturing problems arising from quality of the raw material

A. Król. *Gaz. Cukr.*, 1984, **92**, 211-212 *(Polish).*

The effects of fluctuations in beet quality and physical properties on processing are discussed, and the problems of preparing for unexpected changes indicated. The distorting effect of climatic conditions is demonstrated in the case of a rise in pol occasioned by dry weather but where the final sugar output was lower than in other years in which the average pol was lower; during processing the juice pol fell markedly and colour and lime salts rose.

Possibilities of optimizing the sugar campaign by computer simulation

B. Lasocki. *Gaz. Cukr.*, 1984, **92**, 213-216 *(Polish).*

The possible application of computer simulation to optimizing the campaign length, using cost or production criteria as bases, is discussed, and the fundamentals of a program explained which tested six variants, each of which was subdivided into four versions characterized by a different campaign starting date. Variant 1 was based on an actual campaign (that of 1981/82), Variant 2 assumed a low beet sugar content, Variants 3 and 4 were based on increasing pol in beet as delivered (Variant 4 assuming a deficiency in factory slicing capacity), Variant 5 described the progress of the campaign in the case of an approximate 10% rise in the overall slicing capacity of the industry, while Variant 6 indicated the position where a small quantity of beets of high sugar content is processed and the slicing capacity remains constant.

Automatic control of the evaporator station

J. C. Giorgi, P. Giraud and A. Deleurence. *Sucr. Franç.*, 1985, **126**, 123-128 *(French).*

Details are given of the modular control system used at Bucy-le-Long on the sextuple-effect climbing-film evaporator. Based on a Solar computer operating on real time, the system was designed to maintain a constant Brix in the final effect and a relatively constant steam consumption while permitting operational flexibility. Pressure in the 1st effect is regulated as a function of that in the 5th effect, while the pressure in the last two effects is kept below a set limit (condensers being used to bleed off vapour should the limit be exceeded). The amount of juice fed to the 4th effect (or removed from it if necessary) is controlled as a function of the Brix at discharge from this effect. The evaporation capacity is controlled by means of bypass valves at the 5th and 6th effects or by means of the 6th effect condenser as a function of factory processing rate and boiling house output. Trials revealed problems associated with sharp fluctuations in juice levels such as with the start of a new strike and the corresponding sudden demand for thick juice, and a new control module was therefore considered necessary so as to prevent rapid opening of the control valves. Absence of regular bleeding of 6th effect vapour for diffuser heating was also encountered. However, the control system operated satisfactorily in other respects, and Brix was maintained within ±1.5° by the end of the campaign.

Automation of continuous diffusers by the IRIS system

G. Windal, B. Portalès and D. Maès. *Sucr. Franç.*, 1985, **126**, 145-149 *(French).*

Aspects of continuous automatic diffuser control by computer at Seclin and Brugelette factories are briefly discussed. While there are differences in the control means between the two factories, the principle is the same, namely regulation of water feed in proportion to the cossettes feed. Despite some minor technical problems encountered in trials, the systems have given very good results, with smoothness of diffuser operation better than with manual control, increased sugar extraction and energy savings.

Sugar refining

The use of IR radiation to dry pressed refined sugar

A. F. Zaborsin and A. R. Kazimirov. *Sakhar. Prom.*, 1985, (1), 26-28 *(Russian)*.

The performances and energy consumption of five different types of dryer used for pressed sugar were evaluated, and tabulated results are compared. For various reasons, each of the systems is regarded as failing to meet requirements. Of the two that combine pressing, drying and packeting, the Chambon unit is preferred; however, while it is technologically advanced, its major drawback is the relatively low efficiency in terms of power usage and correspondingly high specific energy consumption. Excessive energy consumption is also the chief snag with the Combiner-6 infra-red system, but investigations of drying kinetics have led to expectations of a substantial reduction in energy usage under optimum conditions, which would make the unit highly economical.

From sugar cane quality to raw sugar acceptability

J. C. P. Chen. *Sugarland,* 1984, **21,** (1, 2, 3), 8, 10, 12-18.

See Chen: *I.S.J.,* 1984, **86,** 54.

Godchaux-Henderson installs new packaging system

Anon. *Sugar y Azúcar,* 1984, **79,** (12), 23, 26-27.

See *I.S.J.,* 1984, **86,** 303-306.

Energy savings at Tirlemont refinery

M. Braeckman. *Zuckerind.,* 1985, **110,** 220-222.

Measures aimed at reducing the energy consumption at Tirlemont refinery in Belgium are outlined, including use of a high degree of automation for the boiling house operations, the use of pan vapours to heat syrup and thick juice and concentration of low-Brix syrups, e.g. after resin decolorization, to at least 73°Bx, recovery of heat from the low-grade vertical crystallizer, reduction in the amount of syrup in circulation, omission of sugar melting, the use of resin instead of bone char for decolorization, and boiling on thick juice and *B*-syrup. Comparison of the new scheme with the previous one shows a reduction in fuel consumption from 37% to 14% on white sugar within a period of only five years. (See also Braeckman: *I.S.J.,* 1984, **86,** 54.)

New resin decolorization station at Finnish Sugar Porkkala refinery

L. Ramm-Schmidt and G. Hyöky. *Sugar J.,* 1985, **47,** (9), 14-19.

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

Elimination of high-molecular impurities in refined cane sugar by ultrafiltration and influence of the impurities on the permeation flux

S. Kishihara, S. Fujii and M. Komoto. *Maku,* 1983, **8,** (6), 371-374; through *S.I.A.,* 1985, **47,** Abs. 85-385.

Commercial refined cane sugars still contain very small amounts of high-molecular weight impurities: substances insoluble in acidified ethanol (AEIS), mainly polysaccharides, as well as substances causing turbidity. The AEIS contents of two Japanese granulated sugars, one coarse crystal sugar, two rock candies and two "guaranteed sucroses" (from chemical manufacturers) ranged from 51 to 238 ppm. Ultrafiltration through PM-10 membrane decreased the AEIS contents to 20 ppm or less, and also improved the turbidity index. The flux decreased by up to 40% during ultrafiltration of the original 10°Bx sugar solutions, but decreased very little during a second ultrafiltration, indicating that the high-molecular weight impurities blocked the pores of the membrane. The content of these impurities can be roughly estimated from the decrease in flux. Reverse osmosis through a RM-15S membrane satisfactorily removed the impurities.

Purification of syrups from cane raw sugar in an electric field

V. V. Mank, M. P. Kupchik, J. Castellanos, R. Fajardo G. and L. D. Bobrovnik. *Sakhar. Prom.,* 1985, (4), 22-23 (*Russian*).

In tests on syrup treatment by electrofiltration, a triple cell was used comprising one working and two electrode compartments separated from one another by neutral (inert) membranes. Platinum electrodes were used and the electrode compartments were filled with distilled water, while the middle compartment was filled with specially prepared bagasse to act as ion exchanger[1]. Refinery syrup containing between 30 and 60% sucrose was fed into the working compartment, and a constant voltage in the range 80-160 V applied to the electrodes for a given time in the range 5-50 min, after which the colour and dispersed colloid contents were determined. The relationship between concentration and decolorization was of a complex nature; decolorization efficiencies with 30 minutes' treatment were 65.3, 47.1, 61.2 and 45.0% at concentrations of 30, 40, 50 and 60%, respectively. The fluctuation corresponding to the first two changes in concentration was attributed to the change in conductivity of the solution, which had a considerable effect on the electric field in the bagasse; the fall in decolorization with the last rise in concentration was related to a sharp rise in viscosity which inhibited settling of the impurity particles on the bagasse surface. Tabulated data also demonstrate the marked effect of the field voltage on treatment, the best results being obtained at 125 V (for 37.5 minutes), after which there was a gradual fall in efficiency with further voltage increase.

1 Rusek: *I.S.J.,* 1972, **74,** 315.

Laboratory studies

Dextran hydrolysis with dextranase

L. A. Sapronova and A. B. Luk'yanov. *Sakhar. Prom.*, 1985, (1), 31-32 *(Russian).*

Pure dextranase of West German origin and having an activity of 40 international units per mg was found, in tests on 60% sucrose solutions containing 0.5% pure dextran, to have maximum activity at pH 3.5-5.5 and a temperature of 45-55°C. Subsequent experiments involved adding 0.28 units/ml of the enzyme to a 51% syrup of low filtrability prepared from white sugar; this was held for 1 hr at pH 5.5 and 50°C. The viscosity, initially 16% higher than that of pure sucrose solution, fell almost to the latter's level and filtrability rose as a result of the treatment. Further studies of the kinetics of dextran hydrolysis showed that within 40 minutes the viscosity of a 60% solution containing 0.5% dextran fell to that of a pure solution under the effect of 0.7% dextranase (w/v).

The viscosity of sugar solutions as a function of purity

V. S. Shterman, L. A. Sapronova and V. I. Smagina. *Sakhar. Prom.*, 1985, (2), 23-25 *(Russian).*

An experimental investigation of the effects of dry solids content, temperature and purity on sugar solution viscosity was followed by mathematical generalization of the results, equations being derived for log viscosity in terms of temperature, sugar and non-sugars molar concentration at constant dry solids. The equations are valid for dry solids of 75-82%, a temperature range of 20-80°C and a purity of 60-92 (data from other sources covering the range up to 100 were used, since the upper limit was reduced in the studies so as to avoid nucleation in supersaturated solutions at low temperatures). A correlation coefficient of 0.988 was established between the experimental and calculated values. Increase in non-sugars was found to cause a slower rise in viscosity than a comparable increase in sugar content—a 1% rise in dry solids caused by non-sugars was equivalent to a 0.6-0.7% increase in viscosity caused by increased sugar. The smaller effect of non-sugars (apart from compounds of high M.W.) is attributed to hydration of sucrose molecules in dilute solutions and increase in sucrose molecular interaction.

