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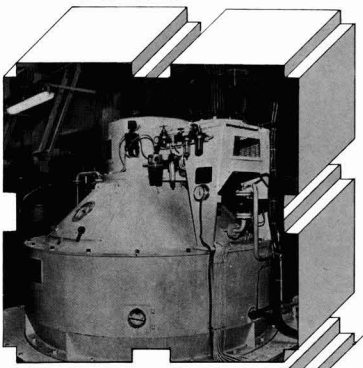

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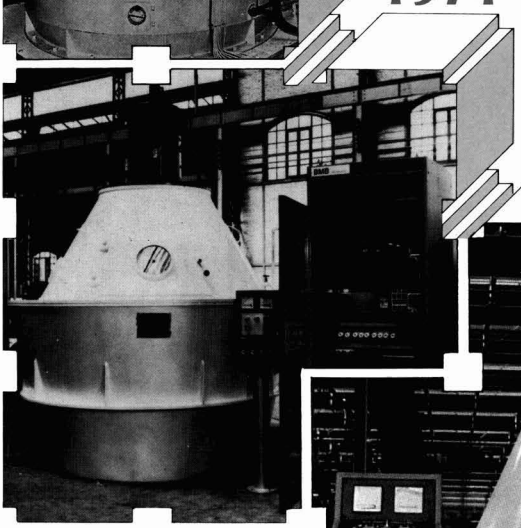
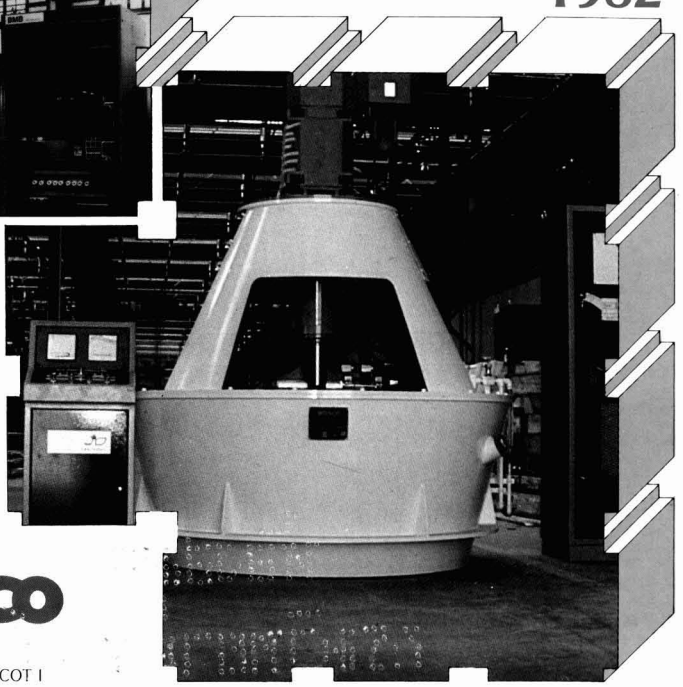


1982



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NOTES AND COMMENTS

Europe sugar beet area, 1983[1]

Good weather during 1982 resulted in exceptionally high beet and sugar yields in Western Europe and, as a consequence, the EEC sugar surplus was as large as the year before in spite of a reduction of 9% in the area sown. The Commission recommended that a further reduction be made in 1983 and the first estimates by F. O. Licht indicate that this is intended, the 1983 total for the Community being 6.5% lower than for 1982. Only in Ireland and the UK are increased areas expected, while greater than average reductions are expected in Belgium, France, Italy and West Germany.

Elsewhere in Western Europe the Austrian beet area is expected to be lower, while a significant increase is expected in Yugoslavia. In East Europe sowings are expected to be lower in East Germany, Hungary and Poland but the small percentage increase for the Soviet Union is in absolute terms sufficient, in combination with increases in Czechoslovakia, Rumania, Albania and Bulgaria, to result in a net increase. In Europe as a whole, a decrease of 1.3% in the beet area is expected. The figures appear below:

	1983	1982	1981	Decrease/ Increase 1983 vs. 1982, %
		hectares		
West Europe				
Belgium	120,000	130,000	135,000	– 7.7
Denmark	75,000	76,000	76,000	– 1.8
France	500,000	543,000	616,000	– 7.9
Greece	40,000	42,000	42,000	– 4.8
Holland	129,000	134,000	133,000	– 3.7
Ireland	36,000	34,000	35,000	+ 5.9
Italy	225,000	255,000	317,000	–11.8
UK	204,000	201,000	210,000	+ 1.5
West Germany	395,000	429,000	464,000	– 7.9
EEC	*1,724,000*	*1,844,000*	*2,028,000*	*– 6.5*
Austria	44,000	58,000	59,000	–24.1
Finland	32,000	32,000	32,000	0
Spain	260,000	260,000	218,000	0
Sweden	53,000	54,000	53,000	– 1.9
Switzerland	16,000	15,000	14,000	+ 6.7
Turkey	370,000	372,000	360,000	– 0.5
Yugoslavia	170,000	139,000	145,000	+22.3
Total W. Europe	*2,669,000*	*2,774,000*	*2,909,000*	*– 3.8*
East Europe				
Albania	11,000	10,000	12,000	+10.0
Bulgaria	54,000	53,000	53,000	+ 1.9
Czechoslovakia	216,000	213,000	225,000	+ 1.4
East Germany	250,000	261,000	265,000	– 4.2
Hungary	110,000	126,000	121,000	–12.7
Poland	490,000	493,000	470,000	– 0.6
Rumania	275,000	269,000	245,000	+ 2.2
USSR	3,640,000	3,620,000	3,633,000	+ 0.6
Total E. Europe	*5,046,000*	*5,045,000*	*5,024,000*	*0*
Total Europe	7,715,000	7,819,000	7,933,000	– 1.3

Licht have assessed the potential sugar output from the estimated sowings, using high, average and low sugar yields from the past six years. They conclude that, compared with an actual outturn of 14,780,000 tonnes, raw value, in 1982/83, a high yield in the EEC would produce 13,585,000 tonnes, an average yield 12,033,000 tonnes and a poor yield 9,522,000 tonnes. Western Europe would, as a whole, produce 19,031,000 tonnes with a high yielding crop, 16,853,000 with an average crop and 13,753,000 tonnes with a low yield; these compare with the 1982/83 outturn of 19,872,000 tonnes.

In East Europe, 1982/83 production totalled 11,940,000 tonnes; high, average and low yields from the estimated areas would yield 13,921,000, 12,008,000 and 9,789,000 tonnes, respectively. For Europe as a whole, the potential exists for production of 32,952,000 tonnes, 28,861,000 tonnes and 23,542,000 tonnes with high, average and low yields, against an actual 1982/83 figures of 31,812,000 tonnes.

World sugar prices

From an initial level of £104, the London Daily Price for raw sugar fluctuated very little during the first 11 days of March, within a range of £103-106, but rose to £109 on March 14 on news that the USSR had decided to exercise its option to buy 250,000 tonnes of Brazilian sugar. After rising to £110, the trend was reversed and the price sank to £104 on March 17 with news that some of the shipments had been deferred.

Subsequently, reports of continuing bad weather in Cuba and suggestions that some southern hemisphere producers might not be able to match the current level of output in 1983/84 as well as the likelihood that the perfect growing conditions experienced in Europe in 1982 will not be repeated this year all combined to persuade the market that production might not be as high in 1982/83 as expected while the succeeding crop might be smaller.' In the meantime, early signs of a recovery from world recession encouraged the hope that sugar consumption might rise faster than had previously been thought likely. The LDP started to rise, reaching £115 per tonne, but fell back to £113 on March 31.

White sugar supplies are readily available and the LDP(W) showed more stability than the raw sugar price; from £139 on March 1 it remained within a range up to £145 during the first three weeks of the month. After this the optimism of the market affected it too and it rose to £150 on March 29 before falling back to £146 on March 31.

E. D. & F. Man comment[2]: "Just as the high prices of 1980/81 encouraged the over-production which has pushed the market to its present levels, so the period of low prices (the ISO spot price has now averaged under 10 cents per pound for 12 consecutive months), together with less favourable weather conditions in some areas, are finally bringing production levels back into line. Although it is too early to speculate with any degree of accuracy, the 1983/84 sugar position seems certain to be one of much reduced surplus and possibly even one of balanced supply and demand. Initial 1983/84 production estimates show that few, if any, major producers will increase their crop; once again, the EEC is expected to reduce the area planted to beet this year by some 6%, Cuba is experiencing well-publicized problems with rainfall, while, conversely, drought appears to be a serious problem for certain Southern Hemisphere producers. In Thailand concern has already been expressed about the quantity of cane that will be produced in 1983/84.

"For the time being demand is probably insufficient to fuel a significant price recovery and the market may

[1] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 133-136.
[2] *The Sugar Situation*, 1983, (383).

spend some months around current levels. However, should the 1983/84 supply/demand picture begin to show the prospect of a balance, even cautious buyers may feel it prudent to cover some of their 1984 requirements around current levels, while producers will withdraw their selling. A recovery to about the 10 cents per pound level would then be a realistic possibility. As in 1979/80, the actual turning point in the market might well be determined by a change in sentiment drawing speculators back into the sugar market."

International Sugar Agreement

The ISO Preparatory Committee met in London during March 14-18, its third and final meeting, and agreed to confirm earlier tentative arrangements to hold a UN Sugar Conference at the UNCTAD headquarters in Geneva, to begin on May 2 and continue for three weeks under the chairmanship of Sr. Jorge Zorreguieta of Argentina. Should a second session be needed this would probably be convened during September/October 1983.

As a preliminary to the March meetings, representatives of Australia, Brazil and Cuba had met officials of the EEC Commission in Brussels at the end of February in order to clarify their different views on requirements for an agreement which would be effective. The Commission also asked the Council of Foreign Ministers for a mandate to negotiate a new agreement; this was eventually granted on March 14 after France dropped its insistence that a proposal for an international buffer stock of sugar be incorporated as part of the mandate.

The EEC was thus formally represented at the Preparatory Committee meeting, where its representatives and those of ISA members involved were provided with a number of working papers prepared by the ISO Secretariat, including one giving the outline of contents of a new Agreement for consideration and amendment, as well as submissions by a number of the countries taking part.

The EEC Commission has proposed a system very different from the current ISA under which amounts from small exporters – up to 70,000 tonnes – would not be limited by quotas or stocks, while medium exporters would be subject to a quota system like the existing one. The major form of control of supplies to the market would be the compulsory holding by large exporters – perhaps the ten largest – of stocks much greater than the present ISA's special stocks. As prices rose, the quota limitations and withheld stocks would be freed in stages. Several objections have been raised, the most important being that it would not be effective since the major exporters could continue to expand production so as to provide the required stocks while still maintaining exports at a level harmful to the interests of other members.

Past agreements have leant heavily on quota mechanisms for control of supplies to the market and these are still favoured by many of the delegates to the meeting. Nevertheless, as C. Czarnikow Ltd. noted[1], "there have been numerous voices raised in favour of augmented stocks. It will be recalled, incidentally that when the question of special stocks was first raised during the course of negotiations in Geneva in 1977 a quantity of five million tonnes was mentioned. This was considered at the time to be impracticable and the quantity was therefore reduced to 2.5 million tonnes and this is the amount which members are scheduled to have set aside by the end of this year. Many delegations are now talking of stocks amounting to five to six million tonnes or, in some instances, even more as an additional regulatory measure.

"Many exporting delegations have called for increased obligations to be taken by importing countries and certainly, to be successful, it will be necessary for importers to play a full part in a new Agreement. Nevertheless, there is an understandable reluctance on their part to undertake measures which, if successful, will lead to their having to pay higher prices, unless there are safeguards to ensure that in times of high prices they have a security of supply and also that the Agreement will work in such a way as to apply effective control on prices.

"Since the last Geneva Conference to negotiate an International Sugar Agreement many countries have suffered considerably as a result of the international trading situation. Delegates have mentioned the high cost of maintaining representation over an extended period and have called for an increased sense of urgency on the part of participants than was apparent in 1977. In that year a total of ten weeks were spent before the Agreement could be satisfactorily negotiated; it is unlikely that so long as a period can be contenanced this year."

Cuban cane drop damage

The harvest in Cuba generally runs from November to April, during the dry season, and ceases with the onset of rains in May. This year, however, has been the wettest for 40 or 50 years and heavy rains have fallen during the past three months with disastrous effects on sugar production. In some parts of the island rainfall has been five times the normal, making harvesting impossible and interrupting supplies of cane to the factories. The newspaper *Granma* has reported operating efficiencies reduced from 93% a year ago to less than 80%, and this does not include the factories which have had to shut down completely for lack of cane.

The Deputy Minister for the Sugar Industry has stated that sugar production would reach only 7 million tonnes against a target of 8.2 million, and it is said that the harvest will run even into June; this would involve losses because of the normal summer rains and also by the diminishing sugar content in the cane.

London sugar futures market currency

Members of the United Terminal Sugar Market Association held an Extraordinary General Meeting on March 23 to decide whether the London No. 4 raw sugar futures contract should be changed from sterling to dollars. Sugar traders sounded out the views of their clients during the previous month and at the meeting it was first announced that there was a majority in favour of the change. It was then discovered that the meeting had not followed the rules of the Association so that the vote was invalid, and it was agreed that a new meeting should take place on April 18 to consider the matter again; in the meantime, quotations on the No. 4 contract have continued to be denominated in sterling.

Originally it was thought that traders in physical sugar, who generally favoured the change, owing to the volatility of the pound relative to the dollar, would ensure that it would be adopted by the Market; however, other dealers, concerned at the loss of opportunity for profitable arbitrage between the London sterling and New York dollar market, are believed to have gathered support for retaining the present contract currency, so that it is not a foregone conclusion that the earlier vote will be repeated.

[1] *Sugar Review*, 1983, (1641), 53-54.

An enzyme electrode for dextran analysis

By RICHARD RIFFER
(Research Department, California and Hawaiian Sugar Company, Crockett, California, USA)

Dextran in raw sugar arises from infection of sugar cane by *Leuconostoc* bacteria, which abound in the environs of the cane fields and mills. Such contamination results in higher refining costs, reduced efficiency of refinery operations, increased sugar losses, and reduced product quality. Thus, rapid and accurate dextran analysis is highly desirable in the sugar refinery.

The analysis is a relatively difficult one because of the striking diversity of structure displayed by this polysaccharide. These dissimilarities affect even those techniques ordinarily thought to be highly specific. For example[1], antisera produced by immunization with dextrans containing a high proportion of secondary linkages contain antibodies that precipitate these dextrans but do not react with those that are more highly 1,6-α-linked*. Since all dextrans contain substantial numbers of 1,6-α linkages (by definition, at least 50%), the use of an enzyme with activity restricted to such linkages offers the prospect for greater specificity than can be achieved using other techniques. Furthermore, such a method should be relatively insensitive to molecular weight, which can affect procedures that involve precipitation or light scattering.

We have used enzymes to develop a rapid, specific, and sensitive potentiometric method for dextran analysis, described here. The technique makes use of a sequentially-working immobilized enzyme system in a three-layer cellulose sheath. This sandwich, overlaid on a platinum redox electrode, systematically degrades dextran and in the process produces an oxidizing species that can be detected by the electrode. Dextran is hydrolysed stepwise to glucose, which acts as a substrate for glucose oxidase that in turn produces gluconic acid and hydrogen peroxide. Enzymes were selected that are readily available commercially. The preparations should in addition be free of contaminant enzymes that could impair specificity, particularly α-amylase, and – if sucrose is to be present – invertase.