Determination of the water content in crystal sugar

J. Copikova, D. Matejova, F. Kvasnicka and H. Bacavcikova. *Listy Cukr.*, 1985, **101**, 25-28 *(Czech).*

Comparative tests were conducted on moisture determination in white sugar by five methods. In one series, samples had been stored in a desiccator at various relative humidities, while in another the samples were taken after a fluidized-bed dryer or after the centrifugal station. Each method had its disadvantages. Drying in a desiccator over silica gel for 21 days gave higher values than drying in an oven for 1½ or 3 hours at 105°C, but all three methods determined only some of the water, particularly that adhering to the outside of the crystal. The Karl Fischer method, while giving higher values than the drying methods, has the drawbacks of necessitating unpleasant working with the reagent and of tedious preparation of anhydrous formamide, which is highly hygroscopic. A special automatic titration system avoids these problems, but is suitable only for a large number of samples. GLC was the fifth method tested; it is highly suitable, but not every laboratory has the required equipment.

The application of high-pressure liquid chromatography for process control

J. Tannock. *Sugar J.*, 1985, **47**, (8), 21-25.

See *I.S.J.*, 1985, **87**, 86A.

Energy of the hydrogen bond in crystal sucrose

L. G. Belostotskii, A. E. Arkhipets, R. Ts. Mishchuk and L. P. Reva. *Izv. Vuzov, Pishch. Tekhnol.*, 1984, (6), 20-22 *(Russian).*

The energy of the hydrogen bonds in the crystal lattice of sucrose is of importance in a study of crystallization and dissolution processes; however, investigation of hydrogen bonds in carbohydrates, particularly by infra-red spectroscopy, is faced with a number of difficulties. An infra-red method is described which is based on use of a twin-prism monochromator having a resolving power of 3-4 cm^{-1} and in which the refracting prism may be held at constant temperature. Results revealed six absorption peaks within the range 3000-4000 cm^{-1}, those at 3480, 3430, 3340 and 3250 cm^{-1} corresponding to intermolecular bonds and those at 3580 and 3400 cm^{-1} to intramolecular bonds. The half-width of the absorption bonds increased with strengthening of the bonds; in the case of the associated O-H groups, these half-widths reflected deviation of the crystal structure from the ideal as well as changes taking place during preparation of the sample. The total energy of the hydrogen bonds was found by calculation to be 134.4 kj/mole.

Calcium carbonate solubility in aqueous sugar solutions

N. M. Podgornova, I. F. Bugaenko and V. M. Perelygin. *Izv. Vuzov, Pishch. Tekhnol.*, 1984, (6), 23-26 *(Russian).*

A laboratory unit is described which was designed for studies of $CaCO_3$ solubility in sugar solutions of 5-60% concentration by weight at 80°C. By substituting values found for two constants in an equation for solubility calculation, solubility values were obtained which differed from experimental results by only ±1.82%. The equation is valid for establishing isotherms where the solid in question does not readily dissolve in sugar solutions.

A simple method for measuring glucose and sucrose using immobilized glucose oxidase

M. Polacsek-Racz. *Elelmiszervizsg. Közl.*, 1983, **29**, (3/4), 131-142; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (3), Abs. 3 R406.

A simple, rapid method is described for determining glucose and sucrose (after hydrolysis with invertase) using immobilized glucose oxidase.

Sucrose solubility in technical sugar solutions

P. Kadlec, Z. Bubnik and M. Winterova. *Listy Cukr.*, 1985, **101**, 57-62 *(Czech)*.

Comparative tests were conducted on solubility determination in beet and cane molasses using two methods based on exhaustion measurement: the Polish test of Wagnerowski *et al.* and a method involving use of a crystallizer consisting of a thermostatically-controlled water bath in which flasks containing the samples rotated at a given speed. For the Polish test, two different types of mixer were used in the vessels. Results showed close agreement between the two methods for Czechoslovakian molasses at 40, 60 and 80°C (each sample comprising 300 g of molasses and 170 g of sugar crystals), while the curve for cane molasses was virtually a continuation of the two mean curves (very close together) for the Czechoslovakian molasses; the curves for French molasses samples were markedly different from those of the Czechoslovakian molasses, a probable result of differences in non-sugars composition and content. Since the Polish test is much more rapid than the other method, it is preferred; moreover, it can be carried out in the same type of laboratory crystallizer as normally available, so that there is no need for new equipment. An empirical equation valid for solubility (S) determination at 40-80°C and purities of 60-100 takes the form: $S = S_0 . \exp [4.107 \times 10^{-3} - 7.64 \times 10^{-6} t)(100 - Q)]$, where S_0 = sugar content of a saturated pure solution, t = temperature and Q = purity.

Colouring matter in the sucrose crystal

G. Mantovani, G. Vaccari, G. Sgualdino, D. Aquilano and M. Rubbo. *Ind. Sacc. Ital.*, 1985, **78**, 7-14 *(Italian)*.

The literature on colorants and colour formation in sugar is reviewed, and experiments reported in which single crystals were grown during continuous stirring at temperatures in the range 25-60°C in the presence of two specially prepared melanoidins, a caramel, normal factory molasses and methylene blue. Colour photographs illustrate the inclusion of the various colorants at varying supersaturation, temperature and stirrer speed. It was found that the possible location of a colorant in the crystal was a function of the type of crystal face and of the crystal growth conditions. The use of methylene blue in the experiments confirmed the absence of selectivity in crystal colour inclusion, since it was included despite the fact that its molecular structure does not allow formation of hydrogen bonds characteristic of the sucrose crystal. The crystal formation kinetics were also found to be of considerable significance with regard to coloration; growth at a sufficiently low rate would allow a colourless crystal to form even in a highly coloured solution. Crystallization under factory conditions at a relatively low supersaturation to give colourless crystals would be somewhat prolonged, but this could be balanced against the lack of need for recrystallization to remove crystal impurities. Discrepancies in the results obtained by different authors in experiments on crystal coloration are attributed to differences in test conditions.

Sugar determination in pulp

P. Devillers and J. P. Lescure. *Sucr. Franç.*, 1985, **126**, 129-131 *(French)*.

Two methods currently used to determine the sugar content in beet pulp involve (i) pressing of the pulp and analysis of the extracted water by polarimetry (however, there is no proof that the sugar content in the extracted water is the same as that in the water remaining in the pulp), and (ii) mixing 40 g of pulp with 369 ml of water, clarifying with subacetate and polarimetry (of insufficient sensitivity in view of the low polarimeter reading). However, a new proposed method is based on enzymatic determination of the sucrose in the filtrate obtained from the mixture of 40 g pulp and 369 ml water; an auto-analyser is suitable, or the Boehringer manual method may be used. Comparison showed that the sugar content in the pulp was generally lower than that in the press water. Correlation between the two was examined, and the suitability of various correction formulae tested. However, it is concluded that it is not really possible to derive an accurate prediction of pulp sugar content from that in the press water, since pressing has two contradictory effects: the pulp contains some marc which has no sugar, so that the sugar content must be calculated from the liquid component; however, the centre of the pulp will be richer in sugar than at the periphery, since the sugar has further to travel to be discharged into the liquid during pressing, so that pressing will produce mainly this sugar-poor liquid. This phenomenon is particularly marked in the case of very large cossettes, and the difference between pulp sugar and that in the water may be even greater.

By-products

Sorbitol production by *Zymomonas mobilis*

K. D. Barrow *et al. Appl. Microbiology and Biotechnol.*, 1984, **20**, (4), 225-232; through *S.I.A.*, 1985, **47**, Abs. 85-0213.

Sucrose or (glucose + fructose) solutions were fermented to ethanol by *Z. mobilis.* This bacterium produced significant amounts of sorbitol, up to 43 g/litre for strain ZM31 when grown in a 250 g/litre sucrose solution. The formation of sorbitol and the decrease in glucose, fructose or sucrose were monitored by NMR and HPLC during batch fermentations. Tests with labelled sugars showed that sorbitol was derived only from fructose. The probable mechanism of the reaction is discussed. Attempts to grow *Z. mobilis* on sorbitol were unsuccessful.

Bacterial protein production from sugar cane bagasse pith

O. E. Molina, N. I. Galvez P. and D. A. Callieri. *Acta Científica Venezolana,* 1983, **34**, (1), 59-64; through *S.I.A.*, 1985, **47**, Abs. 85-0224.

A mixed culture of bacteria identified as a strain of *Cellulomonas* sp. and *Bacillus subtilis* was used to produce single-cell protein from bagasse pith. Maximum yield (0.17 g protein/g pith) and output (3.43 g protein/litre) were obtained at 34°C, pH 7.0, with $NaNO_3$ as the N source. The optimum dissolved O_2 concentration, 20%, was obtained by agitation at 400 rpm and 0.15 volumes of air per min. The mixed culture of the two organisms contained 50% crude protein; the lysine content was high (6.4% on protein), and the essential amino-acids fulfilled FAO requirements except for methionine.

Production of volatile fatty acids from bagasse by rumen bacteria

C. H. Matei and M. J. Playne. *Appl. Microbiology and Biotechnol.*, 1984, **20**, (3), 170-175; through *S.I.A.*, 1985, **47**, Abs. 85-0225.

Conditions are described for converting bagasse lignocellulose to volatile fatty acids (VFA's) by anaerobic fermentation. Rumen fluid was used as a source of cellulolytic and hemicellulolytic bacteria. With various pretreatments, yields of VFA's were up to 54% on dry bagasse. The VFA productivities, 0.25-0.65 g/litre/hr were higher than previously achieved with a lignocellulosic substrate, but lower than with sugar substrates. Batch fermentations neared completion after 66 hr.

Prevention of rapid deterioration of sugar cane molasses during storage

S. K. D. Agarwal. *Sugar J.*, 1984, **47**, (7), 13-15.

The Brix and reducing sugars content of molasses stored at a distillery in India were found to have fallen markedly over a short period, and a 4-5 mm layer of fungal growth was discovered which had formed within 7-10 days. Recirculation of the molasses and treatment with an antifoam and an antiseptic prevented further deterioration.

Degradation of lignocellulose

P. L. Ragg. *Paper presented at Symposium on "Potential Impact of Biotechnology upon Agriculture"* (Soc. Chem. Ind., Agric. Group), 1985 (*Abstract only*).

Studies on lignocellulose degradation to provide feedstocks for fermentation and chemical use are reported. While chemical degradation can be achieved with mineral acids, hydrolysis with dilute acids at high temperatures causes dehydration, particularly of the pentose fraction to furans, and so reduces the yield of monosaccharides. Improved yields are obtainable using concentrated acids at lower temperatures and for longer periods, but product isolation and acid recovery are major obstacles to process viability. Although enzymatic methods have the advantages of specificity and mild conditions, they require very long times, and significant problems arise with the dilute product streams (partly a consequence of product inhibition) and the life and re-use of the enzymes. Cellulose, unlike hemicellulose, is present in a substantially crystalline form, and so is the most intractable of the three lignocellulose components (the third being lignin). Investigations to find an efficient method for its conversion to glucose showed that treatment of a 10% concentration (w/w) of cellulose with 6-7M HCl in the presence of saturating concentrations of Li, Ca or Zn chloride at 50-90°C for <30 min gave more than 75% conversion to glucose with only minimal by-product formation. Further studies showed that the $CaCl_2$/HCl combination was preferable; treatment of a number of different substrates with it hydrolysed both the hemicellulose and cellulose. Hemicellulose is preferably removed e.g. with dilute mineral acid before cellulose hyrolysis where relatively pure glucose is required for fermentation purposes. The sugars derived from both process streams have been used successfully as C sources for microbial growth. HCl recovery is facilitated by the presence of the $CaCl_2$, which in turn can be separated from the glucose solution by various techniques including solvent extraction, electrodialysis or crystallization.

Continuous alcoholic fermentation of sugar cane juice in a single vessel on a pilot scale

L. H. Koshimizu, M. R. M. Cruz, E. I. Valdeolivas, C. L. B. Netto, A. C. R. Gonçalves, M. R. de la Iglesia and W. Borzani. *Brasil Açuc.*, 1984, **102**, (1), 14-16, 18-21 (*Portuguese*).

An account is given of studies carried out at the Luiz de Queiroz laboratory where a discontinuous fermentation process was extended by addition of new cane juice and operated continuously for 107 days. During the first 15 days there was fluctation in the fermentation owing to the inhibitory effect of intermittent high alcohol concentrations. Later, the fermentation became stable, although it was affected by poor quality juice obtained by milling stale cane; it was not possible to obtain a steady supply of fresh cane during the experiments. During the first 73 days the yield obtained was 83.3% on total sugars, with a productivity of 4.4 g per litre per hour. After an accidental stop, corresponding figures for the subsequent 7.4 days were 88.8% and 5.7 g/l/hr, respectively. The results are considered sufficiently good as to warrant full-scale trials where better care could be taken of the yeast used.

Time factors in the process of alcoholic fermentation

W. Bozan, M. F. V. de Queiroz and M. L. R. Vairo. *Brasil Açuc.*, 1984, **102**, (1), 41-42 (*Portuguese*).

The time T required to complete a fermentation depends directly on the initial sugars concentration S_0 and is in inverse proportion to the initial concentration of yeast (X_0). By means of experiment, the factor k in the equation $T = kS_0/X_0$ was evaluated as 0.773, but this was found to provide an error averaging 0.72 hr over 44 experiments. The equation was therefore expanded to take into consideration factors related to the effect of alcohol concentration in the must and the "dead time" before fermentation starts.

Informative investigations of the biotechnical use of beet pulp

R. Butzke and W. Mauch. *Zuckerind.*, 1985, **110**, 209-216 (*German*).

A number of biotechnical processes involving beet pulp were examined which would cause little environmental pollution. Almost complete enzymatic hydrolysis of the cellulose and hemicellulose components was achieved using cellulase obtained from *Trichoderma viride* or *Aspergillus niger*, but the quantity of ethanol obtained by fermentation from the hydrolysate was so small as to place doubts on the economic viability of the process in view of the considerable energy consumption. Technically the simplest process was found to be single-stage anaerobic conversion of the cellulose to methane; details are given of a laboratory continuous fermentation unit set up for tests, in which the yield of gas (containing 75-80% methane) rose with fall in particle size of the pulp, the best yield being 265 dm^3/kg dry solids at a particle size of 45 μm. Optimum temperature was 40°C. Large amounts of undigested pulp occurred; at least 20 days would have been necessary for complete digestion (making it difficult to adjust the process to normal sugar factory operations, where the constraint of pulp storage time would permit only 2-6 days' residence in the main fermenter, giving only 50-60% degradation). Even the use of a combined settling and post-digestion system failed to provide a complete answer to the protein (details are given of the original vessel and of a modified form of it), 10% of the material remaining undigested. Activated sludge recycle in batches had no adverse effect on continuous fermentation and allowed enrichment of the methane bacteria. A 3-stage process tested involved pre-fermentation of sugar-containing factory waste water plus some press-water to ethanol and volatile acids parallel with pulp hydrolysis using thermophilic bacteria (*Clostridium thermocellum*) to yield ethanol and acetic acid, and fermentation of the mixed pre-fermentate and hydrolysate to yield methane. After only 20 hours, 54% of the pulp dry solids had been converted to soluble material. Thus, the process demands much less time than the others tested, even in batch form, and a continuous version would give still better results. Moreover, the process is compatible with methods currently used for sugar factory waste water treatment.

Fermentation of molasses wort with *Saccharomyces carlsbergensis* yeasts

V. N. Shvets *et al. Izv. Vuzov, Pishch. Tekhnol.*, 1984, (6), 26-30 (*Russian*).

Experimental alcoholic fermentation of molasses of 80% dry solids content with *S. carlsbergensis* is reported. Although raffinose was completely fermented, the yeast was not as effective as *S. cerevisae* V-30 in regard to sucrose, glucose and fructose fermentation, and gave only half of the biomass obtained with the other yeast. It caused a rise in the acetaldehyde, methyl and ethyl acetate and ethyl propionate contents, and a reduction in *n*-propanol, *iso*-butanol, 2-methyl-l-butanol and 3-methyl-l-butanol. Yeasts obtained from the molasses had a high zymase and maltase activity.

A new concept of heat economy in a beet sugar factory

E. Otorowski. *Gaz. Cukr.*, 1984, **92**, 223-225 (*Polish*).

A proposed scheme is described in which beet pulp is dried in a drum with super-heated steam obtained from flue gases in a heat exchanger located directly before the drum; the steam is fed into the dryer through spray nozzles. After saturation with the vapour from the pulp, the steam passes to multicyclones where it is treated together with hot water at 120°C and some of it then transferred for use in other processes and some recycled to the heat exchanger. The pulp may be pre-dried with vapour from the main dryer or with low-heat steam during passage along a screw conveyor feeding to the main dryer. An approximate heat balance is calculated for the system, and an indication given of the expected fuel consumption.

operator.

Establish grain—by boiling down to an operator-determined resistivity.

Open out—to an operator-determined start feed resistivity.

Feed.

Brix up.

Drop.

Pan supersaturation for the cycle is controlled by resistivity.

Figure 6 illustrates the shock-seeded AP pan cycle in use up to 1981. The principal stages of this cycle are:

Charge—with high and low green syrup to volumes determined by the operator.

Boil down—to an operator-determined resistivity.

Seed—with a small amount of sugar dust.

Establish grain—during which time pan resistivity is allowed to rise to an internally-set point.

Open out—to an operator-determined resistivity.

Feed.

Brix up.

Drop.

Pan supersaturation for the cycle is controlled by resistivity.

Section II

Developments in pan control strategy and sugar end operations, 1981-1984

In 1981 fuel usage reduction was a priority and to this end an "Energy Task Force" was set up at Newark Factory. This was composed of persons from all disciplines and its brief was to identify, quantify and eliminate or minimize energy losses. Table I shows the reduction in energy usage per 100 tonnes of white sugar achieved to date.

Table I. Energy usage 1979-1984

	GJ/100 tonnes white sugar	
Year	*Campaign*	*Refining*
1979/80	1140	726
1980/81	1100	657
1981/82	955	444
1982/83	740	401
1983/84	726	379

This energy saving has required a re-think of sugar end work, and the problems arising and solutions employed are outlined below in chronological order. The effects of the changes discussed on some key operating parameters are shown in Appendix A.

1981/82 Campaign

Standard liquor Brix and pan drinks are clearly the most easily measurable indication of sugar end energy losses and Table II shows the improvements over recent years. The increase in standard liquor Brix had several effects

Table II. Standard liquor Brix and pan drinks 1979-1984

	Standard Liquor Brix		*Pan Drinks m³/100 tonnes white sugar*	
Year	*Campaign*	*Refining*	*Campaign*	*Refining*
1979/80	64.51	67.49	N/A	N/A
1980/81	64.78	66.35	N/A	N/A
1981/82	67.47	71.70	22.01	4.05
1982/83	70.18	72.44	8.24	10.72
1983/84	71.55	71.80	6.42	7.55

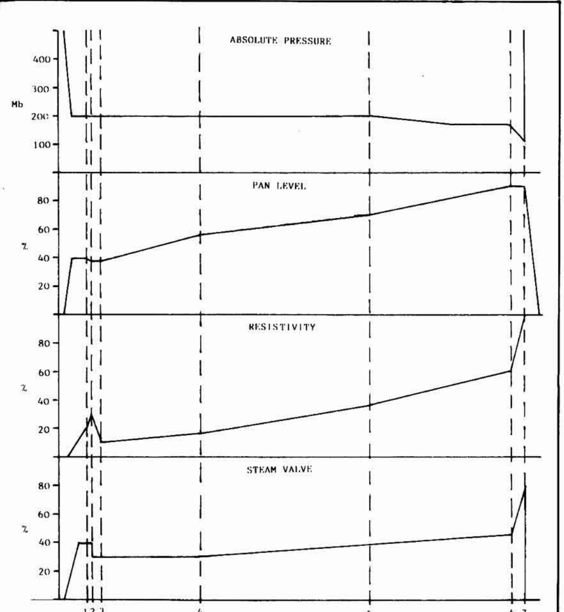

Fig. 6. A.P. pans — shock seeding: 1. End charge; 2. Seed; 3. Start feed; 4. 1st set-point changes; 5. 2nd set-point changes; 6. High level; 7. Pan tight

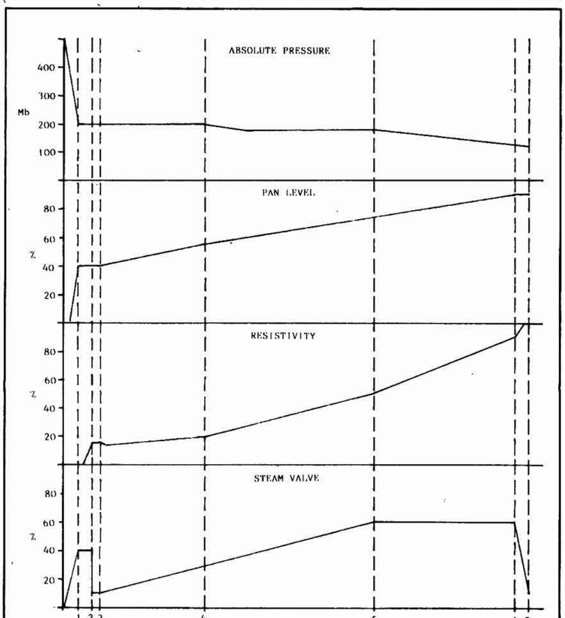

Fig. 7. A.P. pans — full seeding: 1. End charge; 2. Seed; 3. Start feed; 4. 1st set-point changes; 5. 2nd set-point changes; 6. High level; 7. Pan tight

on white pan quality:

pan yield decreased to as little as 0.63 tonnes/m^3 and consequently sugar end throughput decreased, while product sugar mean aperture decreased and coefficient of variation increased.