Dextranase

Pure mould dextranase, such as that from *Penicillium*, is likely to be endo-1,6-α-D-glucosidase, which catalyses hydrolysis of dextran to isomaltose and higher isomaltosaccharides. The initial attack is not entirely random, because certain linkages in close proximity to branch points tend to be resistant to hydrolysis[2, 3]. *Bacterial* endo-dextranases yield tri-, tetra-, and pentasaccharides as the principal products; only small amounts of isomaltose are liberated[4].

R. Riffer

Pure preparations of the *exo*-enzyme, which would produce glucose directly from dextran, are not readily available commercially. However, crude preparations of the endo-enzyme may contain the exo-enzyme as a contaminant.

The dextranase must be free of α-amylase activity, which would hydrolyse starch. α-Amylase also slowly attacks 1,6-α linkages in dextran[5–7], but a parallel hydrolysis of 1,4-α starch linkages by dextranase apparently does not occur.

The possibility of interference by starch (amylopectin) and hemi-celluloses ("gums") in analyses using dextranase was investigated by Richards & Stokie[8]; the apparent "dextran" contents were 2.5% and 0.8%, respectively.

α-Glucosidase

For hydrolysis of isomaltose to glucose, the enzyme of choice is isomaltase which, however, is not at present readily available commercially. This at first seemed an insuperable barrier to fabrication of a dextran electrode. However, α-glucosidase, which is easily obtained, attacks 1,6-α bonds, albeit more slowly than the 1,4-α bonds of its normal substrate, maltose.

The substitution of α-glucosidase for isomaltase imposes restrictions on the construction and use of the dextran electrode, however. First, α-glucosidase is active toward sucrose so that measurement must be performed on a total polysaccharide fraction, which is readily obtained by precipitation with 80% ethanol. Second, α-glucosidase catalyses hydrolysis of starch to glucose via endwise attack. This problem can be circumvented by imposing a dialysis membrane barrier between the dextranase and the α-glucosidase. This envelope permits passage of isomaltose and isomaltosaccharides but excludes starch. An alternative we have found more satisfactory is pre-treatment with immobilized α-amylase. Another option is removal of sucrose and invert by dialysis or ultrafiltration. It should be noted that currently-used methods for specific analysis of traces of polysaccharides in sugar also require removal of the sugar before attempting to determine the polysaccharide.

* This apparent drawback in the immunological procedure can be exploited. We are currently studying the use of immobilized concanavalin A (a lectin, or haemoglutin, from jack bean) to characterize polysaccharides by degree of branching. Secondary linkages are important because they confer additional solubility on the molecule, which hinders removal in the refining process.

1 Walker: "International Review of Biochemistry, Biochemistry of Carbohydrates II", Vol. 16, Ed. Manners (University Park Press, Baltimore) 1978, p. 83.
2 Abbott & Weigel: *J. Chem. Soc.*, 1966, 821.
3 Bourne, Hutson, & Weigel: *Biochem. J.*, 1963, **86**, 555.
4 Walker: "International Review of Biochemistry, Biochemistry of Carbohydrates II", Vol. 16, Ed. Manners (University Park Press, Baltimore) 1978, p. 99.
5 Marshall: *Adv. Carbohydrate Chem. & Biochem.*, 1974, **30**, 286.
6 Robyt, Kimble, & Walseth: *Arch. Biochem. Biophys.*, 1974, **165**, 634-640.
7 Robyt: Private communication.
8 *I.S.J.*, 1974, **76**, 103-107.

Glucose oxidase

The enzymatic catalysis of glucose oxidation proceeds as follows:

$$\beta\text{-D-glucose} + ENZ_{(ox)}(FAD) \rightleftharpoons \delta\text{-gluconolactone} + ENZ_{(red)}(FADH_2)$$

$$\delta\text{-gluconolactone} + H_2O \rightleftharpoons \text{gluconic acid}$$

$$ENZ_{(red)}(FADH_2) + O_2 \rightleftharpoons ENZ_{(ox)}(FAD) + H_2O_2$$

The net reaction is:

$$\beta\text{-D-glucose} + H_2O + O_2 \overset{ENZ}{\rightleftharpoons} \text{gluconic acid} + H_2O_2$$

The glucose oxidase should be relatively free of catalase, which rapidly decomposes hydrogen peroxide, increasing its rate of disappearance[9] by a factor of 10^{15}. A single molecule of catalase is able to decompose more than 10×10^6 molecules of hydrogen peroxide per second!

The anomeric form of the glucose present is an important consideration. The reaction is specific for β-D glucose, which is oxidized 157 times more rapidly than the α-form[10]. Glucose oxidase preparations frequently contain mutarotase as an impurity, which permits oxidation of total α-glucose more rapidly than would spontaneous mutarotation. Highly purified samples of the oxidase may require addition of mutarotase if voltage readings are observed to drift.

A ferrocyanide/ferricyanide redox system is used as indicator of the peroxide generated. This is accomplished by adding a known excess of the reduced form to the sample to be analysed. A stable redox potential reading requires an equilibrium between two oxidation states. Without the additive, the concentration of the reduced form of peroxide, water, is so much greater than that of the oxidized form that the logarithmic term in the Nernst equation is indefinite. Because of the relatively high ferrocyanide concentration, the formed hydrogen peroxide is so rapidly reduced that the effect of low levels of catalase contaminant is nullified. Ferricyanide has also been reported to activate oxidase systems[11].

Enzyme kinetics

Enzymatic hydrolysis of dextran to a true limit is a relatively slow process. Dextranases are much smaller molecules than dextrans. The latter, which tend to occur as molecular aggregates, must diffuse to a suitable site on the enzyme before reaction can proceed. Tilbury & French[12] studied the kinetics and found that 20 units of dextranase (in solution) hydrolysed 15 ppm of dextran per minute in 100 ml of Puerto Rican cane juice. Thus, under similar conditions, a five-minute equilibration would be sufficient for measurement of dextran at concentrations approaching 75 ppm; at high dextran levels, dilution might be advisable. Note that, according to the unit definition, 20 units of dextranase should liberate 20 μmoles or 6.84 mg of isomaltose per minute, which is equivalent to 6.48 mg of dextran (65 ppm.min^{-1}).

This discussion assumes, of course, that the dextranase treatment is rate-determining. However, in a multistep enzyme system, as in any series of consecutive reactions, the reaction rate is determined by the slow step. Since isomaltose is a poor substrate for α-glucosidase, it may be assumed that this step is limiting.

It is important to note that complete hydrolysis of dextran to glucose is not a requirement for useful electrode function. The immobilized enzyme system can be considered analogous to a living cell, in which reactants and products are transferred by diffusion across the cell membrane. In such a flow system, after reaction has proceeded for some time, a steady state is attained. An integrated rate law can be written for such a system that is identical to that for a static system, but in which t represents contact time rather than reaction time: t is the average time that a dextran anhydroglucose unit takes to pass through the enzyme reactor, emerging as gluconic acid.

Thus the time required for analysis using the electrode is actually the time required to establish a steady state. Of course, if newly released glucose is being oxidized continuously during measurement, it is necessary to record the potential reading of each sample after a definite time interval and to do likewise during calibration.

We did not attempt to assay the individual immobilized enzymes but instead calibrated the sequential system with standards. Tilbury & French[12] reported apparent K_m values of 0.034 and 0.472 for dextranase on mixed juice from Puerto Rico and Jamaica, respectively, clearly reflecting differences in branching. If the substrate concentrations for the consecutive steps are all much smaller than their respective K_m values, $V < V_{max}$ for each step, and the reaction follow first-order kinetics. Under such conditions the concentration changes can be represented as in Figure 1.

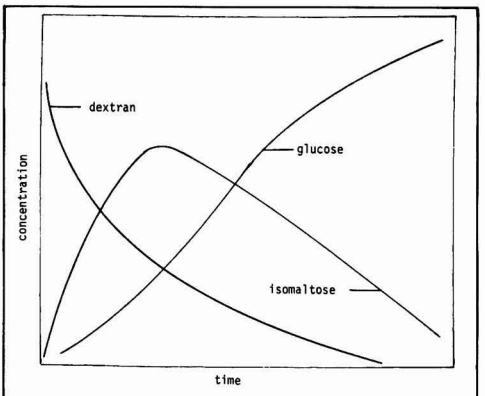

Fig. 1. Representation of the three-step sequentially working enzyme system, with [S] $< K_m$ for each step. As isomaltose accumulates, its rate of decomposition becomes greater, and therefore its concentration passes through a maximum. A high maximum concentration is shown, reflecting a relatively small rate constant

If the α-glucosidase step is rate determining,

$$[Fe(CN)_6^{-3}] \propto [\text{dextran}]_0(1-e^{-kt}),$$

where k is the rate constant for isomaltose hydrolysis. When a steady state is attained, t is fixed.

For enzymatic determination of substrates, the reaction must be first order (or pseudo first order) with respect to substrate, i.e. [S] $< K_m$. When [S] $\gg K_m$ the reaction is zero order with respect to substrate and first order with respect to enzyme concentration; such conditions are used for enzyme activity measurement.

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9 Tinoco, Sauer, & Wang: "Physical Chemistry, Principles and Applications in Biological Sciences," (Prentice-Hall, Englewood Cliffs, N.J.) 1978, p. 328.

10 Bentley: "The Enzymes," 2nd edn., Vol. 7, Ed. Boyer, Lardy, & Myrbäck. (Academic Press, New York) 1963, pp. 567-576.

11 Cheng & Christian: *Anal. Chim. Acta,* 1979, **104**, 47-53.

Potentiometry

A platinum electrode, when immersed in a solution containing both the oxidized and reduced states of a reversible redox system, develops a potential that is proportional to the ratio of the two oxidation states. For a ferro/ferricyanide system the Nernst expression is

$$E = E^{\circ} - 0.0591 \log \frac{[Fe(CN)_6^{-3}]}{[Fe(CN)_6^{-4}]}$$

The only role of the redox electrode is to provide or accept electrons.

Enzyme electrodes require fairly high enzyme activity to ensure a short response time. If the enzyme preparation used is of low activity, a thicker enzyme layer is needed, which requires more time for diffusion. At high stirring rates the substrate, in this case dextran, quickly diffuses to the enzyme surface, where it can react, ultimately producing ferricyanide. A potential is produced which is a log function of the dextran concentration. A saturated calomel electrode (SCE) is used as reference.

A high impedance voltmeter should be used so that current flow does not cause a voltage drop. An amperometric version of the glucose electrode has been described in the literature[13-16].

The electrode is relatively insensitive to temperature. Small shifts in equilibrium potential occur because of the temperature coefficient in the Nernst equation; the form shown above is for 25°C. Room temperature operation is convenient; high temperature will, of course, denature the enzymes. Heavy metal ions may also be damaging. As with any electrodes, daily calibration is good practice.

There is a critical amount of enzyme necessary to produce a Nernstian response; further increases have little effect on the response characteristics of the electrode. The useful life of the electrode can be extended by using high enzyme levels, but the sensitivity cannot be improved beyond a certain limit. Buffer salts are required to maintain linearity at high flux rates.

The response curve shows departure from linearity at low concentrations owing to the detection limit of the sensing electrode. At high concentrations the levelling-off is due to saturation of enzyme at concentrations greater than K_m, as predicted by the Michaelis-Menten equation: this reflects a transition from first-order to zero-order kinetics as V approaches V_{max}.

The enzyme reactor

Smith & Lenhoff[17] found in their immobilization studies on cellulose that the maximum amount of bound protein was 2.9 $\mu g.cm^{-2}$, but this figure seems low. As a general rule of thumb, 10-20 units of enzyme activity are sufficient to give an excellent response curve[18]. If one assumes that a 5 cm^2 surface area is available, about 1.45 x 10^{-2} mg of enzyme can be immobilized on it. Thus, to obtain 10 units, one requires an enzyme activity of at least 690 units/mg. Such activities may not be available in enzymes from suppliers, but we believe the figure is on the high side.

In order to increase the area available for enzyme immobilization, we developed a three-layer cellulose sheath made from filter paper; see template, Figure 2. After immobilization the sections are assembled into open-ended boxes, which nest and slip over the redox electrode. A dialysis membrane (MW cut-off 14,000) can be used beneath the dextranase layer to exclude starch (Figure 3); this can be dispensed with if isomaltase is available for the middle layer, or if samples are to be pre-treated with α-amylase.

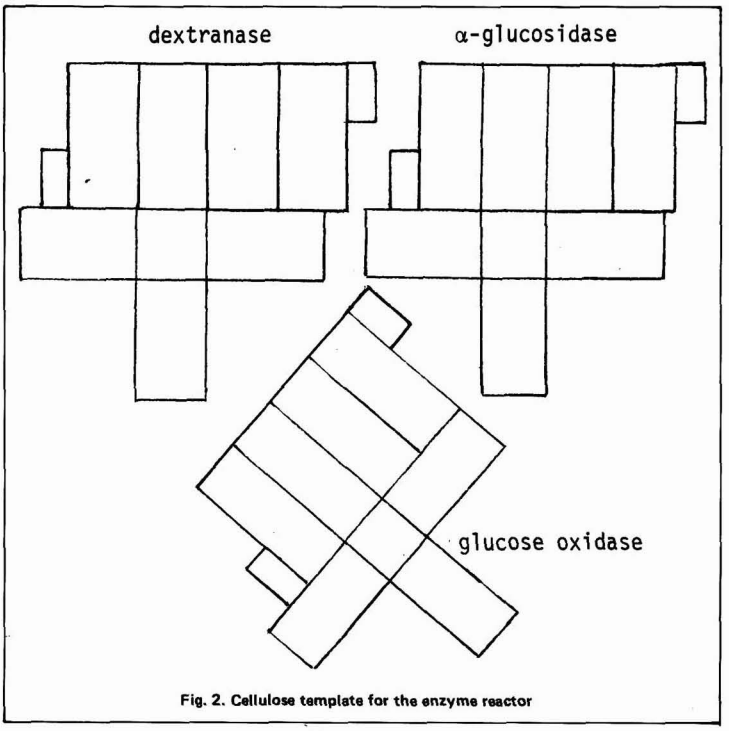

Fig. 2. Cellulose template for the enzyme reactor

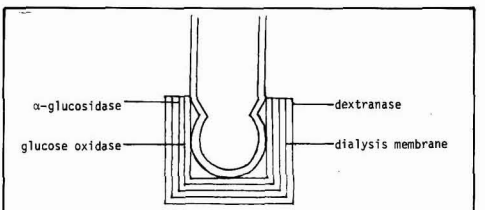

Fig. 3. Assembled dextran electrode

12 *Proc. 15th Congr. ISSCT*, 1976, 1277-1287.
13 Guilbault & Lubrano: *Anal. Chim. Acta*, 1972, **60**, 254.
14 Idem: *ibid.*, 1973, **64**, 439.
15 Lemke, Falk, Haker, & Seel: *Z. med. Labor.-Diagn.*, 1977, **18**, 80-101.
16 Clark: *Methods in Enzymology*, 1979, **16**, 448-479.
17 *Anal. Biochem.*, 1974, **61**, 392-415.
18 Guilbault: *Methods in Enzymology*, 1976, **44**, 579-633.

As an alternative to the cellulose sheath we studied copolymerization with glutaraldehyde and cross-linking to bovine serum albumin (BSA)[19], but this allows no means to exclude starch and thus requires isomaltase (or α-amylase pre-treatment). BSA is an inert lysine-rich protein that acts as a supporting matrix; glutaraldehyde reacts with the amino groups in lysyl residues. This is reported to have a favourable effect on the insolublilized activity and stability. The technique, although widely used, might be less favourable for dextranase because of its large substrate; steric hindrance or diffusion problems could result.

Materials and methods

Substrates: Dextran standards were obtained from Pharmacia Fine Chemicals, Piscataway, N.J., USA.

Enzymes: Dextranase *(Penicillium),* lyophilized solid, 1200 units/mg; α-glucosidase (yeast), crystalline suspension in ammonium sulphate, 250 units/mg; glucose oxidase *(Aspergillus niger),* lyophilized solid, 277 units/mg; and α-amylase *(Aspergillus oryzae),* 132 units/mg were all purchased from Calbiochem-Behring, La Jolla, Calif., USA or from Sigma Chemical Co., St. Louis, Mo., USA, and used without further purification.

Reagents: N-(3-Aminopropyl) diethanolamine and 2,4,6-trichloro-1,3,5-triazine (cyanuric chloride, sTT) were obtained from Aldrich Chemical Co., Milwaukee, Wis., USA; the latter reagent was recrystallized from carbon tetrachloride.

Electrode: The platinum redox electrode was obtained from Orion Research Inc., Cambridge, Mass., USA.

*Preparation of dichloro-*sym*-triazinyl cellulose*[17]: Patterns (Figure 2) were cut from 9-cm circles of Whatman No. 1 filter paper and weighed. The papers were washed and drained, then soaked in 3M NaOH for 15 min and the excess removed by draining. (The wet papers should be manipulated carefully with a rubber policeman; forceps tend to tear them.) To the papers was added an equal weight of 5% w/w sTT in dioxane-xylene (1:1 w/w). After 30 min the excess was removed by draining, which was followed by washing for 10 min each in (a) dioxane (twice); (b) acetic acid-water-dioxane (1:1:2 w/w/w); (c) water; and (d) acetone (twice). The papers were dried *in vacuo* and stored for later use. The treatment stiffens the paper considerably, probably as a result of cross-linking between cellulose chains.

Treatment of activated cellulose papers with N-(3-aminopropyl) diethanolamine[20]: The papers were made slightly cationic by treatment at room temperature with 20 ml of a solution containing 82.5 mM N-(3-aminopropyl) diethanolamine and 2.5M NaCl. After 7.5 min, 10 ml of 1M HCl was added. The papers were drained, then washed with 5M NaCl, followed by water and acetone, and replaced in the vacuum desiccator.

Preparation of immobilized enzymes[17]: Each paper was treated with 2 ml of 50 mM sodium acetate buffer of pH 5, containing 8 mg of enzyme. After 4 hr at room temperature, the papers were drained and washed thoroughly with 1N NaCl and with water, to remove noncovalently bound material.

Assembly of enzyme reactor: The dried papers were assembled into open-ended boxes using epoxy resin and waterproof tape, such as weather stripping. Openings at the base were sealed with epoxy resin. After drying, the boxes were fitted together. A dialysis bag (MW cut-off 14,000) with one end sealed was placed beneath the dextranase layer. The assembled sheath fitted snugly over the end of the platinum redox electrode.

Immobilization of α-amylase on alkylamine glass beads: To 100 g of alkylamine glass beads (Corning Glass Works, Corning, N.Y., USA) was added 150 ml of 2.5% glutaraldehyde in 0.1M sodium phosphate buffer of pH 7. The reaction mixture was placed in a vacuum oven at room temperature and evacuated for 1 hr to remove air bubbles.

The mixture was then filtered with suction and washed with distilled water. One gram of α-amylase was dissolved in the minimum amount of the pH 7 buffer and chilled in an ice bath. The glass derivative was added and the mixture allowed to react for four hours. Mechanical stirring should be avoided; it grinds the glass. The product was filtered, washed with distilled water, and stored in a closed container. The product should not be frozen: the high moisture content causes the beads to crack.

α-Amylase immobilized on polyacrylamide is available from Sigma Chemical Co.

Preparation of samples: Starch was removed by treatment with immobilized α-amylase. A 50 ml sample of 40°Bx was incubated with 2.5 g of α-amylase beads for 1 hr at 55°C with frequent agitation and then filtered. Alternatively column treatment may be used. The polysaccharide fraction was precipitated by treating 10 ml of the α-amylase-processed solution with 40 ml of absolute ethanol. A small amount of filter aid was added, and the mixture filtered through 8μ paper, then washed with 150 ml of 80% v/v alcohol. The polysaccharides were eluted with 95 ml of boiling water and diluted to the mark of a 100 ml volumetric flask.

Measurement: Calibration was made with standard dextrans measured in 0.025M sodium acetate buffer of pH 5. To each was added 1.0 ml of 0.62M $K_4Fe(CN)_6$ per 100 ml of sample. Samples to be measured were diluted with an equal volume of 0.05M sodium acetate buffer of pH 5, and $K_4Fe(CN)_6$ was added. The samples should be stirred magnetically with enough vigour for a vortex to appear: the glucose oxidase reaction requires oxygen. Between measurements the electrode is equilibriated in buffer containing ferrocyanide.

Storage: The electrode was stored for several weeks with no evidence of loss of activity. It may be stored in buffer at room temperature, but we recommend refrigeration with a dialysis membrane cover (MW cut-off 2000) for protection from bacterial action. We have dried the cellulose sheath in a vacuum desiccator repeatedly without inactivating the enzymes.

The sTT-hardened cellulose is quite durable, whereas untreated filter paper would rapidly disintegrate under comparable usage. According to Guilbault[18], one can expect to get 200-1000 assays from an enzyme electrode.

Results

If the sheathed electrode is used to measure maltose or glucose, one or two of the enzyme layers are by-

19 Broun: *ibid.,* 263-280.

20 Wilson, Kay, & Lilly: *Biochem. J.,* 1968, **109,** 137-141.

passed. Even if only a single layer is being utilized, the argument for steady-state kinetics is valid. A certain minimum initial concentration of substrate is required to achieve a steady state. When the electrode is immersed in a solution containing ferrocyanide and a small amount of glucose, the potential rises rapidly to value E_{ss}† as a steady state is attained. However, glucose is not being continuously supplied to the system; there is a small initial concentration that is consumed as the reaction proceeds. As the substrate level drops off, the steady-state equilibrium can no longer be sustained, and the rate of potential rise declines, finally reaching a new equilibrium at E_{final}.

There is a linear relation between the potential and the logarithm of the substrate concentration. To prepare a calibration curve, either E_{ss} or E_{final} values may be plotted; a curve is shown in Figure 4. The linear range for glucose is from about 50 to 150 ppm, but the useful range is somewhat larger.

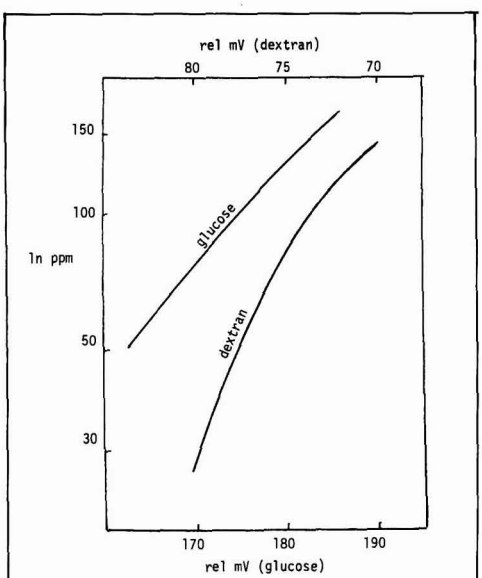

Fig. 4. Relative mV as a function of substrate concentration

With dextran a similar curve is obtained. The slope will vary according to the characteristics of the enzyme reactor. Interestingly, with at least one reactor that we constructed, a negative slope was observed (Figure 4). How is it possible that progressively higher concentrations of dextran will result in *declining* voltages? The unexpected result arises, we believe, from the slow α-glucosidase step.

Dextran is non-reducing, except for end groups. Upon hydrolysis by dextranase, a much higher concentration of reducing groups is formed, and these accumulate at the α-glucosidase bottleneck. Differences in the enzyme purity (activity) will of course be manifested in this limiting step. Note that, of all polysaccharides present, only dextran will generate such reducing species. The slow α-glucosidase step appears to be comparable in rate to the oxidation of the newly formed aldehyde groups by ferricyanide. Such oxidation reduces the value of the $[Fe(CN)_6^{-3}]/[Fe(CN)_6^{-4}]$ ratio and lowers the equilibrium potential.

It is important here to note that the rate of disappearance of ferricyanide under these conditions is first order[21–27]. Thus, we have ferricyanide being formed and depleted by two competing first-order reactions, k_1 and k_2. The integrated rate equation can be expressed as

$$k_1 + k_2 = \frac{1}{t} \ln \frac{[Fe(CN)_6^{-3}]_e}{[Fe(CN)_6^{-3}]_e - [Fe(CN)_6^{-3}]_t}$$

where subscript e refers to the amount formed at equilibrium and subscript t refers to the concentration at time t. Since the net reaction is first order, linearity is preserved.

To test this hypothesis, a set of dextran samples was measured in which iodide replaced ferrocyanide. Like ferrocyanide, iodide rapidly reduces hydrogen peroxide, but the iodine formed does not readily oxidize reducing sugars. Under such circumstances, a positive slope would be expected, and this was what was observed. Iodide thus could be a possible substitute for ferrocyanide in the procedure.

The curve shown in Figure 4 is for dextran T70 (MW 70,000), but higher molecular weight material results in an essentially identical curve. Samples with added starch, when pre-treated with immobilized α-amylase, yielded results that could not be distinguished from starch-free samples. With sheaths constructed using a dialysis membrane, added starch had no effect on potential, but the time required to attain equilibrium was somewhat longer because of the additional diffusion burden.

The linear range and useful working ranges are similar to those observed for glucose. A departure from linearity is observed as S approaches K_m. The sensitivity of the method is comparable to that of the alcohol haze procedure, and the two techniques show good agreement in comparative tests. Glucose, maltose, or isomaltose may be determined in the presence of dextran by using an external dialysis membrane.

Conclusion

Using this technique, starch-free samples of polysaccharides can be analysed potentiometrically in a few minutes, much faster than other analytical methods for dextran. Availability of isomaltase would eliminate the starch removal step and greatly enhance the usefulness of the technique. The full potential of the method as originally conceived cannot be realised without this critical enzyme.

It should be evident from these discussions that by no means do we regard the technique described here as the ultimate in dextran potentiometry. Rather it is hoped that this article will serve as both a stimulus and a focus for further development. Toward that end, we have included here much detail and documentation. The electrode offers promise as an additional approach in solving a difficult analytical problem.

† To avoid confusion voltages are designated by E, and V reserved to refer to reaction velocities.

21 Green: "The Carbohydrates," 2nd edn., Vol. 1B, Ed. Pigman & Horton. (Academic Press, New York) 1980, p. 1148.
22 Singh: *Vijnana Parishad Anusandhan Patrika*, 1960, **3**, 97.
23 Nath & Singh: *Z. Physik. Chem.*, 1963, **224**, 419.
24 Idem: *J. Phys. Chem.*, 1965, **69**, 2038.
25 Srivastava, Nath & Singh: *Bull. Chem. Soc. Japan*, 1965, **39**, 833.
26 Idem: *Tetrahedron*, 1967, **23**, 1189.
27 Kasper: *Z. Physik. Chem.*, 1963, **224**, 427.

Summary

A detailed description is given of a potentiometric method using an enzyme electrode for determination of dextran in sugar solutions. The method is very rapid and gives results comparable to those of the haze test. However, it requires prior separation of starch if this is present, which reduces its utility; realization of the full potential of the method awaits commercial availability of the enzyme isomaltase to eliminate the starch removal step.

Une electrode à enzyme pour l'analyse du dextrane

Une méthode potentiométrique, utilisant une électrode à enzyme pour la détermination du dextrane dans les solutions sucrées, est décrite en détail. La methode est très rapide et donne des résultats comparables à ceux de l'essai néphélométrique. Cependant, elle requiert la séparation préalable de l'amidon s'il y en a, ce qui réduit son utilité; la réalisation des pleines possibilités de la méthode attend la disponibilité commerciale de l'enzyme isomaltase pour éliminer le stade de séparation de l'amidon.

Eine Enzymelektrode für die Dextrananalyse

Eine genaue Beschreibung einer potentiometrischen Methode unter Verwendung einer Enzymelektrode zur Dextranbestimmung in Zuckerlösungen wird gegeben. Die Methode ist sehr schnell und liefert Ergebnisse, die mit dem Trübungstest vergleichbar sind. Sie erfordert jedoch die vorherige Abtrennung der Stärke, sofern welche vorhanden ist, was die Anwendung beschränkt. Die Realisierung des gesamten Potentials der Methode wird von der zukünftigen, kommerziellen Verfügbarkeit des Enzyms Isomaltase zur Eliminierung der Stärke-Abtrennung abhängen.

Un electrodo enzimático para análisis de dextrano

Se presenta una descripción detallada de un método potenciométrico que emplea un electrodo enzimático para medir dextrano en soluciones azucarados. El método es muy rápido y produce resultados comparable con ellos del ensayo de calina. No obstante, requiere separación previa del almidón si es presente, que reduce la utilidad del método; realización de su potencial entero espera la disponibilidad comercial del enzima isomaltasa para eliminar la etapa de separación de almidón.

Evaluation of deteriorated beet

By M. SHORE, J. V. DUTTON and B. J. HOUGHTON
(British Sugar plc, Research Laboratories,
Colney, Norwich, Norfolk)

(*contd. from p.* 110)

THE VALUE OF DETERIORATED BEET

Beet frosted after harvesting

It should be stated at the outset that *any* beet deterioration is undesirable and represents a loss in value both to the grower and the processor. However, recognising that deterioration as described above does occur, it is relevant to try to assess the losses in value represented by various degrees of deterioration. It is also pertinent to consider how the factory might carry out their assessments in order to minimize the effects.

With the present state of knowledge it is suggested that the factory assessment, because it has to be quick, must be based upon visual examination. The actual mechanism of carrying out that visual assessment is not for detailed consideration here but in general it involves splitting the beet in half longitudinally in order to examine the condition of the beet tissue.

Examples of beet treated in this way, photographs of which are given in Figures 1-4 may be used to draw up approximate assessments.

The photograph of beet sample D (Figure 3) is typical of a beet frozen and just thawed in the clamp. From analysis this sample is just acceptable for processing, the dextran (0.3 g/100 g S) and invert sugar (1.6 g/100 g S) being less than the limits suggested above. A few more days' storage of these beet would be enough for further deterioration such that the analysis exceeded these limits, thus causing factory processing problems. These beet should be processed immediately on receipt and definitely not stored on the factory site. There will be no excess payment for false pol with sample D (see comparison of pol and sucrose in Table II where the small difference is probably due to sampling error) but some financial penalty will be placed upon the factory because of the high level of invert sugar (Table II) and its certain destruction in process mainly to acids, means that additional soda ash will be required (ca. 0.5 g per 100 g S); juice colours will be high and, consequent on this, the extraction of sugar will be reduced by at least 3% because of the resultant purity drop owing to the non-sugars introduced by the invert and soda ash.

As beet such as sample D deteriorate on storage they will change from a translucent appearance to resemble sample E (Figure 4) where the oozing, sticky juice from cut surfaces indicates a very high dextran content (4.9 g/100 g S) and suggests a correspondingly high invert sugar level (13 g/100 g S). These beet are definitely not processable. Beet sample J (Figure 1) shows a sound beet for visual comparison with samples D & E.

Often the factory has to contend with deliveries of mixed loads of frosted beet and sound beet; for example, from clamps where the outer layer is affected by frost but the inside layers are well protected. To decide if such a load is acceptable for processing can be an extremely difficult matter.