The decrease in pan drinks had effects on raw and AP pan quality: circulation in pans was reduced giving poorer grain quality, affecting centrifugal capacity; poorer grain quality in after-product pans also gave higher sugar loss to molasses.

The overall reduction in vapour demand to the sugar end due to energy savings significantly reduced the factory evaporative capacity, particularly since Newark is a thick juice refining factory, storing some 25% of thick juice produced. This was recovered in part by changing vapour grades where possible, and in part by not using the prescalder to full effect, by partially bypassing raw juice/condensate heat exchangers.

1982 Juice refining run

Following-on from the information gathered during the campaign, standard liquor Brix was further increased and pan drinks further decreased.

Investigation of control reaction on the white pans during the juice run showed that, at high standard liquor Brix, the control system became very sensitive to fairly small (±2°C) changes in standard liquor temperature. This was due to the standard liquor feed causing a local increase in temperature close to the temperature sensors. Under conditions of increasing temperature, this local effect could cause a pan to feed very quickly, resulting in unstable control. Thus, improving standard liquor temperature control resulted in better pan control.

During this refining run a satisfactory product sugar was produced at a much improved pan yield, although crystal size was still a source of some concern.

By the end of the period, significant energy savings had been achieved, but other problems were becoming apparent. Product quality, throughput and extraction had all suffered to varying extents and factory evaporative capacity was becoming a problem.

1982/83 Campaign

Following trials at Peterborough factory, after-product pan stirrers were installed at Newark. It was intended that these would reduce pan drinks requirement, improve pan circulation, permit pans to be boiled on low temperature (100°C) vapour, and improve pan crystal quality, giving reduced re-circulation of non-sugars and lower sugar in molasses. In addition, different arrangements of stirrer and stirrer types were to be evaluated.

To enable a true comparison of stirrer types and arrangements to be made it was necessary to eliminate variations in pan boiling characteristics. This was achieved by optimizing the boiling program for each pan individually and, after 20 strikes, it was felt that this had been achieved.

The following 145 strikes were monitored and a statistical analysis undertaken to compare crystal content at dropping, mother liquor purity at dropping, boiling time and crystal quality to establish which, if any, pan was performing the best. The statistical method used was the Student 't'-test and the significant variations between pans were that No. 7 boiled to a higher Brix than No. 8, which boiled to a higher Brix than No. 9, while No. 7 had a longer boiling time.

Following the successful completion of this stage of the project, a basic change was made to the pan control philosophy in that full seeding using icing sugar was introduced. This required boiling down to a lower resistivity and introducing a "hold" stage after graining to give the grain time to establish in the high purity charge syrup. At the end of the "hold" period the pan cycle was completed as previously. Figure 7 illustrates the change in boiling strategy made at this time.

Again, pan results were analysed for significance. For the 139 strikes considered pan quality improved significantly in terms of crystal content for all three pans, although boiling times decreased. Once again No. 7 pan boiled to a higher Brix than 8 or 9, and also had a longer boiling time.

As a further aid to compare and evaluate the stirrer types, an attempt was made to measure massecuite flow rate in the pan calandria tubes and down-take. Doppler probes were used for this and considerable effort went into the work, but no useful results were obtained. This was felt to be due to the difficulty of measuring very low massecuite speeds when the measuring device itself represented a considerable resistance to flow.

To assist in setting up pan control parameters, pan microscopes were fitted to all AP pans.

These proved to be a very valuable aid, particularly after closed circuit TV cameras were fitted, enabling pan condition to be monitored from the control room. The use of TV cameras also enabled valuable video recordings to be made of different strikes for comparative purposes.

The effect of the AP stirrer installation on overall factory performance was remarkable. Centrifugalling of AP massecuite had been a sugar end capacity-limiting factor. This ceased to be the case and record daily sugar output was increased from 740 tonnes/day to 820 tonnes/day. This in turn resulted in a radical improvement in the factory steam balance owing to the increased evaporative capacity given by increased sugar end steam demand.

Molasses purity achieved after the stirrer installation was lower than in any previous campaign, and pan drinks were reduced to a minimum.

Taking all the benefits of the stirrer installation together, the pay-back


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period was less than one campaign.

Pan No. 7 was chosen for further trials on the use of Pan-aid at various addition rates. This chemical would be expected to reduce pan liquor viscosity, thereby decreasing mother liquor purity and increasing pan dropping Brix for a constant stirrer trip-load. These trials were undertaken at a later stage of the campaign and since only one pan was being considered, the number of strikes analysed was reduced. Even so, for the two-week period of the trials, a small but statistically significant improvement in mother liquor purity was obtained by using Pan-aid.

Slight modifications were made to the white pans boiling system during the campaign in that the stirrers were modified to allow heavier strikes to be dropped, and charge volumes were reduced. This resulted in improved pan yields but crystal size and coefficient of variation deteriorated further.

(to be continued)

Identification of flavonoid compounds in HPLC separation of sugar cane colorants

By Nancy H. Patron*, Peter Smith* and Tom J. Mabry†

Introduction

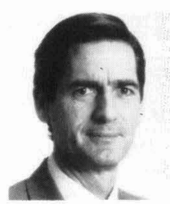
Flavonoid pigments account for a significant proportion of raw sugar colour and therefore are important in sugar processing.

We recently reported the use of high performance liquid chromatography (HPLC) to follow the removal of flavonoids during decolorization of raw liquor at our refineries[1]. At that time it was only possible to identify tentatively the components of some peaks as apigenin derivatives or tricin derivatives.

Subsequently Mabry *et al.*[2] and Ulubelen *et al.*[3] isolated and identified 14 flavonoids in Australian mill syrup. They used a composite of colour solids recovered from several samples of mill syrup as their starting material. The 14 compounds were all flavones, 13 of them were glycosides or methyl ethers of apigenin, luteolin and tricin, and the other was the aglycone tricin. The structures of these compounds, together with tricin 7-glucoside sulphate also isolated from *Saccharum*, are given in Table I.

We now report an improved HPLC separation of flavonoid colorants with


Nancy H. Patron


Peter Smith


Tom J. Mabry

a different column, and the location of 13 compounds on the colorant profile.

Experimental

Chromatographic system: The same HPLC apparatus was used as described previously[1].

Column: An Aquapore RP-300 column, 4.6 mm ID×25 cm long (Brownlee) and Aquapore MPLC guard column, 3 cm long (Brownlee), replaced the μBondapak phenyl column used previously.

Chemicals: Gradient elution was employed with mixtures of methanol:acetic acid:water, A 5:5:90 and B 90:5:5.

Procedure: The previous procedure was modified slightly and the following conditions were used: flow rate 1.5 ml/min; detection 365 nm; sensitivity 0.05 aufs; recorder chart speed 0.4 cm/min; elution process 8 minutes of solvent A then a linear gradient from 0 → 50% B over 60 minutes.

The colorant profile of the composite mill syrup was recorded with a 20 microlitre aliquot of 0.5% solution of colour solids with the addition of apigenin as an internal standard. The profile of individual flavonoids was recorded with an appropriate aliquot of a dilute solution which also contained apigenin. The retention time of each flavonoid indicated its position on the profile and this was confirmed by

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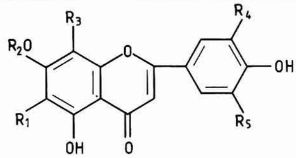
1 Paton & Smith: *I.S.J.*, 1983, **85**, 102-105, 139-145.
2 *J. Nat. Prod.*, 1984, **47**, 127-130.
3 *Rev. Latinoamer. Quim*, (in press).