The acceptability of such a load may be deduced by considering loads consisting of mainly sound beet like sample J (Figure 1) but mixed with either 10% of gumming like beet sample E (Figure 4), or 3% of a much more deteriorated beet like sample B (Tables II and VI).

Using the analysis from Tables I, II and VI a mixed load composed of 90% of sample J and 10% of sample E may be expected to have an overall analysis of:

GLC Sucrose	16.0% beet
Dextran	0.3 g/100 g S
Invert	1.3 g/100 g S

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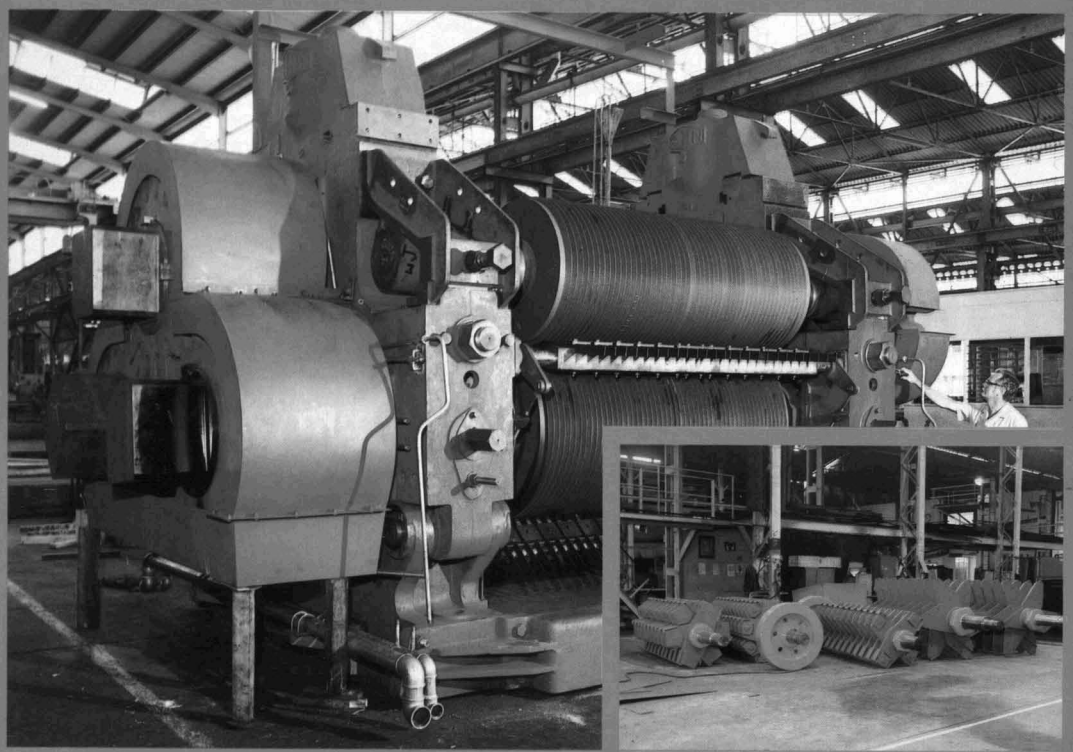

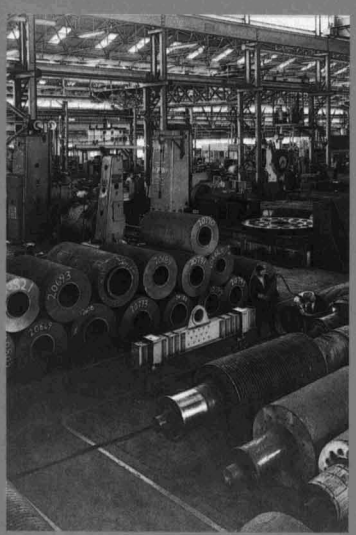

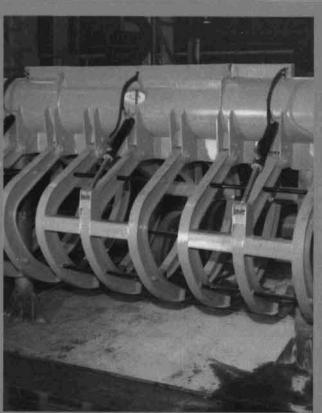

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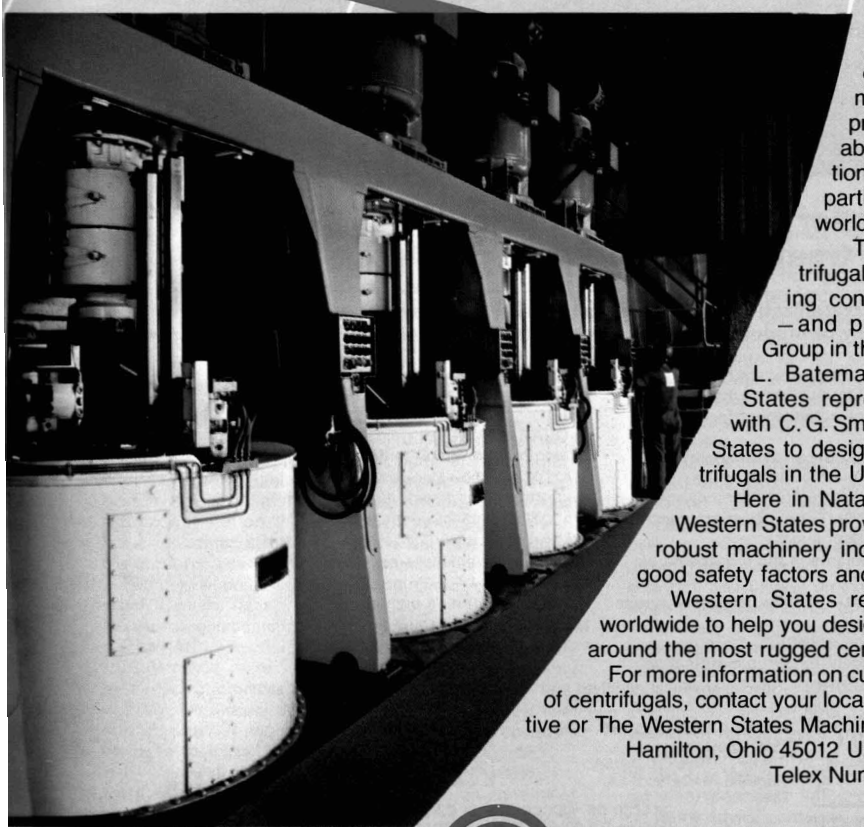

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This analysis would make such a mixed load acceptable according to the average levels of dextran and invert.

However beet in such a state of deterioration as represented by sample E may not be easily distinguishable from the very much worse state of deterioration as represented by the sample B and using the analytical data for sample B from Tables II and VI, it will be found that a mixed load composed of 97% of sample J and 3% of sample B would have the following overall analysis:

GLC Sucrose	16.2% beet
Dextran	0.5 g/100 g S
Invert	1.1 g/100 g S

In this case the dextran level would make such a mixed load unacceptable. If such a load were accepted for processing then the factory would necessarily have to resort to the use of flocculants at 1st carbonatation and to aragonitic calcium carbonate addition at 2nd carbonatation to alleviate filtration difficulties so as to continue processing[5, 6].

It is therefore concluded that mixed loads in which any significant percentage of deteriorated beet is present should be rejected.

Beet frosted before harvesting

A difficult problem arises (Figure 2) where beet have been frosted before harvesting, subsequently thawed and harvested and then have started to decompose. The lower unfrosted section consists of relatively healthy processable tissue. Table VIII shows the analysis of such beet as sample F top and G bottom (Figure 2) and samples L top and K bottom (not photographed).

Table VIII. Analysis of frosted and healthy sections of beet frozen before harvesting

Beet sample and section	Weight of section % beet weight	GLC sucrose % beet	Invert g/100 g S	Dextran g/100 g S
F Top	50	13.1	4.0	0.3
G Bottom	50	15.4	0.6	0.1
Whole beet F & G	(Calculated analysis)	14.3	2.2	0.2
L Top	67	3.8	95	23
K Bottom	33	14.3	0.9	0.1
Whole beet L & K	(Calculated analysis)	7.3	34	8.1

Figure 2 illustrates samples F and G; these beet were carefully divided to include beet material from visibly frost-damaged tissue as sample F and the remaining bottom section of the root as G producing about equal amounts of sections F and G. These particular beet were harvested when a thaw was under way and the frosted top sections were starting to decompose.

Samples K and L were beet from the same plot harvested 3 weeks later when the decomposition was more advanced.

The bottom sections G & K, although not apparently frost-damaged, have some dextran present, presumably by translocation from the upper rotted sections.

From the analytical data in Table VIII the whole beet (i.e. F plus G) would not be considered processable owing to their high invert content (> 2.0 g/100 g S).

However, although Section F is gummy in appearance, there would be no objection to its dextran content of only 0.3 g/100 g S, i.e. just lower than the proposed limit for rejection, although this level is, of course, undesirable. On the other hand, the levan concentration in Section F was much higher, viz. 0.3% on beet (2.3 g/100 g S) and this was undoubtedly the major reason for the gummy appearance which would probably have led to rejection during factory inspection.

On inspection in the factory there is no way of telling which of the two gums is causing the gumminess. Consequently rejection would be justified as although our investigations have shown levan to have a less serious effect than dextran on processing, Reinefield has stated that levan is involved in processing problems[9].

There is also the further justification for rejection involving the financial value of beet material such as Section F and reference to Table II shows that this beet material would be paid for as though it contained 14.1% sugar whereas in fact it contained only 13.1% sugar (sucrose). Thus a substantial financial overpayment would be made for beet material of very doubtful processing value.

If harvested in the form shown in Figure 2, therefore, beet such as F/G should be rejected, but, if such beet were somewhat overtopped before harvesting it is possible the remaining root would be acceptable for processing.

Beet which have frozen and thawed in the ground have in practice been harvested by overtopping to remove the majority of the decomposing top section, but it is important that all the visibly decayed section is removed before delivery otherwise the beet may not be processable. Samples K/L show that if the decomposition has been allowed to proceed for a much longer period then two-thirds of processable material would have to be removed. It is unlikely that this would be practical for the grower; consequently, such beet would be a total loss with respect to sugar processing.

The cost of process modification due to deteriorated beet

Since January 1977, when it was first tested, aragonitic calcium carbonate has been added to dextran-containing juices in order to assist the 2nd carbonatation filtration stage. Thereby, severe reductions in slice rate have been avoided and ultimately it has been possible to slice more deteriorated beet than would formerly have been the case. This type of remedial measure was introduced into British Sugar factories because frost damage is unpredictable in the UK and this particular procedure does not require any major changes in process or process plant. The cost of doing this is however not insignificant.

In January last campaign (1981/82) the additional cost of this calcium carbonate alone was in excess of £100,000 but this additional cost was incurred in the processing of between 250,000 and 500,000 tonnes of beet, much of which might have previously proved too difficult to process and so have been lost. Reductions in slice rate also involve an extension of the campaign thus putting good beet at risk of becoming deteriorated.

Purchase of this particular calcium carbonate represents the major new cost in processing; there are of course other increased costs associated with reduced slice rate, the use of increased amounts of lime and soda ash, the use of 1st carbonatation flocculants as well as the loss of revenue associated with lower extraction[6].

Cold winters affecting the end of the beet campaign in the UK are relatively infrequent so it is difficult to get some growers to follow British Sugar's harvesting and clamping advice consistently. Although there were more frequent and severe frosts in December 1981 than in that

month for the past century, excepting 1947, many of the additional processing costs could probably have been avoided if all growers had followed British Sugar's recommendations. In the event, there was significant frost damage so that it was deemed prudent to institute a rigorous inspection and rejection system at factories to obviate instances of deteriorated beet seriously interfering with slice rate.

As a result approximately 7.4 million tonnes of beet were processed and although 60,000 tonnes were lost this was a much smaller amount than would otherwise have been predicted.

Conclusions

(1) Deteriorated beet in the UK are principally beet which have been frozen and allowed to thaw. Similar deterioration can be caused by anaerobic conditions but the incidence is considered to be less than that caused by frost.

(2) The UK beet contract allows for rejection of frost damaged beet which are considered unsuitable for sugar manufacture. Unsuitability is best judged by the visual appearance of the cut tissue when the beet is split longitudinally.

(3) Relative to white healthy beet tissue, frozen but unthawed beet have a darker and translucent appearance with no gumming (e.g. D Fig. 3). Such beet are generally acceptable providing they can be processed immediately. However, any possibility of delays between reception and processing would necessitate rejection of such beet.

(4) Obviously darkened and gumming beet tissue should be rejected. Generally dextran gum is produced which has known deleterious effects in processing, especially at levels of more than 0.5 g/100 g sugar.

Gummy beet have also been found to contain relatively high invert sugar contents and, under normal process conditions, white sugar cannot be produced at levels above 2 g invert/100 g sugar without excessive remelting of sugar, with consequent extra fuel costs and decrease in sugar-end capacity.

Beet of gummy appearance may contain levan gum rather than dextran and while it has been reported from Germany that levan gum has similar deleterious effects on processing as dextran this has not been confirmed under UK conditions.

However, gummy beet containing high levan and low dextran were also found to contain sufficiently high levels of invert sugar to render them unacceptable for processing.

(5) Analysis of badly deteriorated beet has shown that as little as 3% of them in mixed loads with sound beet would render the load unprocessable.

(6) Beet frozen and thawed before harvesting can be suitable for processing if the deterioration in the crown is slight and the beet are overtopped at harvesting.

(7) While in healthy beet there is good agreement between the sucrose measured by polarimetry and the true sucrose content, the true sucrose content decreases significantly relative to the pol according to the extent of deterioration of the beet. In effect such beet are bought at higher prices than is merited by their true sugar contents.

(8) Although deteriorated beet are paid for at the full price they all prove more costly to process than sound beet because they tend to reduce slice rate, they reduce extraction and they require additional costly processing aids.

(9) Even under almost unprecedentedly severe UK winter conditions a combination of rigorous rejection based upon visual appearance of sectioned beet, concomitant with the use of suitable processing aids, was able to keep beet losses to the minimum.

Acknowledgements

The authors acknowledge with thanks the assistance of M. J. Coleman and K. Lambert in carrying out the analytical work reported and of R. Parslow in providing the prints of Figures 1-4.

APPENDIX I. METHODS OF ANALYSIS

(1) Preparation of beet extracts for analysis

6-12 beet were cut up into a brei with a Hobart VCM 25 food cutter. This brei was either deep frozen in batches or used immediately for further analysis.

52 g of brei were macerated with 356.4 cm^3 of either water or dilute basic lead acetate solution at 10,000 rpm, for 5 min in an Atomix blender[14] to give aqueous solutions, after filtration, for analysis.

Normally only pol was measured on the basic lead acetate filtrate with all other analysis immediately carried out on the water extract. Pol was measured on a 2 dm tube using an Optical Activity automatic polarimeter. GLC sucrose determined on the basic lead acetate filtrate gave the same results as determined on the water extract, but all the GLC sucrose measurements reported, except those in Tables VIIA and VIIB, were carried out on the water extracts for consistency.

(2) Sucrose by GLC

This method is as described previously[3] using the reported modifications for use with more dilute solutions. It would be expected to achieve coefficients of variation of about 0.3% by preparation of duplicate derivatives for each sample and quadruple injection of each derivatization.

(3) Glucose and fructose were determined by enzymmatic analysis[15].

(4) Raffinose was determined by paper chromatography[16].