Table I. Flavonoids identified in mill syrup



Compound	R_1	R_2	R_3	R_4	R_5
Apigenin 6-C-glucosyl-7-O-methyl ether (Swertisin)	Glu	CH_3	H	H	H
Apigenin 6-C-glucosyl-8-C-arabinoside (Schaftoside)	Glu	H	Ara	H	H
Apigenin 6-C-arabinosyl 8-C-glucoside (Isoschaftoside)	Ara	H	Glu	H	H
Apigenin 6, 8-Di-C-glucoside (Vicenin 2)	Glu	H	Glu	H	H
Luteolin 6-C-glucoside (Isoorientin)	Glu	H	H	OH	H
Luteolin 6-C-glucosyl 7-O-methyl ether (Swertiajaponin)	Glu	CH_3	H	OH	H
Isoorientin-7,3′-O-dimethyl ether	Glu	CH_3	H	CH_3O	H
6 Methoxyluteolin	CH_3O	H	H	OH	H
Luteolin 8-C-glucoside (Orientin)	H	H	Glu	OH	H
Orientin-7,3′-O-dimethyl ether	H	CH_3	Glu	CH_3O	H
Luteolin 6-C-glucosyl-8-C-arabinoside (Neocarlinoside)	Glu	H	Ara	OH	H
Tricin 7-O-rhamnosyl -O-galacturonide	H	Rha-galur	H	CH_3O	CH_3O
Tricin 7-glucoside	H	Glu	H	CH_3O	CH_3O
Tricin	H	H	H	CH_3O	CH_3O
Tricin 7-glucoside sulphate	H	Glu-SO_3	H	CH_3O	CH_3O

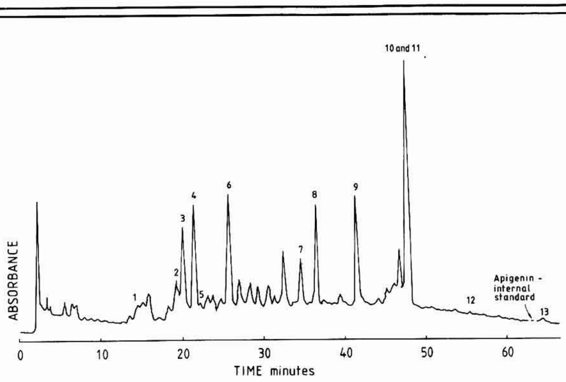


Fig. 1

injecting the solution of mill syrup colour solids spiked with one compound.

Results and discussion

The HPLC colorant profile of the composite mill syrup and the flavonoid constituents for many of the major peaks are shown in Figure 1. Better resolution of colorants was obtained with the Aquapore RP-300 column than the μBondapak phenyl column, resulting in more peaks. For instance compounds 2 and 3 in Figure 1 are apigenin diglycosides and they were eluted together from the phenyl column. However the order of elution of flavonoids was similar for both columns with apigenin derivatives being eluted before tricin derivatives.

The HPLC colorant profiles of fine liquor off char and resin reported previously[1] showed that the decolorizers had characteristic preferences for flavonoid compounds. It is now evident that the major flavonoid colorants present in fine liquor off char will be isoschaftoside and schaftoside with smaller amounts of tricin 7-rhamnosyl-galacturonide and tricin 7-glucoside. The major flavonoid colorant in fine liquor off resin will be isoorientin 7,3′-dimethyl ether with tricin 7-rhamnosyl-galacturonide, tricin 7-glucoside, swertisin and swertiajaponin also being present.

These compounds are either C-glycosides or 7-O-glycosides with the former being very stable and resistant to hydrolysis and the latter less so. Thus these colorants tend to pass through the milling and refining operations unchanged.

It is highly probable that the same flavonoid compounds will be found in cane sugar process streams elsewhere. We have recorded colorant profiles of raw sugar from several countries and all have the same peaks, though in varying concentration. This is not unexpected as commercial sugar cane has been developed from a limited number of *Saccharum* species[4].

4 Arceneaux: *Proc. 12th Congr. ISSCT*, 1965, 844-854.

Acknowledgements

Two authors (NHP and PS) wish to thank CSR Limited for permission to publish this paper. Some of the work described here was supported by the National Institutes of Health grant 9R 01 GM 35710-21 to Tom J. Mabry.

Summary

The resolution of flavonoid colorants in cane sugar process samples by HPLC was improved with the use of an Aquapore RP-300 column instead of a µBondapak phenyl column. The identity of 13 flavonoids on the colorant profile is reported. The predominant flavonoids in fine liquor off char are apigenin 6,8 di-C-glycosides and in fine liquor off resin are isoorientin 7,3'-dimethyl ether and tricin 7-O-glycosides.

Identification des composés flavonoïdes par la séparation HPLC des colorants de la canne à sucre

On a amélioré la résolution par HPLC des colorantes flavonoïdes dans des échantillons prélevés au cours du processus avec la canne à sucre. A cet effet on a utilisé une colonne Aquapore RP-300 au lieu d'une colonne µBondapak-phényl. On rapporte l'identité des 13 flavonoïdes dans le profil du colorant. Les principaux flavonoïdes dans la liqueur blanche après noir sont des di-C-glycosides apigenine 6-8 et dans l'effluent après résines de l'éther isoorientin 7,3'-dimethyl et des glycosides tricin 7-O.

Identifizierung von Flavonoid-Verbindungen bei der Auftrennung von Zuckerrohr-Farbstoffen mittels HPLC

Die Auflösung von Flavonoid-Farbstoffen in Rohrzuckerverarbeitungs-Proben mittels HPLC wurde durch die Verwendung von Aquapore RP-300-Säulen in Stelle einer µBondapak-Phenyl-Säule verbessert. Die Identität von 13 Flavonoiden aus dem Farbstoff-Profil wird angegeben. Die vorherrschenden Flavonoide in der Kläre nach Knochenkohl-Behandlung sind Apigenin-6,8-di-C-glycoside und in der Kläre nach einem Ionenaustauscher Isoorientin-7,3'-dimethylether und Tricin-7-O-glycoside.

Identificación de compuestos flavonoides en separación por HPLC de las materias colorantes en caña de azúcar

Estuvo posible mejorar la resolución de materias colorantes del tipo flavonoide en muestras del proceso de fabricación de azúcar de caña por el uso de una columna de Aquapore RP-300 en lugar de una columna µBondapak-fenil. Se relatan las identidades de 13 de estos compuestos en el perfil del materias colorantes. Los flavonoides predominantes en licor refinado por carbón animal estan 6,8-di-C-glicosidas de apigenina, y en licor refinado por resina estan el 7,3'-dimetileter de isoorientina y 7-O-glicosidas de tricina.

Brevities and statistics

Fuel alcohol distillery for Ethiopia

SOFRECO of Paris, France, has been engaged as consulting engineer by the Ethiopian Sugar Corporation for tendering in connexion with a project of construction of a fuel alcohol distillery and yeast plant. The cost of the project is about $20 million and follows a feasibility study made by SOFRECO. Financing of the major part of the project is to come from Italy.

Brazilian alcohol feasibility mission[1]

At the GEPLACEA meeting in June, the Brazilian delegation offered to provide, at no cost to the countries requesting it, a pre-feasibility evaluation mission to analyse the possibilities for using ethanol in gasoline blends. Nine countries so far have asked to be included in the mission visits; these include Bolivia, Colombia, Dominican Republic, Guatemala, Guyana, Honduras, Panama, Peru and Trinidad.

New sugar factory/distillery in Brazil

The Tavares de Mello Group which operates sugar factories and distilleries in the north-east of Brazil, has ordered from Zanini S.A. Equipamentos Pesados a new plant to be installed as Agro-Industrial Santa Helena, in Rio Brilhante, Mato Grosso do Sul, having a production capacity of 13,800 tonnes of sugar per season and 120,000 litres per day of alcohol. It will process cane from an area of 3000 ha which will be used exclusively for cane varieties selected to give high yields.

New Dominican Republic distillery[2]

Tropicana Petroleum is planning to build a fermentation alcohol distillery of 15 million gallons/year capacity in the Dominican Republic, to be completed within 18 months. The firm plans to buy the raw material from private sugar interests in the country where there is sufficient surplus for the proposed plant.

Guyana sugar exports, 1984[3]

	1984	1983
	tonnes, raw value	
Canada	5,740	30,533
EEC	172,901	167,215
Tanzania	0	2,075
USA	36,113	19,941
Other Central America	160	6,840
	214,914	226,604

Thailand sugar production increase[4]

The Thai Cane and Sugar Corporation reported that production during the 1984/85 crop year reached 1.75 million tonnes of white sugar and 820,000 tonnes of raws, compared with 1.44 million and 720,000 tonnes, respectively, in the previous crop year. It is believed that production in 1985/86 will be at the same levels as 1984/85, despite government efforts to reduce it.

New Argentina distillery[5]

Zanini S.A. Equipamentos Pesados has signed a contract for the supply of a distillery having a daily capacity of 90,000 litres, to produce both anhydrous and dehydrated alcohol at Ingenio Arno, Las Toscas, Sante Fé, Argentina.

Philippines sugar production, 1984/85[6]

Sugar production in the Philippines in 1984/85 reached 1.71 million tonnes, tel quel, somewhat more than recent trade estimates. However, production in 1984/85 was significantly down on last season's figure of 2.3 million tonnes, tel quel. The Philippine Sugar Commission said in a statement that production from Negros Island, which accounts for more than 60% of total sugar output, dropped by 28%. At least eight sugar factories will be closed this year because of the expected cutback in the sugar cane crop.

1 *GEPLACEA Bulletin*, 1985, **2**, (3), 1-2.
2 *Amerop-Westway Newsletter*, 1985, (141), 8.
3 *I.S.O. Stat. Bull.*, 1985, **44**, (6), 20.
4 *GEPLACEA Bulletin*, 1982, **2**, (3), 15.
5 *Zanini Noticias*, July 1985.
6 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 463.

South Korea sugar imports, 1984[7]

	1984	1983
	tonnes, raw value	
Australia	333,456	273,180
Brazil	72,058	14,250
Colombia	36,437	24,000
Dominican Republic	15,480	0
Fiji	12,192	0
Philippines	76,245	136,409
South Africa	83,435	88,000
Taiwan	25,390	80,300
Thailand	183,524	159,023
	838,217	775,162

Sugar factory maintenance seminar[8]

A seminar on maintenance in cane sugar factories was held during August 19-22 in San José, Costa Rica, sponsored by the Liga Agrícola e Industrial de la Caña de Azúcar and GEPLACEA and held within the framework of a UNDP/GEPLACEA/UNIDO Regional Maintenance Project. Implementation of modern maintenance system techniques, as discussed at the seminar, would lead to increased productivity and a reduction in sugar manufacturing costs.

US sugar refinery sale[9]

The Georgia sugar refinery in Mathews, Louisiana, has been sold to Colonial Sugars Inc., owners of the Gramercy refinery. The refinery had been owned by seven cooperative sugar factories with an annual production of about 200,000 short tons of raw sugar; it is to be closed and production shifted to the Gramercy plant. The closure will leave three refineries in the state: the Amstar plant in Arabi, Supreme Sugars in Labadieville and Colonial Sugars in Gramercy.

Drought damage to Cuban sugar cane[10]

Cuba's sugar crop could fall by almost a million tonnes next year because of drought, President Castro said in a televised address. "Almost all of our agriculture has been affected by the drought, and first estimates show that the next sugar crop will be about 10% lower than planned." This year Cuba produced approximately 8 million tonnes and has a production target for 1990 of about 12 million tonnes.

Pakistan beet sugar crop

Five years ago, beet sugar constituted 5% of the total of 574,188 tonnes of white sugar produced in Pakistan. Two years later, in 1981/82, total white sugar production stood at 1,300,620 tonnes but beet sugar had fallen to about 2%. By 1983/84, the proportion of beet sugar had fallen further to 1.32% of the total. The 1984/85 campaign has seen an all-time high white sugar production of 1,316,000 tonnes, while the proportion of beet sugar has reached a record low of 0.79%. Sugar beets are grown only in the North West Frontier Province, where four factories slice beets as well as crushing cane. The area sown to beets fell from an expected 8500 hectares to only 2796 ha, giving so small a crop — 103,137 tonnes — that only two of the four factories processed beet and these at only one-third of capacity. The season lasted only 25 days and white sugar output amounted to 10,430 tonnes.

Bangladesh sugar imports, 1984[11]

	1984	1983	1982
		tonnes, raw value	
Brazil	10,826	0	0
Czechoslovakia	11,957	0	0
EEC	102,343	2	2,828
Germany, East	12,914	0	0
India	40,000	0	0
Korea, South	1,685	0	0
Malaysia	51,013	5,435	0
Singapore	805	9	20
Taiwan	13,588	0	0
Thailand	58,182	0	0
	303,313	5,446	2,848

Czechoslovakia sugar production, 1983[12]

White sugar production in Czechoslovakia in 1983 totalled 835,969 tonnes, of which 107,303 tonnes was produced from imported raw sugar. Production in 1982 was 894,086 tonnes, of which 112,589 tonnes was from imported raw sugar. Hence, sugar production from domestic beets in 1983 amounted to 728,666 tonnes, white value, compared with 781,497 tonnes in 1982.

New USSR sugar factory[13]

A new 6000 tonnes/day beet sugar factory, supplied by Poland, is to be built at Khmelnitskii, in the Podolien region of West Ukraine. In a 110-day campaign it should produce 85,000 tonnes of white crystal sugar and 30,000 tonnes of molassed dried pulp. Sugar storage will be in three tower silos, each of 15,000 tonnes capacity, as well as a bagged sugar store.

Venezuela sugar expansion[14]

In Caracas, the Minister of Labour, speaking to labour leaders in the sugar sector, said that Venezuela expects to produce 540,000 tonnes of refined sugar in 1985/86. Production totalled 454,000 tonnes in 1984/85 and 378,000 tonnes in 1983/84. Venezuela has been importing sugar since 1974 but the government expects to be self-sufficient by 1986/87, according to Reuters.

Belize sugar company ownership[15]

Belize has agreed to buy over nine years Tate & Lyle's 83% majority shareholding in the local sugar industry; the Esquivel government which came to power in December had previously refused to go through with a deal reached with the previous government. The Belize government has been unable to persuade Tate & Lyle to make further investments in the country, however, which has clouded plans for Howell Petroleum Company of the US to convert the recently closed Libertad sugar factory into an alcohol plant in partnership with Tate & Lyle.

UK trials on pelleted straw as fuel[16]

British Sugar is planning full-scale trials during its next campaign using pelleted straw as fuel, according to a *Big Farm Weekly* report. The work is the result of a long-term research program which could eventually open up a major new market for some of Britain's six million tonnes of surplus straw. As a substitute for coal, 200,000 tonnes of straw could be needed while, if it also switched out of oil, British Sugar would need 450,000 tonnes.

Fiji sugar agreements[17]

An agreement has been reached under which Fiji will supply New Zealand with up to 63,000 tonnes of sugar a year initially for a period of three years but with provision for extension. This follows an earlier agreement made with China under which 40-50,000 tonnes of sugar will be supplied by Fiji each year for five years, commencing in May 1985, also at preferential prices.

Dominican Republic sugar industry contraction[18]

The budget of the State Sugar Council (CEA) of the Dominican Republic is to be halved, owing to low world prices and reduced exports. The Finance Minister said that the cut would mean closure of three of the CEA's 12 sugar factories, a cut-back in production in three others and a rise in domestic sugar prices.

New US HFS facility[19]

In the spring, two months later than planned, a new HFS facility went into operation at Eddyville, Ohio. It cost $100 million and belongs to Cargill Inc., which also operates plants at Cedar Rapids, Iowa, Dayton, Ohio, and Memphis, Tennessee. The new facility can produce 350,000 short tons a year of HFS from 20 million bushels of maize.

Spain beet sugar production, 1984/85[20]

Sugar production in the 1984/85 campaign totalled 1,064,941 tonnes, white value, of which nearly half (521,939 tonnes) was produced in the Duero region, 395,278 tonnes in Andalucia and the balance in the Central and Ebro regions.

7 *I.S.O. Stat. Bull.*, 1985, **44**, (6), 25.
8 *GEPLACEA Bulletin*, 1985, **2**, (3), 2.
9 *Sugar Bull.*, 1985, **63**, (22), 3.
10 *Financial Times*, October 1, 1985.
11 *I.S.O. Stat. Bull.*, 1985, **44**, (7), i-ii.
12 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 477.
13 *Zuckerind.*, 1985, **110**, 745.
14 *GEPLACEA Sugar Letter*, 1985, (6).
15 *Financial Times*, August 23, 1985.
16 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 490.
17 C. Czarnikow Ltd., *Sugar Review*, 1985, (1740), 103.
18 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 494.
19 *Zuckerind.*, 1985, **110**, 746.
20 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 490.

World sugar production estimates, 1985/86[21]

	1985/86	1984/85	1983/84
	tonnes, raw value		
Beet			
Belgium	975,000	912,000	850,000
Denmark	465,000	595,000	376,000
France	3,950,000	4,303,000	3,870,000
Germany, West	3,100,000	3,147,000	2,725,000
Greece	360,000	237,000	323,000
Holland	975,000	1,014,000	807,000
Ireland	200,000	241,000	214,000
Italy	1,350,000	1,397,000	1,352,000
UK	1,250,000	1,440,000	1,157,000
EEC	*12,625,000*	*13,286,000*	*11,674,000*
Albania	39,000	37,000	35,000
Austria	425,000	464,000	385,000
Bulgaria	150,000	145,000	120,000
Czechoslovakia	830,000	825,000	750,000
Finland	125,000	129,000	155,000
Germany, East	700,000	750,000	692,000
Hungary	505,000	525,000	518,000
Poland	1,975,000	1,875,000	2,140,000
Rumania	650,000	875,000	585,000
Spain	1,000,000	1,159,000	1,339,000
Sweden	330,000	392,000	298,000
Switzerland	125,000	131,000	124,000
Turkey	1,500,000	1,655,000	1,770,000
USSR	8,000,000	8,550,000	8,750,000
Yugoslavia	1,000,000	980,000	772,000
Total Europe	*29,979,000*	*31,778,000*	*30,107,000*
Canada	115,000	113,000	110,000
Chile	370,000	361,000	330,000
China	1,000,000	930,000	1,020,000
Iran	575,000	490,000	515,000
Japan	600,000	647,000	510,000
Morocco	360,000	350,000	385,000
Uruguay	35,000	25,000	30,000
USA	2,625,000	2,633,000	2,449,000
Other countries	241,000	236,000	251,000
Total beet	35,900,000	37,563,000	35,707,000
Cane			
Spain	15,000	11,000	9,000
Argentina	1,100,000	1,545,000	1,624,000
Barbados	100,000	100,000	101,000
Belize	85,000	110,000	108,000
Bolivia	200,000	198,000	197,000
Brazil	8,200,000	9,332,000	9,576,000
Colombia	1,250,000	1,390,000	1,177,000
Costa Rica	270,000	260,000	240,000
Cuba	7,500,000	8,125,000	8,331,000
Dominican Republic	950,000	1,100,000	1,197,000
Ecuador	265,000	250,000	125,000
French West Indies	52,000	55,000	55,000
Guatemala	490,000	490,000	515,000
Guyana	275,000	255,000	256,000
Haiti	45,000	50,000	50,000
Honduras	170,000	250,000	226,000
Jamaica	200,000	200,000	200,000
Mexico	3,500,000	3,500,000	3,242,000
Nicaragua	250,000	240,000	249,000
Panama	175,000	158,000	176,000
Paraguay	92,000	85,000	80,000
Peru	700,000	805,000	620,000
Puerto Rico	75,000	90,000	90,000
St. Kitts	25,000	30,000	32,000
El Salvador	270,000	250,000	259,000
Trinidad	80,000	83,000	67,000
US — Hawaii	875,000	890,000	900,000
— Mainland	1,775,000	1,745,000	1,711,000
Uruguay	65,000	65,000	60,000
Venezuela	425,000	425,000	423,000
Other Americas	6,000	7,000	8,000
Total Americas	*29,475,000*	*32,083,000*	*31,895,000*
Angola	35,000	33,000	25,000
Egypt	750,000	725,000	715,000
Ethiopia	175,000	203,000	202,000
Ivory Coast	100,000	115,000	125,000
Kenya	360,000	378,000	403,000
Madagascar	115,000	78,000	100,000
Malawi	175,000	160,000	187,000
Mauritius	700,000	610,000	640,000
Morocco	85,000	76,000	80,000
Mozambique	125,000	95,000	75,000
Nigeria	65,000	70,000	58,000
Réunion	250,000	260,000	240,000
South Africa	2,250,000	2,551,000	1,480,000
Sudan	450,000	435,000	460,000
Swaziland	420,000	410,000	408,000
Tanzania	125,000	130,000	143,000
Zaire	50,000	40,000	45,000
Zambia	150,000	141,000	132,000
Zimbabwe	475,000	460,000	433,000
Other Africa	266,000	274,000	246,000
Total Africa	*7,121,000*	*7,244,000*	*6,197,000*
Bangladesh	75,000	97,000	160,000
China	3,700,000	3,755,000	2,830,000
India	7,000,000	6,650,000	6,405,000
Indonesia	2,000,000	1,800,000	1,785,000
Iran	200,000	200,000	205,000
Japan	280,000	283,000	296,000
Malaysia	80,000	75,000	75,000
Pakistan	1,250,000	1,420,000	1,225,000
Philippines	1,400,000	1,500,000	2,350,000
Taiwan	595,000	690,000	661,000
Thailand	2,500,000	2,598,000	2,349,000
Vietnam	225,000	220,000	215,000
Other Asia	109,000	109,000	102,000
Total Asia	*19,414,000*	*19,402,000*	*18,658,000*
Australia	3,450,000	3,643,000	3,254,000
Fiji	415,000	497,000	286,000
Other Oceania	45,000	43,000	37,000
Total Oceania	*3,910,000*	*4,183,000*	*3,577,000*
Total cane	59,925,000	62,923,000	60,336,000
Grand total	95,825,000	100,486,000	96,043,000

21 C. Czarnikow Ltd., *Sugar Review*, 1985, (1740), 99-100.

New books

Sugar cane

F. Blackburn. 414 pp; 14.5×22.3 cm. (Longman Group Ltd., Longman House, Burnt Mill, Harlow, Essex CM20 2JE, England.) 1984. Price: £37.50.