(5) Dextran and levan were determined by TLC[17].

(6) Invert sugars were determined by tetrazolium colorimetric procedure[18].

Summary

The extent and nature of deterioration of beets in the UK, caused mainly by frost damage, has been studied and indications given on the losses and difficulties caused in processing as well as the economic cost through payment for optically-active non-sucrose as sucrose. Recommendations are made on rejection or acceptance of beets damaged by frost.

L'évaluation de betteraves détériorées

On a étudié l'étendue et la nature de la détérioration des betteraves en G.B., principalement causée par des

15 "Methods of Enzymatic Food Analysis" (Boehringer, Mannheim) 1980.

16 "Sugar Analysis – ICUMSA Methods" Ed. Schneider (ICUMSA, Peterborough) 1979, pp. 64-65.

17 *ibid.*, pp. 76-78.

18 Carruthers & Wootton: *I.S.J.*, 1955, **57**, 193.

dégâts de gel. On donne des indications sur les pertes et les difficultés du travail, ainsi que sur le coût économique provenant du paiement comme saccharose de non-sucres optiquement actifs. On fait des recommendations sur le rejet ou l'acceptation de betteraves endommagées par le gel.

Beurteilung von alterierten Rüben

Zustand und Eigenschaften von alterierten Rüben in Großbritannien, die in der Hauptsache durch Frost verursacht werden, wurden untersucht. Über die Verluste und die Schwierigkeiten bei der Verarbeitung und die ökonomische Bedeutung der Bezahlung von optisch-aktiver Nichtsaccharose als Saccharose werden Hinweise gegeben. Für die Ablehung und Abnahme von frostgeschädigten Rüben werden Empfehlungen gegeben.

Valoración de remolachas deterioradas

El grado y la natura de deterioración de remolachas en el Reino Unido, causado principalmente por daño como resulta de helado, se han estudiado y indicaciones se presentan sobre las pérdidas y dificultades que resultan en el proceso así como el costo económico por pago como sacarosa de no-sacarosa de actividad optical. Recomendaciones se hacen sobre denegación o aceptación de remolachas dañado por helado.

Colorant adsorption in the refinery

An HPLC study of the changes in colorant composition following factory decolorization of raw liquors with bone char, resin and granular carbon

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(*contd. from p.* 105)

The relative concentration of flavonoid colorants in ppm on sugar solids in raw liquor and fine liquor is given in the Appendix; in Table III for bone char refineries (Trials A and B), in Table IV for the resin refinery (Trial C) and in Table V for the granular carbon/char refinery (Trial D). The results for refined sugar (3rd strike) have also been included in the above tables where applicable.

The HPLC profiles of colorants of raw liquor before and after bone char, resin and granular carbon decolorization for given trials are shown in Figures 3-5, respectively. The profiles of colorants in fine liquor and the corresponding 3A sugar are shown in Figure 6.

Table III. Relative concentration* of flavonoid colorants in raw liquor, average fine liquor and 3A refined sugar from bone char refineries

Peak No.	Components	Trial A			Trial B		
		RL	AFL	3A	RL	AFL	3A
		ppm			ppm		
16							
17		0.1			0.04		
18		0.1			0.04	0.01	
19							
20							
21	Apigenin derivatives	0.4	0.05	0.005	0.6	0.03	0.005
22							
23		0.1		0.005	0.2	0.01	0.003
24		0.1	0.02		0.3	0.01	
25		0.1			0.04		
26		0.1	0.02		0.08	0.01	0.003
27					0.04		
28							
29		0.1			0.2		
30	Tricin derivatives	0.1	0.02		0.1	0.01	
31				0.005			
32		0.1	0.02				
33		0.2			0.4		
34	T7GS	0.1			0.2		
35		0.1					
36							
37		0.1			0.08		
38							
39		0.1			0.1		
40		0.1			0.04		
41	T7GG	0.4			0.6		
42					0.04		
	Total	2.4	0.13	0.015	3.1	0.08	0.011

* The concentration of colorants was calculated using apigenin as an external standard and assuming the same response factor for all compounds.

Table IV. Relative concentration* of flavonoid colorants in raw liquor, average fine liquor and 3A refined sugar from a resin refinery

Peak No.	Components	Trial C		
		RL	AFL	3A
		ppm		
16				
17		0.1	0.03	
18		0.1		
19				
20				
21	Apigenin derivatives	0.8	0.1	0.01
22			0.03	
23		0.1	0.03	
24		0.3	0.1	0.01
25		0.1		
26		0.1	0.1	0.01
27				
28				
29		0.1	0.1	0.01
30	Tricin derivatives	0.1	0.03	
31				0.03
32				
33		0.5	0.4	0.02
34	T7GS	0.4		
35		0.1	0.03	
36			0.03	0.01
37		0.1	0.05	
38			0.03	
39		0.2	0.1	0.01
40		0.1		
41	T7GG	1.5	0.3	0.01
42			0.03	
43				
44				
45			0.03	
	Total	4.7	1.5	0.12

* The concentration of colorants was calculated using apigenin as an external standard and assuming the same response factor for all compounds.

Table V. Relative concentration* of flavonoid colorants in raw liquor and average fine liquor from a refinery with bone char and carbon decolorization in parallel – Trial D

Peak No.	Components	RL	AFL off char ppm	AFL off carbon
16		0.04	0.01	
17				
18		0.1	0.03	
19				
20		0.05		
21	Apigenin derivatives	0.9	0.22	
22				
23		0.1	0.01	
23a		0.5	0.08	N
24				o
25		0.1	0.02	t
26		0.2	0.04	
27				
28		0.1	0.01	d
29		0.1		e
30	Tricin derivaties	0.1	0.04	t
31				e
32			0.02	c
33		0.3	0.02	t
34	T7GS	0.4	0.03	e
35		0.04	0.01	d
36			0.01	
37		0.1	0.01	
38			0.01	
39		0.3	0.03	
40				
41	T7GG	1.0	0.06	
45		0.02		
46		0.04		
47				
48		0.05		
	Total	4.5	0.66	0

* The concentration of colorants was calculated using apigenin as an internal standard and assuming the same response factor for all compounds.

Removal of colorant types

Previous laboratory and factory colour investigations based on conventional colour measurements indicated that decolorizers differed in their propensity to remove certain colour types[10]. The data in Table I confirm these earlier findings. It is clear that in CSR refineries bone char and granular carbon have a higher affinity for pH-sensitive colorants than resin since there was little or no change in indicator value following resin decolorization. In bone char and carbon decolorization of raw liquor there was a significant decrease in indicator values. In one of our refineries (Trial D) granular carbon and bone char were used in parallel to decolorize the same raw liquor. It is evident from Table I that granular carbon removed more pH-sensitive colour than bone char. When this raw liquor was partially decolorized by carbon it had a colour of 270 at pH 9 and an indicator value of 2.1. As this colour was only slightly less than fine liquor off char, this suggested that carbon had a higher affinity for pH-sensitive colorants than bone char.

The data in Table I also show that the indicator values of refined sugar reflected those of fine liquor in Trials A and B, i.e. the colorant composition of refined sugar was related to that of fine liquor. In Trial C, with a higher proportion of pH-sensitive colorants in fine liquor, some of these colorants were removed in the crystallization step. Also, more pH-insensitive colorants may have been formed in sugar boiling, thus lowering the indicator value of the sugar.

The application of HPLC to factory colour studies has enabled us to obtain more details, than with other techniques such as gel filtration, of the changes in colorant composition following the decolorization of raw liquor with bone char, resin and granular carbon.

Bone char decolorization

The HPLC colorant profiles of raw and fine liquor of Trial B in Figure 3, show that bone char decolorization resulted in the removal of many of the flavonoid peaks, in particular peaks 33-48 which included the tricin glycoside sulphate and diglycoside derivatives T7GS and T7GG. The apigenin derivatives were the main flavonoid pigments found in fine liquor off bone char as shown by peak 21 in Figure 3 and confirmed by TLC.

From the profiles in Figures 3 it is evident that the peak corresponding to part of the factory colorant increased considerably in fine liquor in Trial B. Some phenolic colorants were also removed and other phenolic peaks were smaller, such as peak 13.

The results in Table III indicate that at least 95% of the total flavonoid concentration was removed by bone char decolorization in these trials. However, up to 15% of the apigenin derivatives in raw liquor was not removed by char.

The low indicator values of the fine liquor off bone char reflected the removal of flavonoids from raw liquor.

Resin decolorization

The data in Table IV show that only a few flavonoid peaks such as T7GS (peak 34), were removed completely by resin decolorization. However the HPLC profiles in Figure 4 show that, while some flavonoid peaks in fine liquor off resin were smaller than in raw liquor, e.g. peak 21 (apigenin derivatives) and peak 41 (T7GG), others were taller, e.g. peaks 24, 26, 29, 33 and 39. It should be noted that peaks 26, 29 and 39 were minor peaks in raw liquor; this indicates that the components of these peaks were far less readily removed than the major flavonoids.

From TLC analysis it was found that the apigenin glycosides, dominant components of peak 21 in raw liquor, were quite weak in fine liquor off resin. The principal components of this peak in fine liquor were two compounds which were minor constituents of peak 21 in raw liquor. This indicated that the apigenin derivatives were removed more efficiently than these minor compounds. The main peak in fine liquor off resin, peak 33, had a major constituent which could be an apigenin mono-C-glycoside, to judge from its TLC and HPLC properties.

From Table IV it is evident that resin removed about 70% of the total flavonoid concentration but almost 90% of peak 21 and 80% of T7GG. However, the concentration of peaks 26 and 29 was the same in raw and fine liquor and that of peak 33 only slightly lower in fine liquor. The raw and fine liquor had the same high indicator value; this was consistent with the high proportion of flavonoids in both feed and resin-decolorized liquors.

Granular carbon decolorization

The HPLC profiles in Figure 5 and data in Table V show that granular carbon was an efficient decolorizer. It removed all flavonoid colorants, since no peaks were

[10] Kennedy & Smith: *Proc. Sugar Ind. Tech.*, 1976, **35**, 156-160.

detected for these compounds in fine liquor. The same profile also shows that carbon removed almost all phenolic derivatives.

Figure 5 and Table V also show that, in Trial D, bone char was not nearly as effective a decolorizer as granular carbon. Nor was char as effective in Trial D as in Trials A and B. Only 85% of the total flavonoid content was removed by char in Trial D. The apigenin derivatives in peak 21 were again the strongest flavonoids in fine liquor off char and only 75% was removed by decolorization.

Comparison of affinities of decolorizers for colorant types

The HPLC profiles of fine liquors obtained from the

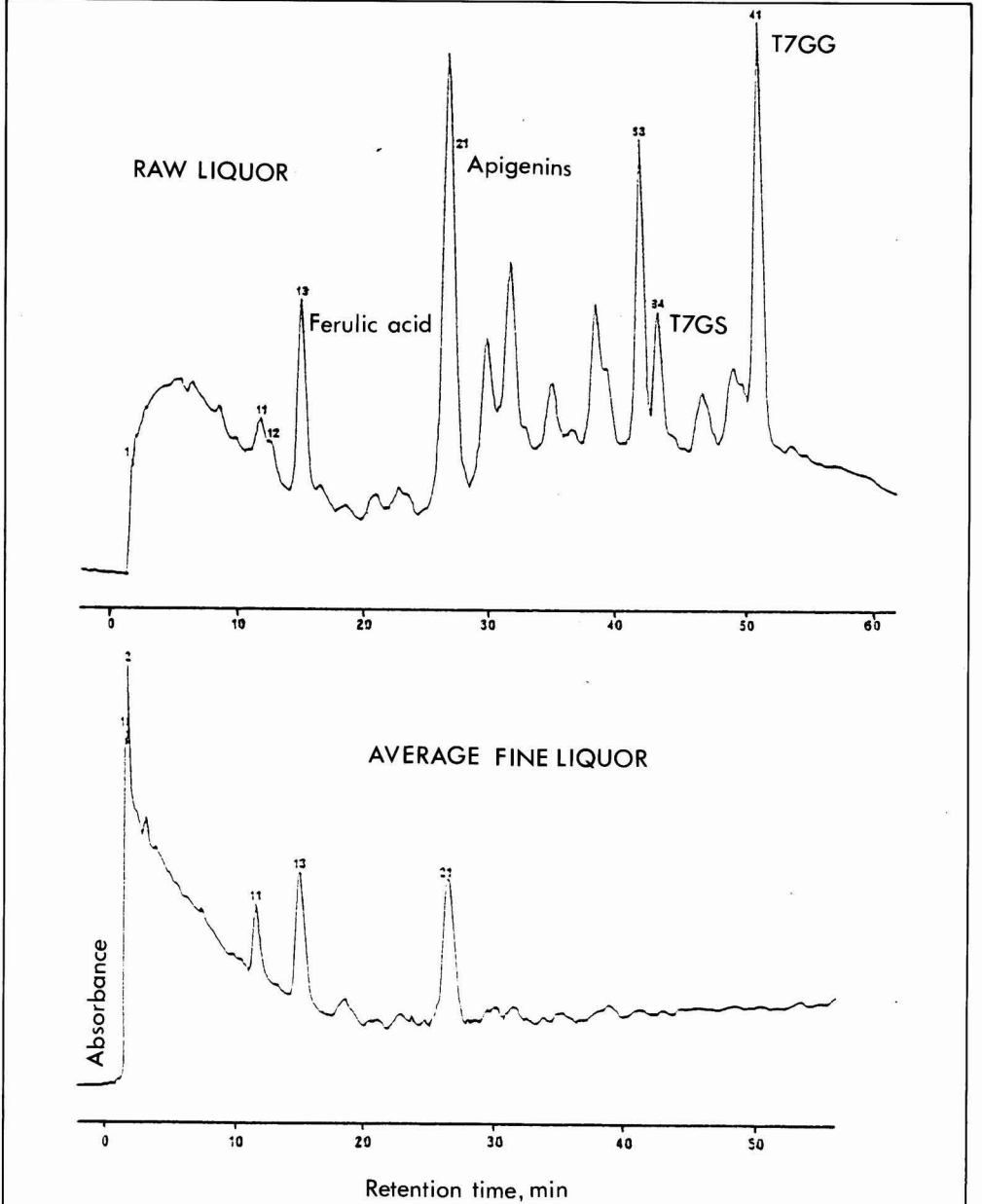

Fig. 3. HPLC profiles of colorants in raw and fine liquor from a bone char refinery — Trial B. Fine liquor sample size x 6.13 of raw liquor. Sensitivity 0.04 aufs

three decolorizers indicated an order of preference for the different types of colorants by the adsorbents. In these trials flavonoid colorants were adsorbed most easily by granular carbon, then by char and finally resin as calculated from the percentage removed from raw liquor. There was further selectivity for different flavonoids by the decolorizers. Carbon adsorbed all flavonoids in the one example discussed but other work in our laboratories has shown that it has more affinity for tricin derivatives than for apigenin compounds. Bone char also adsorbed tricin derivatives more readily than apigenin derivatives. Resin however had a higher affinity for apigenin derivatives than tricin derivatives and a very low affinity for some minor flavonoid constituents of raw liquor. The presence of flavonoid colorants in fine liquor, in particular tricin derivatives, is detrimental for the refiner because it will lead to higher-coloured refined sugars.

Carbon appeared to be more effective than char and resin for removing phenolic derivatives.