Although the title would suggest that this is solely devoted to cane agriculture, two chapters concern sugar manufacture and by-products as well as sucro-chemistry. Moreover, the book would probably serve a useful purpose in providing information on the agricultural side of the industry to those engaged in cane processing who wish to broaden their view, since it is important that neither side should be isolated from the other. The relative compactness of the book helps in this respect. The author has had wide experience in the Trinidad sugar industry in a senior capacity, so that what he says is not based on theory or hearsay. It is a very readable book, and certainly to be recommended.

Sweetness and power—the place of sugar in modern history

S. W. Mintz. 274 pp; 15.5×23.1 cm. (Viking Penguin Inc., 40 West 23rd Street, New York, NY 10010, USA.) 1985. Price: £14.95.

The author of this history of sugar manufacture and its significance in modern Western life is Professor of Anthropology at Johns Hopkins University, so that it is understandable that he should look at the subject of sugar from a somewhat different viewpoint than is taken by other writers of non-technical sugar books. However, this social historical account is interesting for allotting to sugar its importance in the economy of nations, particularly the UK, and for demonstrating the part sugar has played in social behaviour; obviously, there is also the treatment of the subject in its relationship to the West Indian plantations and the slave trade. In all, this is a readable book, with much information to digest; some of the views expressed are open to argument, but in a book of this nature that is to be expected. A bibliography, notes on the text and a subject index are included at the back. Incidentally, Note 10 on p. 232 refers to "'golden syrup' perfected toward the end of the nineteenth century by the Glasgow-based giant of British sugar, Tate and Lyle"; in fact, the merger of the two refining companies took place in 1921, and until then Golden Syrup manufacture was the prerogative of Abram Lyle & Sons at Plaistow Wharf refinery in London, while Henry Tate & Sons Ltd. produced crystal and cube sugar at their Love Lane refinery in Liverpool and at their Thames refinery 1½ miles from Plaistow Wharf.

Making sugar. Volume 2. Vacuum pans

M. P. Arca and R. Esparza. 107 pp; 13.5×21.2 cm. (Acra Corp., 757 N.W. 27 Avenue, Miami, FL 33125, USA.) 1984. Price: $28.95.

This paper-back is a trouble-shooting guide to the different problems an operator can encounter in the pan station. It offers advice on preventive maintenance and shows how to solve the problems. A subject index and a list of abbreviations are included at the back of the book. The type is of relatively large font, making for easy reference, and the work undoubtedly will be of great value in the sugar factory. The book is also available in a Spanish version as "Haciendo azúcar — Tachos" which costs the same as the English one.

The energy cane alternative

A. G. Alexander. xx+510 pp; 16.2×24.7 cm. (Elsevier Science Publishers B.V., P.O. Box 211, 1000 AE Amsterdam, Holland.) 1985. Price: US$ 109.25.

This book, No. 6 in the Sugar Series, is an expansion of the argument for the growing of sugar cane as a source of biomass for subsequent use as e.g. fuel, chemical feedstock as well as for recovery of some of the sucrose and production of high-test molasses, etc. The author, well-known for his cane research work in Puerto Rico, examines the many facets of the subject, with prior consideration to the agronomic aspects in the first three parts of the work, while the fourth part concerns utilization of the cane and its constituents. The four parts are subdivided into a total of 16 chapters, which in turn are subdivided into varying numbers of sections. The chapter headings are: Tropical biomass: a resource for all seasons; Sugar planting at a crossroads; The biomass planting alternative; Origin of the *Saccharum* biomass system; *Saccharum* as a growth mechanism; Alternative grasses integration (in which sorghum×Sudan grass hybrid forage grasses represent short-rotation crops, and Napier grass is a highly suitable intermediate-rotation grass having a potential lignocellulose yield approaching that of sugar cane); Production assessment and planning; Seedbed preparation and planting; Growth management and monitoring; Harvest and delivery; Postharvest management; Alternative grasses management; Energy cane improvement; Fermentable solids utilization; Lignocellulose utilization; Energy planting *vs.* food planting. While the work is based on the situation in Puerto Rico, there is much in it that undoubtedly would be of value to readers involved in the sugar industries of other countries faced with the problem of diminishing returns on sugar where energy cane growing for power generation and sale could be an answer. The references to the literature cited are collected together in alphabetical order of authors towards the back of the book. A subject index is the last and, unfortunately, the weakest item in the book, since the entries are in only a vague alphabetical order under each letter of the alphabet. Little attempt seems to have been made to edit this section.

Trade notices

Dust filters

DCE Group Ltd., Humberstone Lane, Thurmaston, Leicester LE4 8HP, England.

The Dalamatic DLM V2 and V3, with fabric areas of 2 and 3 m^2, respectively, are two new insertable dust filters designed for continuous operation in small pneumatic systems, for pressure relief of large rotary seals, and for other small powder conveying and processing applications. The Dalamatic range of insertable filters now contains more than 80 different units which maintain a high collection efficiency at constant resistance to air flow. The V2 and V3 each have three pocket-shaped filters inserted in a silo or process equipment; a reverse jet of compressed air cleans the fabric and returns the cake of collected dust to the bulk product. An optional header and fan remote from the filters ensure maximum flexibility of installation. Collection efficiencies often exceed 99.99%.

Syrup filtration

Tate & Lyle Process Technology, 55 Liddon Road, Bromley BR1 2SR, England.

The Talo deep bed filter of 3.5 m overall height and 1.8 m diameter has been developed for the filtration of Talo-clarified sugar refinery liquors, sugar factory syrups and corn syrups. It operates as a fine filter after Talofloc, Talodura and Taloflote clarification processes, producing a high-clarity filtrate to give complete protection to downstream operations such as those involving bone char, granular carbon and ion exchange resins. No filter aid is required, no sweet-water is produced and operation is fully automatic. Capital and operating costs are low and filtration rates high at >10 $m^3/m^2/hr$. Suspended solids in the liquor are removed by a bed of Talo media specially formulated to give maximum particle entrapment throughout its depth; when the bed is full of suspended solids, the automatic control system senses from a pre-set maximum working pressure differential that it needs cleaning, and a backwash cycle is triggered which discharges the trapped solids at the top of the filter, and the bed is then automatically scoured, regraded and put back on line. Filtrate is used to clean the bed, and no water is used in the backwash process. The system is provided with a safety shutdown procedure in the event of air or electrical power failure.

Static electricity elimination in packaging

WLT Limited, Sugden Street, Thornton Road, Bradford, West Yorks. BD1 2JW, England.

In packaging of powdered products such as sugar, unwinding of the wrapping film and transportation to the bag forming and filling station causes a build-up in the static charge on the plastic film, so that the sugar tends to adhere to the film and interferes with the bag sealing, leading to a reduced storage life. By positioning a Simco antistatic bar around the formed tube, the charge is completely neutralized before the sugar is released into it, so that there is no hold-up. The bar is supplied with its own power unit that can be located at any convenient position on the packaging machine.

PUBLICATIONS RECEIVED

Pressure regulator

Auld Valves Ltd., Cowlairs Industrial Estate, Finlas Street, Glasgow G22 5DQ, Scotland.

The Standfast high-capacity pressure regulator developed by Auld Valves is able to handle steam and water as well as many other fluids with accuracy and stability. The accuracy is provided by a pilot valve (complete with optional remote sensing facility), while the stability is a result of positioning the piston valve downstream of the main valve seat, which also allows the guide and piston to be only slightly larger than the seat. Special O-rings have been developed to withstand hot and cold conditions and chemical attack while still producing complete shut-off. Valve characteristics can be altered as easily after installation as at selection, ensuring that the valve matches the duty and minimizing the cost of related safety valves. The valve is available in 14 sizes up to 12 inches and in three standard materials.

Tower diffusers

Braunschweigische Maschinenbauanstalt AG, Postfach 3225, D-330 Braunschweig, Germany.

Brochure B/1, newly available from BMA, describes their tower diffusers, the sizes of which have been gradually increased in line with the trend towards higher beet throughputs at minimum juice draft and losses; the largest built to date is one of 8000 tonnes/day capacity that was constructed in 1982. BMA supplied 9 diffusers for the 1984 campaign, of 55,000 tonnes total daily capacity, and are to supply another 5 to Holland, Italy, Switzerland and West Germany for the 1985 campaign, providing a total capacity of 32,000 tonnes/day.

Chains and sprockets

Mechanical Power Division, Rexnord, P.O. Box 2022, Milwaukee, WI 53201, USA.

Literature available from Rexnord features their new highly durable welded steel chain for general conveying applications, the NH45 polymeric chain and sprockets designed for light-duty unit handling on straight conveyors, and the NH82 polymeric chain and N82 sprockets (which have a polymeric body integral with a corrosion-resistant steel hub) designed for use with conveyors or elevators where a 3.075-inch pitch drive is required.

Process instrumentation

Yokogawa Hokushin Electric Corporation, P.O. Box 4125, Shinjuku Center Building (50F), 25-1 Nishi Shinjuku l-chome, Shinjuku-ku, Tokyo 160, Japan.

Catalogue OA2B1-E is a 60-page brochure giving details of YEW electronic and pneumatic process control systems, computer systems and optical fibre communications systems as well as electronic recorders, instrument panels and cabinets, field instruments, control valves and actuators and analytical instruments, etc.

Boiling control

Finnsugar Engineering, Rintekno Oy., P.O. Box 146, SF-02101 Espoo, Finland.

A leaflet from Finnsugar features their Panmatic automatic boiling control which provides continuous and precise calculation and control of supersaturation throughout the entire boiling process. The microprocessor-based system controls the vacuum valve, steam feed valve and syrup feed valve, for which the following input data are required: mother liquor refractometric dry solids, total dry solids (as determined by radioactive density meter), temperature of the massecuite at the bottom of the pan, temperature in the massecuite discharge line, massecuite level in the pan and vacuum. Details are given of the requisite digital input signals and of the valves operated by the digital output signals, as well as the massecuite stirrer. Benefits of the system include increased capacity as a result of reduced boiling time, a consistently high crystal quality, and operational flexibility (the system is applicable over the range from refined sugar boiling to low-grade working).

Intermittent boiling control system

Yokogawa Hokushin Electric Corporation, P.O. Box 4125, Shinjuku Center Building (50F), 25-1 Nishi Shinjuku 1-chome, Shinjuku-ku, Tokyo 160, Japan.

Bulletin 34B6A1-51E features the Yewpack II intermittent boiling control system in which a given volume of water or syrup is fed into the pan when the rheometer, which is the core of the system, shows a predetermined set point for the massecuite. The rheometer continuously measures the sum of massecuite viscosity, supersaturation, crystal content and grain size, and has a sensitivity 20 times greater than that of a supersaturation meter over the consistency range required for boiling. The system is universally applicable to all boiling systems and types of vacuum pan and may be used for cane raw *A*-, *B*- and *C*-sugars, various types of refined sugar and granulated and low-grade beet sugars. Advantages include improved yield, reduced steam consumption and boiling time, and better crystal uniformity.

Tube cleaning systems and pressure washers

Goodway Tools Ltd., 2A Purdeys Way, Industrial Estate, Rochford, Essex, England.

Catalogue No. 385A from Goodway features their tube cleaning systems and components as well as pressure washers for boiler soot and scale removal.

Fine filtration

Stella-Meta Filters, Division of Permutit-Boby, Laverstoke Mill, Whitchurch, Hants. RG28 7NR, England.

Brochure SMF 29 describes the construction and operation of the pressure precoat Metafilter, which incorporates ring-type elements, each having one flat side while the other side has accurately dimensioned scallops projecting above the general surface; when assembled flat side to scalloped side on a central support and tightened down, they provide a rigid and robust precoat and filter cake support to give a number of benefits, including a high filtration efficiency down to a sub-micron particle size in treatment of a wide range of liquids, including sugar syrups.

Membrane processing

APV Membrane Processes Ltd., P.O. Box 4, Crawley, West Sussex RH10 2QB, England.

APV Membrane Processes Ltd. is a newly-formed company in the APV Group which produces membranes for reverse osmosis, ultrafiltration and microfiltration. The membranes are available spirally wound for minimum cost and tubular for liquids of high fouling characteristics or having high suspended solids contents; they are made of organic polymers for a pH range of 2-12 and temperatures of 0-80°C, and of inorganic materials for extremes of pH and temperature. They may be hydrophobic or hydrophilic, and may be designed as backwashable elements. Publication A555 illustrates the principles and applications of reverse osmosis and ultrafiltration, the latter of potential use in raw juice treatment in place of liming.

Brazil sugar machinery and distillery equipment exports

Zanini S.A. Equipamentos Pesados is to supply milling machinery — roller shells, turnplates, carriers and gearing — to Sodesucre, of the Ivory Coast, for use in the renovation of their sugar factories. Ingenio y Refinería San Martín del Tabacal, of Tucumán, Argentina, has ordered a distillery from Zanini to have a daily production capacity of 150,000 litres of anhydrous alcohol. In addition equipment is to be provided for installation in the existing distillery for dehydration of 60,000 litres/day of alcohol.

White sugar silo order

Nils Weibull AB have received an order from the USSR for a white sugar silo of 50,000 tonnes capacity as part of a sugar factory expansion project by A/S De Danske Sukkerfabrikker in the Kiev area of the Ukraine. The order brings the total number of Weibull silos delivered to 103, although this will be the first supplied to the Soviet Union.

Applexion in USA

Applexion, the French ion exchange resin manufacturers, have established a subsidiary company in the USA, with Mr. X. Lancrenon as Director of US and Canadian operations. The address of the company is: Applexion, 15700 Lathrop Avenue, Harvey, IL 60426, USA.

Darenth weigher for animal fodder

Darenth Ltd. are supplying a tailor-made system to British Sugar plc to handle molassed beet pulp now sold in various forms as Trident Feeds. The system consists of a variable-speed screw conveyor, stitcher and control console. The product is mixed in a computer-controlled vessel, conveyed to an automatic pneumatic weighing and bagging station (where it is loaded into 25-kg bags), the bags then carried on a slat conveyor to an auto-stitcher and finally, via a metal detector, to the palletizing station. A Darenth liquid molasses weigher and two systems for handling limestone and coke have already operated at British Sugar for over 7 years without any problems.

Benin sugar factory operation

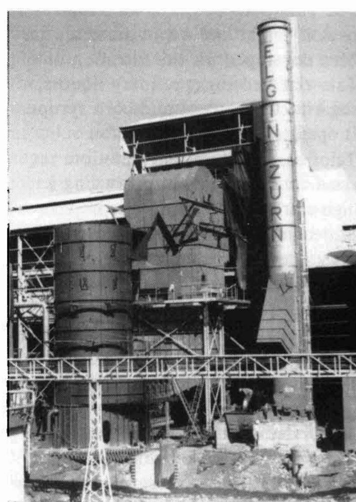
The Société Sucrière de Savé in Benin has successfully begun its first campaign. The factory was built on a turnkey basis by ABAY S.A., of Belgium, under a contract worth more than US $100 million. The complex covers more than 5000 hectares, and ABAY was responsible for land preparation, installation of an irrigation system, the supply of vehicles and construction of a village in addition to the construction of the factory and supply of equipment for it.

Switchboard for British Sugar

Arcontrol Ltd. have received an order worth over £45,000 for motor control centres for the British Sugar factory at Wissington. The 15-module switchboard is more than 8 m long and contains 53 d.o.l. starters ranging from 0.25 to 30 kW. In addition, six panels house thyristors controlling 3-phase heaters for silo air conditioning systems, while other feeders control pumps, valves, fans and screw conveyors. The board forms an extension to an existing switchboard to which it is connected by cable.

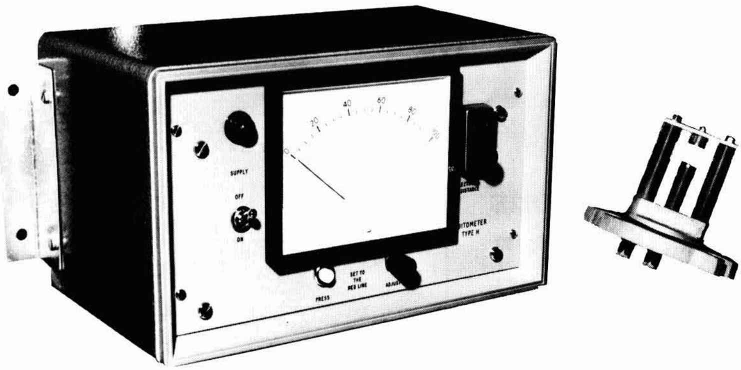
Elgin/Zurn boiler

The illustration shows the Elgin/Zurn boiler under construction at the cane sugar factory of Umfolozi Cooperative Sugar Planters Ltd. in South Africa. With the exception of certain special items of equipment such as valves, mountings, controls and drives, the entire boiler was manufactured at the works of Elgin Engineering (Pty) Ltd. in Durban. Operating conditions of the boiler are 80 or 108 tonnes evaporation per hr on bagasse of 53% and 49% water content, respectively, or 64 tonnes/hr on coal, at an operating pressure of 3100 kPa and a feedwater temperature of 105°C, giving a final steam temperature of 410°C. The design and reliability of the travelling-grate type of stoker was a major factor in the decision to order the boiler, which is of the top suspended type. The combustion chamber is much taller than normally found in the sugar industry; this, plus its large volume and low gas velocities, will contribute to minimization of sand carryover. A revolutionary bagasse storage and feed system provides a 20-minute storage buffer which will avoid the need for burning of auxiliary coal during short or intermediate factory stoppages. The steam drum water level plan area is relatively large.



Suma Products

VACUUM PAN CONTROL



The redesigned **CUITOMETER** type H incorporates solid state electronics. Three d.c. outputs are now provided so that the unit can be used either for manual or semi-automatic control. Provision for testing the instrument during operation is provided so that a greater degree of control is now available. A special sensitivity control device is incorporated so that the high purity syrups can also be controlled as well as low product boilings, thus increasing the scope of the instrument. A further modification lies in the fact that the instrument will now operate either from a 50 or 60 Hz supply single phase A.C. 110/125 or 220/240 V.

The **CRYSTALOSCOPE** crystal projection instrument enables the pan operator to view the crystal growth throughout the boiling cycle. The $8\frac{1}{2}''$ diameter observation screen is fitted with a squared graticule each side of which represents 0.5mm. on the crystal surface. The instrument will fit into an aperture of $6\frac{1}{2}''$ diam. in the pan wall and is held in position by 8 equally spaced $\frac{5}{8}''$ diam. bolts on $8\frac{3}{4}''$ P.C.D. The magnification is $\times 30$. Provision is made for the alteration in gap between the two observation ports and for focussing the crystals on the screen to give a sharp image over the entire screen area which is evenly illuminated. Operation is from a single phase A.C. 110/125 or 220/240V supply.

Write now for details of our complete range of factory and laboratory equipment.

The Sugar Manufacturers' Supply Co. Ltd.

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