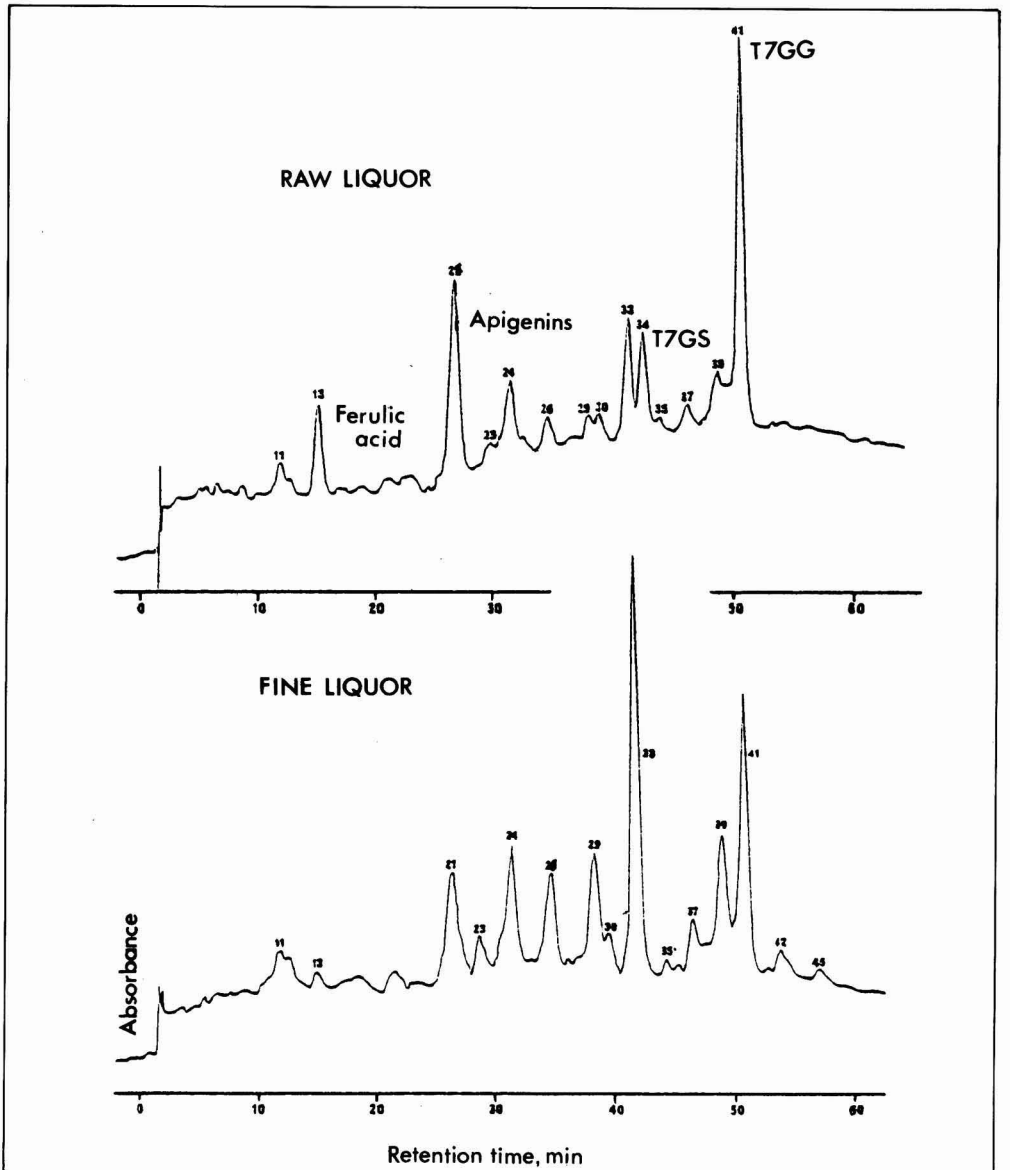

Fig. 4. HPLC profiles of colorants in raw liquor and fine liquor from a resin refinery — Trial C. Fine liquor sample size x 4.15 raw liquor. Sensitivity 0.04 aufs

Colorant composition of refined sugar

The data in Tables III and IV show that traces of flavonoid colorants persisted into granulated sugar. The colorant composition of refined sugar was influenced by the type of decolorizer used to decolorize the raw liquors as may be seen in Tables III and IV and Figure 6. Refined sugar from the resin refinery in Trial C had a greater range and concentration of flavonoid colorants than the corresponding sugars from bone char refineries

Colorant adsorption in the refinery

in Trials A and B. This was consistent with the higher indicator value of the refined sugar from the resin refinery.

The most prominent peaks in granulated sugar from resin-treated liquor were 31 and 33. The main component of peak 31 was not identified but it was observed as a minor constituent of peak 30 in fine liquor. In the sugars from char refineries a major peak was 21 contain-

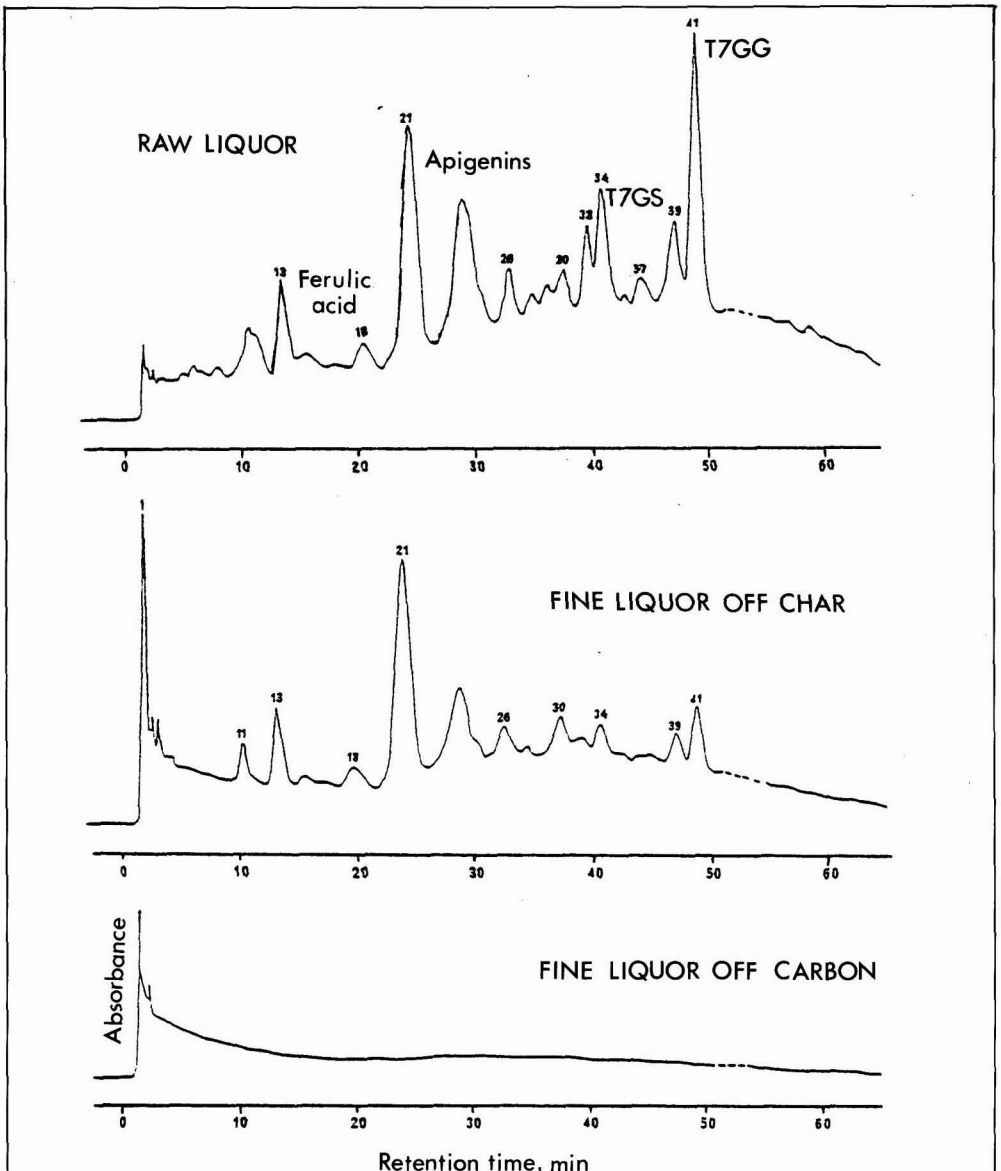

Fig. 5. HPLC profiles of colorants in raw and fine liquor from a refinery with bone char and carbon decolorization in parallel — Trial D. Fine liquor sample: ex char x 3.7 raw liquor, ex carbon x 8.9 raw liquor. Sensitivity 0.05 aufs. Internal standard peak omitted

ing apigenin derivaties; peak 31 was also detected in these samples.

The HPLC profile of refined sugar in Figure 6 also shows an increase in peak 1 by comparison with fine liquor, indicating formation of factory colorant in crystallization; this would lower the indicator value of the sugar.

DISCUSSION

The use of HPLC to separate and estimate the relative concentration of cane sugar flavonoid colorants was successful. For the first time a reasonable estimate was obtained of the concentration of natural plant pigments in sugar process samples. This study has shown that flavonoid colorants are present only at ppm level in raw and fine liquor. However, this work is just the first step towards accurate measurements of flavonoid colorant

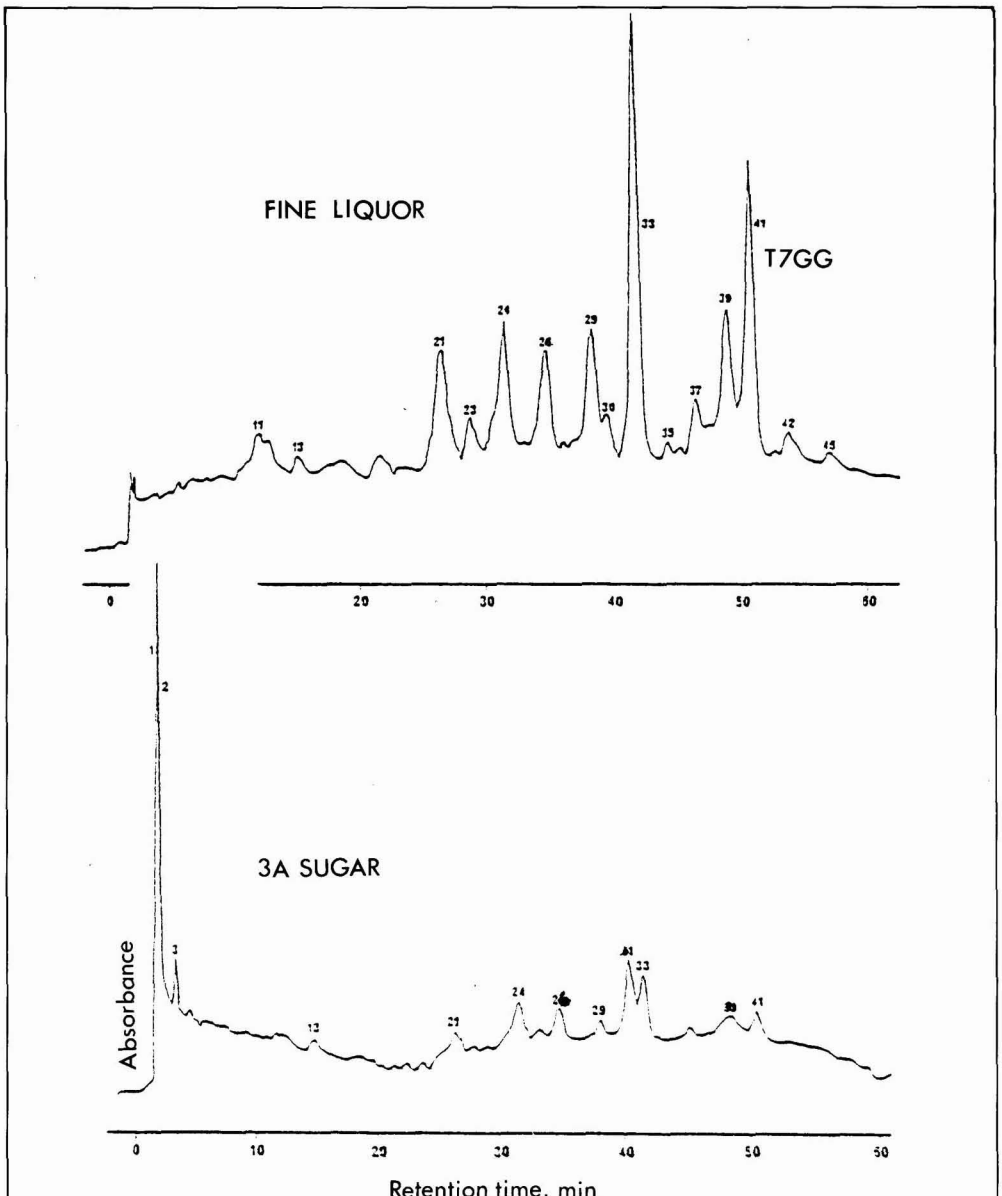

Fig. 6. HPLC profiles of colorants in fine liquor and 3A sugar from a resin refinery — Trial C. Sugar sample size x 2.55 fine liquor. Sensitivity 0.04 aufs

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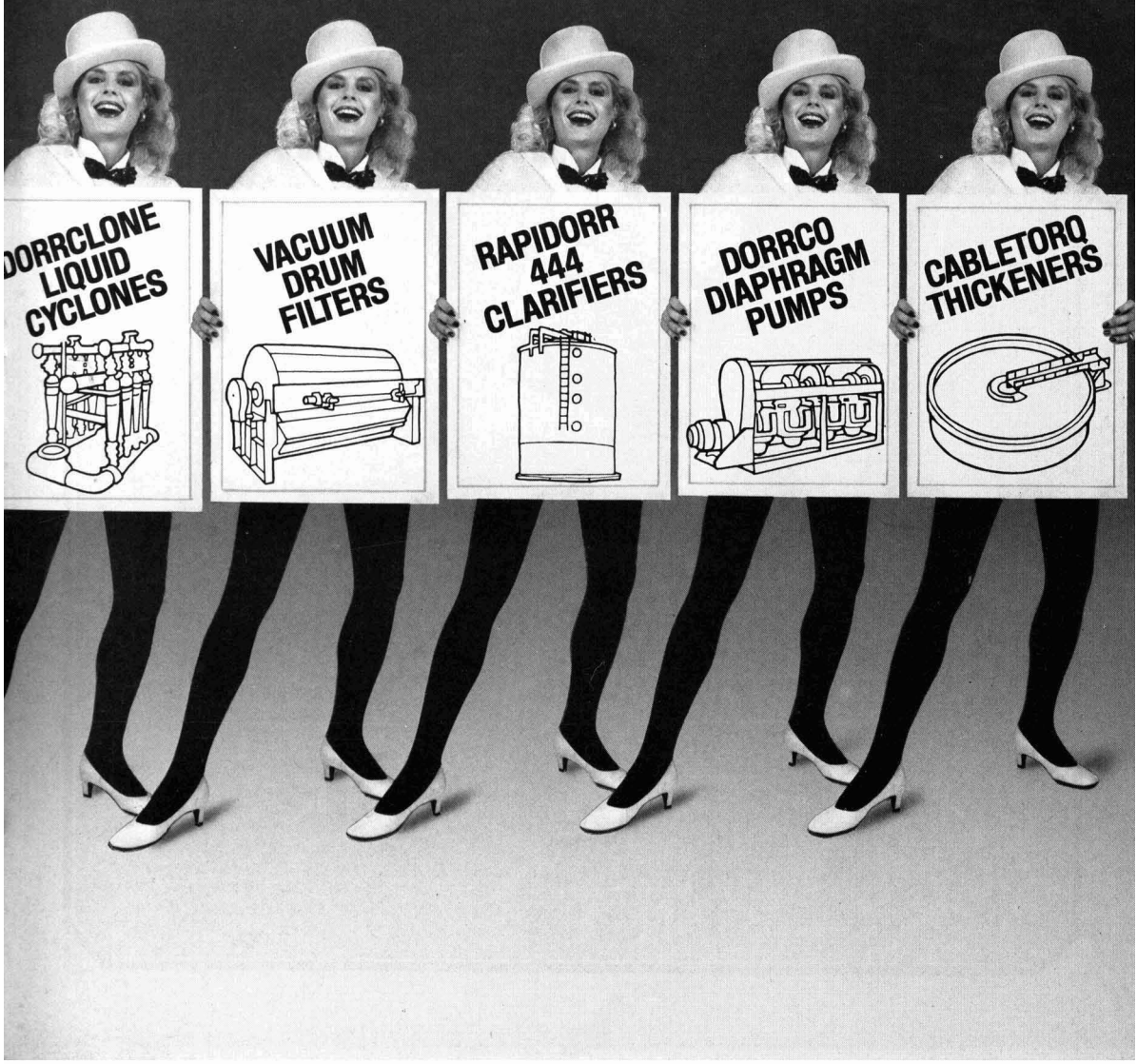

concentration. As column packings are improved it should be possible to obtain better resolution combined with a shorter analysis time.

While the HPLC method employed is adequate for the estimation of flavonoid colorants it is unsuitable for other types of colorants such as phenolic acids and factory colorants. However simple phenolic acids, such as *p*-coumaric, ferulic, vanillic and syringic acids, may be determined by other HPLC techniques[7], using solvent extraction for preferential recovery of the phenolic acids for HPLC analysis.

The HPLC method contributed more detailed information on the differences in the colorant composition of the fine liquors produced by the three decolorizers than would have been possible with gel filtration or conventional colour measurements. HPLC analysis of refinery products detected differences in the concentration of individual flavonoids. Thus, while samples may have the same colour at pH 9, they may differ significantly in their flavonoid constituents and concentrations.

Carbon and bone char had a greater affinity for the more intensely coloured natural pigments than resin. This has practical implications for the refiner in that the colorant composition of white sugar is partly dependent on the fine liquor from which it is crystallized. The presence of small amounts of natural cane pigments, i.e. flavonoids, contributes more to the white sugar colour than the equivalent mass of factory colorants.

We need to have more detailed identification of the cane flavonoid colorants if reliable estimates of their concentration are to be made in mill and refinery products. This work is currently in progress.

Acknowledgement

The authors wish to than CSR Limited for permission to publish this paper.

Summary

The application of colour concentration and HPLC techniques to colour studies in CSR refineries has shown that bone char, resin and granular carbon have characteristic preferences for the removal of colorants from raw liquor.

Granular carbon has the highest affinity for flavonoid colorants followed by bone char then resin on the basis of % removal. Carbon adsorbs apigenin and tricin derivatives readily; char shows a preference for tricin compounds and resin a preference for apigenin derivatives.

The decolorizing agent influences the colorant composition of refined sugar in that sugars crystallized from fine liquor off resin have a higher proportion of flavonoid colorants than corresponding sugars produced at bone char refineries.

Granular carbon is the most efficient of the three adsorbents in removing phenolic colorants.

An approximate estimate of the concentration of flavonoid colorants in refinery products was obtained using HPLC analysis with apigenin as a standard.

L'adsorption des colorants à la raffinerie

En appliquant aux études des matières colorées les techniques de concentration de couleur et de HPLC on a montré dans les raffineries CSR que le noir animal, les résines et le charbon actif ont des préférences caractéristiques pour l'enlèvement des colorants du sirop de refonte de sucre brut.

Le charbon actif possède l'affinité la plus élevée pour les colorants flavonoïdes. Sur la base du % d'enlèvement il est suivi par le noir animal et ensuite les résines. Le charbon adsorbe aisément les dérivés de l'apigenine et de la tricine. Le noir animal montre une préférence pour les composés de la tricine et les résines pour les composés de l'apigenine.

L'agent de décoloration influence la composition de colorant du sucre raffiné en ce sens que les sucres obtenus aux dépens de clairce blanche provenant des résines ont une proportion plus importante de colorants flavonoïdes que les sucres correspondants obtenus dans les raffineries à noir animal.

Le charbon actif est le plus efficient des trois adsorbants pour enlever les colorants phénoliques.

On a obtenu une estimation approximative de la concentration en colorants flavonoïdes dans les produits de raffinerie en utilisant l'analyse HPLC avec l'apigenine comme standard.

Farbstoffadsorption in der Raffinerie

Die Anwendung der Farbstoffkonzentrierung und der HPLC-Technik auf Farbstoffstudien in CSR-Raffinerien zeigte, daß Knochenkohle, Harz and granulierte Kohle Charakteristika bei der Entfernung von Farbstoffen aus Rohzuckerklären zeigen. Granulierte Kohle hat die höchste Affinität für Flavonoid-Farbstoffe gefolgt von Knochenkohle und Harz, bezogen auf % Entfernung. Kohle adsorbiert schnell Apigenin- und Tricin-Derivate. Knochenkohle zeigt eine Präferenz für Tricin-Verbindungen und Harz für Apigenin-Abkömmlinge.

Das Entfärbungsmittel beeinflußt die Farbstoffzusammensetzung von raffiniertem Zucker in der Weise, daß Zucker, die aus mit Harz entfärbter Kläre kristallisiert wurden, einen höheren Anteil an Flavonoid-Farbstoffen haben als die entsprechenden Zucker, die in einer Knochenkohleraffinerie hergestellt wurden. Granulierte Kohle ist das wirksamste der drei Adsorbentien bei der Entfernung von phenolischen Farbstoffen.

Eine durchschnittliche Abschätzung der Konzentration der Flavonoid-Farbstoffe in Raffinerieprodukten wurde durch HPLC-Analyse mit Apigenin als Standard erhalten.

Adsorción de colorantes en la refinería

Aplicación de técnicas de concentración de color y HPLC (cromatografía liquida sobre alta presión) en estudios de color en refinerías de la compañía CSR ha demostrado que carbón animal, resina y carbón granular tienen preferencias características para la separación de colorantes de licor crudo. Carbon granular tiene la más grande afinidad para colorantes de la familia flavonoide; en secuencia, carbón animal y resina tienen menos grande afinidad sobre el base de % separación. Carbón granular absorbe derivados de apigenina y tricina facilmente; carbón animal demuestra una preferencia para compuestos de tricina y resina una preferencia para derivados de apigenina.

El agente dezcolorizante influye la composición de colorantes en azúcar refinado en que azucares cristalizado de licor fino tratado con resina tienen un proporción más grande de colorantes de la familia flavonoide que azucares corespondientes producido en refinerías que usan carbón animal. Carbón granular es el más eficiente de los tres adsorbentes en separación de colorantes fenólicos.

Un estimación aproximada de la concentración de colorantes de la familia flavonoide en productos de una refinería se ha obtenido usando análisis por HPLC con apigenina como patrón.

SUGAR BEET AGRONOMY

The California sugar beet contract. B. Goodwin. *Proc. 1st World Sugar Farmers' Conf.*, 1981, IV.1-IV.9. – An account is given of the system of contracts used in California, where payment for beet is based on sugar content while the contract is based on a prefixed extraction rate but is not directly related to the amount of sugar recovered. Details are given of division of funds between processor and grower for appropriate operations, including transport, and the tare laboratory procedure for determining the amount to be deducted from the payment for dirt tare and trash is briefly described. Beet growing costs and the net return on sugar are calculated.

Sugar industry in Canada. J. Vaselenak. *Proc. 1st World Sugar Farmers' Conf.*, 1981, VI.1-VI.2. – A brief survey is presented of the sugar industry in Canada, covering both refining of raw cane sugar and manufacture of beet sugar, with particular emphasis on the costs of growing sugar beet and reasons for stagnation of beet growing.

The cultivation and processing of sugar beets in the Netherlands. R. L. Schilpzand. *Proc. 1st World Sugar Farmers' Conf.*, 1981, VI.9-VI.14. – Information is given on the organization of the sugar beet industry in Holland, beet sampling and payment, the differences between the prices paid for beet by Coöperatieve Vereniging Suiker Unie UA (a cooperative) and N. V. Centrale Suiker Mij., a private company. Data from the 1980 campaign are presented.

Controlling weed beet in June and July. A. Vigoureux. *Le Betteravier*, 1982, **16**, (165), 9-12 *(French)*. – Control of weed beet is discussed, and advice given on suitable means according to the population per ha (extending from 100 to 15,000) and stage of development of the bolter. Both manual and mechanical work is advocated in some cases, and illustrated descriptions are given of herbicide applicators; details are also given of herbicide mixtures suitable for application by the machines.

Mineral fertilization and manuring of sugar beet. M. V. Homès and G. V. van Schoor. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1981, **49**, 105-127 *(French, Dutch)*. Trials are reported that were aimed at establishing optimum composition of the feed at a given total dosage rate, optimum application rate at which a maximum theoretical yield was obtainable, and the effects of modifications to both composition and application rates on yield. Results were tabulated and statistically processed to yield formulae for calculation of the required parameters.

Mechanization of bolter destruction in the beet crop. A. Vigoureux. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1982, **50**, 3-36 *(French, Dutch)*. – Descriptions are given of various methods and machines for elimination of beet bolters. Photographs are reproduced of the equipment and results of trials at various locations in Belgium are tabulated. On the basis of these, a scheme is proposed for effective control of weed beet.

Organic matter and lime, two ingredients vital for a good soil stucture. R. Vanstallen. *Le Betteravier*, 1982, **16**, (166), 12 *(French)*. – The importance of organic matter and lime for maintenance of soil structure is discussed. The value of green manure and of straw (the latter needing to be supplemented with nitrogen) is stressed, while it is pointed out that liming must not be carried out without first establishing the pH of the soil. Optimum pH values are indicated for clay, loam and sandy loam soils, and filter cake from sugar factories considered of great benefit because of its lime content coupled with organic matter.

EUF-P contents required in sugar beet cultivation. L. Wiklicky and K. Németh. *Zuckerind.*, 1982, **107**, 607-611 *(German)*. – Soil phosphate desorption and dissolution rates were determined by electro-ultrafiltration (EUF) for soils that had received, over a 10-year period, P applied at the same rates and where the same rotation had been practised. The amount of P found by EUF that would correspond to a maximum potential beet yield was established on the basis of 41 field experiments and surveys of 5600 beet fields (per year). The results are discussed in some detail, and a number of recommendations made.

The available phosphorus content in soil as sugar beet fertilization indicator. E. Jaszczolt. *Gaz. Cukr.*, 1982, **90**, 9-10 *(Polish)*. – Field trials are reported in which P was applied to soil of known chemical composition, a P content of 82 $mg.dm^{-3}$ and a pH of 7.3. There were little differences between the results obtained by applying 0, 50, 250, 640 and 1040 $kg.ha^{-1}$ P, indicating that the available P content in the control plot was adequate in respect of root and sugar yield, sugar content and Brix.

Beet research in France. Anon. *Compte rend. Inst. Tech. Franç. Betterave Ind.*, 1981, 314 pp *(French)*. – A detailed report is presented on beet research in France, including: (1) spring work (soil preparation – studies on reducing the number of passes made by machinery in seedbed preparation and on herbicide incorporation; drilling and seedling transplanting, which has been found to have sufficient disadvantages as to restrict its general use); (2) varietal trials and experiments involving seed treatment with various fungicides; (3) chemical weed control, including trials on control of specific weeds *(Aethusa cynapium* and *Ammi majus)* and beet bolters; (4) insect pest and disease control; (5) irrigation and nitrogen trials, and investigations on beet pulp silage and factors affecting its quality; and (6) harvesting.

High and constant sugar beet yields as a result of irrigation. G. Rizescu. *Prod. Veg., Cereale si Plante Tehn.*, 1982, **34**, (6), 22-27 *(Rumanian)*. – Irrigation x fertilization trials are reported in which the beneficial effects of irrigation (increase in root yield) were increased by fertilization, while the sugar content remained unchanged, so that the overall effect was an increased sugar yield. Optimum conditions were: water application in the range 2300-4200 $m^3.ha^{-1}$ by 4-7 irrigations to give a soil moisture content of 50% down to 80 cm; application of 100-200 $kg.ha^{-1}$ N + 50-100 $kg.ha^{-1}$ P_2O_5 + 40-60 $kg.ha^{-1}$ K_2O plus 30-40 $tonnes.ha^{-1}$ farmyard manure; and a final plant density of 100,000 per ha.

BEET BREEDING AND VARIETIES

The work of the National Institute of Agricultural Botany. D. Kimber. *British Sugar Beet Rev.*, 1981, **49**, (2), 37-40. — The beet varietal testing work carried out by the NIAB is described, with details of the techniques used. The main diseases recorded in the trials are virus yellows, downy mildew, powdery mildew, leaf spot and rust. The procedures used in the compilation of the recommended national beet variety list are also explained.

Optimum levels of some characters for genetic improvement of sugar yielding ability of sugar beet (*Beta vulgaris* L.). II. Diploid and anisoploid hybrids. R. K. Agarwal, P. S. Bhatnagar and B. Raj. *Indian Sugar Crops J.*, 1981, **8**, (1), 23-29. — Trials with beet varieties representing the two groups of hybrids are reported. The results were generally in agreement with findings from similar studies involving inbred lines and open pollinated populations, i.e. that the ideal beet for maximum sugar production would have a root weight of 3.05 kg, a sucrose content of 17.8%, a total soluble solids content of 21.6% and a top weight of 0.69 kg.

Results of sugar beet varietal trials in Belgium 1978-80. N. Roussel, R. Vanstallen and W. Roelants. *Publ. Trimest. Inst. Belge. Amél. Betterave*, 1981, **49**, 5-32 *(French, Dutch)*. — Results of trials at six sites in 1980, involving 35 varieties, are reported and compared with the mean values obtained in the 3-year period 1978-80.

Trials of commercial varieties of sugar beet. D. Kimber and S. McCullagh. *British Sugar Beet Rev.*, 1981, **49**, (3), 29-31. — Results of trials are recorded for the ten varieties that occur in the UK Recommended List, showing % field establishment, sugar content, average percentage of bolters (for early sown plots), the impurity content in the lead acetate extract, calculated sugar yield and growers' income. The values for 1978-80 show that Salohill was generally the best variety, although Monoire was not far behind in terms of monetary return. Two new varieties, Arigomono and Novagemo, also performed very well over a restricted trial period. Vytomo, first recommended in 1984, has been removed from the list; although it had a high yellows tolerance, some higher-yielding varieties now available perform at least as well as it even when they become infected.

Differences among sugar beet cultivars in sucrose loss during storage. W. R. Akeson and J. N. Widner. *J. Amer. Soc. Sugar Beet Tech.*, 1981, **21**, 80-91. — Sugar loss and its component factors were evaluated in 25 varieties that had been tested during 3-4 years within a 9-year period. Significant differences were found, varying by 46.7%, 41.3%, 170% and 70.4% between minimum and maximum for sugar loss, respiration rate, invert sugar accumulation and raffinose accumulation, respectively. The varieties were ranked in a similar order from year to year with respect to each factor. Pedigree had a significant effect on sugar loss. Respiration rate and invert sugar accumulation (r = 0.92 and 0.70, respectively) were well correlated with sugar loss, while a fair correlation (r = 0.53) existed between respiration rate and invert sugar accumulation. Despite this correlation, the varieties tested had all combinations of the two components, viz. low respiration rate and low invert sugar accumulation, low respiration rate with high invert accumulation, high respiration rate with low invert accumulation, and high respiration rate with high invert accumulation. The results indicate the need for evaluation of varieties for storage properties before they are released for commercial use.

Characteristics and evaluation of sugar beet varieties grown in Poland. M. Jassem. *Gaz Cukr.*, 1981, **89**, 14-16 *(Polish)*. — Details are given of the performances of varieties in Poland, with information on the proportion of the total beet area represented by given varieties and on the type of seed drilled as well as the extent to which the different types are used.

The sugar beet program at the Plant Breeding Institute. M. Arnold. *British Sugar Beet Rev.*, 1982, **50**, (2), 7-9, 12-13. — A survey is presented of activities at the UK Plant Breeding Institute that are concerned with breeding new beet varieties of high bolting resistance, sugar content, stability under varying growth conditions, resistance to pests and diseases and yield potential. Other work is aimed at producing varieties that germinate rapidly and emerge uniformly even at below-optimum temperatures, so that drilling could be carried out from the end of February onwards, and at reducing the time required for desirable genetic attributes to be transferred from fertile to male-sterile lines.

Results of sugar beet varietal trials. N. Roussel and W. Roelants. *Le Betteravier*, 1981, **15**, (159), 13-16 *(French)*. Results of trials, conducted at six locations and involving 20 varieties, are given in tabular and block diagram form. Besides the values for 1981, the mean values for 1979-81 are also given, showing Volo as by far the best in sugar yield and gross return for the 3-year period, while Monohil gave the best results for 1981.

Results for varieties newly admitted to the National List in 1981. Anon. *Le Betteravier*, 1982, **16**, (160), 18 *(French)*. — Descriptions are given of Diana, Delamon, Monoscope and Regina varieties, and their performances in varietal trials are summarized.

Why risk yield loss? Compaction — the risk factor. G. Ball. *British Sugar Beet Rev.*, 1982, **50**, (3), 49-50. In order to ensure optimum returns from beet crops, it is necessary to avoid compaction of the seedbed soil and consequent reduction in the rate of root growth of seedlings, and to avoid excessive concentration of fertilizers, particularly N and K, which may lead to gappy stands under dry conditions. Where N, P and K are applied just before drilling, they have to be worked into the soil — this necessitates increased movement of machinery and hence greater compaction; fertilizers other than N should therefore be applied before autumn ploughing, while N should be applied at or after drilling, and between the rows.

CANE SUGAR MANUFACTURE

Preliminary trials with a horizontal vacuum filter. O. L. Crees, R. T. Hutchinson and A. L. Willersdorf. *Proc. Australian Soc. Sugar Cane Tech.,* 1982, 261-266. The performances of a pilot-scale horizontal vacuum filter and a convential rotary filter of similar size were compared in the handling of clarification mud. Results showed that the horizontal unit, supplied by Envirotech Australia Pty. Ltd., had a much higher mud solids output rate, although the filters were similar when comparison was made on the basis of output per unit escribed area to allow for differences in speed. While the quantity of wash water that could be applied was strictly limited by cake porosity in the case of the horizontal filter, washing efficiency was always high, since the water was fully utilized in displacement washing; on the other hand, while there are no such contraints on wash water usage with a rotary filter, it appeared that, with cake of low porosity, much of the water will simply run back into the boot – the resultant feed dilution will be of some benefit but not as effective as displacement washing. The rotary filter needed much less attention, since it could cope with quite large variations in operating conditions without loss of cake; by contrast, the horizontal filter was often rapidly and adversely affected by small changes in feed composition and wash water addition, with the risk of very wet cake of high pol. However, since the hold-up volume in the system was considerably smaller than in the rotary filter, problems could be quickly rectified. Proper conditioning of the feed was critical to the operation of the horizontal filter, and addition of 20 ppm Sedipur TF2 low-molecular weight polyelectrolyte gave best performance in terms of both rate and pol recovery – the feed was so heavily flocculated that the rotary filter could not retain such a cake. The polyelectrolyte improved cake porosity and retention, as did increase in the amount of bagacillo added. High-molecular weight flocculants offered no advantages.

Tube materials for juice heaters, evaporators and vacuum pans. D. R. Hargreaves. *Proc. Australian Soc. Sugar Cane Tech.,* 1982, 283-286. – Desirable properties of material used for tubes are listed, and the suitability of given materials in terms of these properties is discussed; mention is made of the findings of a number of authors concerning mild and stainless steel, brass and copper.

Modifications to an ATV clarifier. R. J. McLean and G. A. Brotherton. *Proc. Australian Soc. Sugar Cane Tech.,* 1982, 287-293. – Modifications to an ATV clarifier at Tully sugar factory are described; they were intended to allow an increase in capacity and thus permit operation of only one clarifier to handle all the juice without detrimental effect on performance. The alterations to the design centred on improvement of the clear juice removal system, a feed system that provided an unclarified juice of minimum possible turbulence while retaining sufficient height to give extra static head should this prove necessary, the provision of three collector pipes for each of the four trays so as to promote radial flow, and modifications to the system of mud rakes in order that they could handle the expected greater load. Trials of the clarifier before and after modification showed that the mud loading on the clarifier was well above the average expected in the sugar industry during a normal season, with an average underflow mud solids content of 7.3% from a feed of 0.88% mud solids, thus providing an hourly throughput in excess of the design value of 560 m^3 of clear juice.

Computer control project management. R. J. Batterham. *Proc. Australian Soc. Sugar Cane Tech.,* 1982, 295-299. With greater awareness of the benefits (both tangible and intangible) that can be derived from computer control in even small sugar factories, there is still need for a rational approach to computer control projects. The author outlines the major aspects of project management, covering two main stages: (1) analysis of the physical problem, a feasibility study to assess tangible and intangible benefits, and an estimate of the total project cost; (2) assuming the benefits outweigh costs, the second stage involves definition of objectives, process specification, development of an implementation strategy, and specification and selection of a suitable computer system. It is stressed that project control should be applied at all stages up to final implementation and, where possible, should include a technical audit to confirm the efficacy of the installed system.

The Racecourse continuous vacuum pan. E. E. McDougall and G. A. Wallace. *Proc. Australian Soc. Sugar Cane Tech.,* 1982, 383-388. – A low-grade continuous pan installed at Racecourse is described. It comprises two 13-m long vessels operating in series and situated 1.5 m apart. The first vessel has a nominal working volume of 40 m^3, while the second has one of 57 m^3. The first vessel is 300 mm higher than the second at the top of the tubes in order to permit massecuite flow into the second vessel. Each vessel is separated into two compartments by a transverse baffle, with a submerged valve, halfway along its length; another baffle runs lengthwise along the centre of each vessel and stops short of the end walls by about 1 m, while additional baffles are spaced approx. 500 mm apart throughout the flow path – they are alternatively 600 mm and 1200 mm above the tubes, so as to restrict massecuite flow to the transverse flow path as much as possible. The calandrias consist of square-sectioned tubes and have neither tube plates nor side plates; the tubes are welded to steel bars at the top, bottom and outside faces where necessary – a number of advantages are listed for this arrangement. Low-grade seed (grained in a batch pan) is pumped to the central region of the first vessel and, as molasses is added, flows toward one end of the vessel where it is directed across to the parallel but opposite flow path. When it reaches the opposite end, the massecuite is redirected to the initial side and flows to the exit adjacent to but separated from the feed port. After undergoing similar flow in the second vessel, the massecuite passes via an overflow weir, down a barometric seal leg to a holding tank and thence to continuous crystallizers. During short periods of operation, lumping occurred and sugar accumulated on the baffles. However, the pan has produced heavy, viscous massecuites of high quality at rates well in excess of design flow, at a mean residence time of 6.7 hours, with a coefficient of variation of 0.12.

A fresh look at Rillieux's principles. S. K. Ghosh. *Sharkara,* 1977, **16,** (3), 19-23. – See *I.S.J.,* 1980, **82,** 83-85.

BEET SUGAR MANUFACTURE

Colloids in beet sugar manufacture. S. T. Krylov. *Sakhar. Prom.*, 1982, (5), 36-38 *(Russian)*. – The behaviour of colloids in beet sugar manufacturing processes and their adverse effect on juice purification (which increases as the campaign progresses) are discussed and electron photomicrographs reproduced of reversible colloids in juice, syrup and molasses. Some of their physical properties are mentioned.

Control of evaporator operation as part of the automatic control system in beet sugar manufacture. S. A. Sergeev, N. M. Spinul and A. Z. Malovichenko. *Sakhar. Prom.*, 1982, (5), 39-41 *(Russian)*. – An outline is presented of an automatic control system for an evaporator, and the basic algorithm is described.

Sugar technology calculations using the three-component diagram. T. Baloh. *Zuckerind.*, 1982, **107**, 515-525 *(German)*. – Application of the sugar:water:non-sugars triangular diagram to calculation of sugar factory balances is described, covering diffusion, juice purification and sugar house operations (including boiling and purging of *A*-massecuite, production of standard liquor, use of water washing in centrifugals, affination, calculation of water evaporation and investigation of purity scatter).

Development of a process having increased juice purification efficiency. K. Vukov. *Zuckerind.*, 1982, **107**, 531-533 *(German)*. – The adsorptive properties of calcium carbonate are due to a specific adsorptive surface and to formation of a selective anion exchange layer by Ca ions on the surface. In the process described, the adsorption is increased by bringing the carbonate particles into contact with milk-of-lime. Lime (0.1-0.3% CaO) is added to unfiltered 1st carbonatation juice to reduce the pOH from 3.0-3.3 to 2.6-2.8. After treatment by filter-thickeners for 2-6 minutes (this may be omitted), 20-40% of the juice is added to the preliming vessel. Trials over two 4-day periods showed that the process increased thin juice purity by 0.6 units, while a slight deterioration in the filtration coefficient was within measuring error. Alcohol-precipitable colloids were greatly reduced. In the first campaign during which the process was used on a full scale, average thin juice purity was 0.75-0.80 units higher than at a neighbouring sugar factory using conventional juice purification. Non-sugars, ash, lime salts and invert sugar contents were the same. *A*-massecuite and green syrup purities were higher and molasses losses lower.

Coal as fuel in the sugar industry. M. Pouillaude. *Zuckerind.*, 1982, **107**, 534-536 *(German)*. – See *I.S.J.*, 1983, **85**, 53.

Regeneration of AN-80-7P anion exchange resin with a solution of ammonia and mixtures with caustic soda. R. F. Kamborova, N. B. Kazakova, I. P. Shamritskaya and N. G. Novikov. *Izv. Vuzov, Pishch. Tekh.*, 1982, (2), 28-31 *(Russian)*. – Tests were conducted on regeneration of AN-80-7P weakly basic, polymeric resin after demineralization of a sugar solution. Results showed that desorption of colouring matter, total N, Cl^- and SO_4^{--} using only ammonia as regenerant was less effective than when NaOH was added, maximum impurities removal being achieved with a solution of 97.5% ammonia and 2.5% NaOH, after which further increase in the proportion of caustic was accompanied by a fall in desorption. The effect of the NaOH was attributed to its positive influence on swelling of the resin, found to be associated with the latter's amphoteric properties.

Mass transfer in ring-type diffusers. N. N. Pushanko and B. D. Kovalenko. *Izv. Vuzov, Pishch. Tekh.*, 1982, (2), 93-96 *(Russian)*. – Investigations were conducted on extraction in a ring-type diffuser at Zbarazh sugar factory[1] and the results discussed in terms of the mass transfer coefficient, the pattern of which in the 16 compartments was evidence of good hydrodynamic conditions and suitability of the diffuser length.

Continuous control of the solid phase content in crystallizing systems. V. I. Tuzhilkin. *Izv. Vuzov, Pishch. Tekh.*, 1982, (2) 116-118 *(Russian)*. – Details are given of a device for continuous determination of massecuite crystal content which can be incorporated in automatic boiling control systems. Based on the linear relationship between crystal content and the conductivity ratio between the solid phase and mother liquor, it consists of a 30-mm diameter vertical, dielectric shaft having a central hollow section housing a metal spindle extending beyond the bottom of the shaft and, at its upper end, topped by a stainless steel electrode which is housed in the solid phase separator; this takes the form of a 10 mm high cylinder sitting across the top of the shaft and having the same length as the shaft diameter, as well as rounded ends to conform to the curvature of the shaft. The inner surface of the electrode is in contact with the end face of the shaft. Two annular stainless steel electrodes are mounted flush with the inside surface and end face of the shaft. A distance plate at the top end of the spindle allows for a 10 μm space, while the lower end of the spindle beyond the shaft carries a spring and bolt for maintenance of a fixed gap. Before operation of the unit, the inner surfaces of the electrode on the spindle and of the separator fit tightly against the end of the shaft. The unit is immersed in the massecuite, whereby the upper end of the shaft is wetted. When the spindle and attached electrode are rotated by electric motor at 10-15 rpm, the separator removes solid phase from the shaft end, while the liquid phase falls into the space between the shaft end and the inside of the electrode and separator. Its conductivity is measured by the top electrode and the upper annular electrode, which are 0.1 mm apart. Simultaneously, the conductivity of the solid and liquid phases is measured by the two annular electrodes. Laboratory and factory trials have show that mean measuring error was ± 4% in the crystal content range 0-50%. One limiting factor is solid phase particle size, which should be not less than 10 μm.

Descaling in the sugar factory – always a topical question. H. Bazaud. *Sucr. Franç.*, 1982, **123**, 235-237 *(French)*. – Chemical descaling treatments for application to evaporators are described, and cleaning of a filter-press briefly mentioned to demonstrate how the methods can be adapted to other pieces of equipment.

Determination of the optimum progressive preliming temperature. L. P. Reva, G. A. S. Makhina, V. M. Logvin and V. Yu. Vigovskii. *Sakhar. Prom.,* 1982, (6), 26-29 *(Russian).* — Investigations showed that, in the temperature range 20-85°C, 60°C was the optimum for degree and rate of albumin settling and for reduction in the concentration of acid anions.

Carrying out the hot liming stage before 2nd carbonatation. A. V. Shmygol', B. M. Moskalev and E. Ya. Goisman. *Sakhar. Prom.,* 1982, (6), 29-31 *(Russian).* Trials were conducted at Novoukrainka sugar factory on a juice purification system in which cold liming (corresponding to the 1st stage of the widely used progressive cold and hot fractional liming process) was carried out for 5-10 minutes at 60-65°C to a juice alkalinity of 0.8-1.0% CaO, while the equivalent of the hot stage was carried out between 1st carbonatation juice filtration and 2nd carbonatation — conditions were a temperature of 85-90°C, a residence time of 15-20 minutes and a limed juice alkalinity of 0.8-1.2% CaO. Comparison was made between the system and a previous one involving cold preliming and progressive cold-hot fractional liming; it showed a lower lime salts content in 2nd carbonatation juice and thick juice and lower colour for both juices.

Application of A2-PSK sulphitation vessels for barometric water sulphitation. S. A. Zozulya, S. A. Chernyshev, G. D. Bobrovnik, V. P. Panchenko and T. A. Derevyanko. *Sakhar. Prom.,* 1982, (6), 32-34 *(Russian).* — Trials are reported on the use of a standard Soviet sulphiter for treatment of barometric condenser water intended for diffusion. SO_2 utilization was 99%, and the pH of the water was reduced from 8 to 6 on average. There is need to clean the gas so that the feedline is not adversely affected by the ash particles and sulphur; restricting the length of the pipe and reducing the number of bends will also be of advantage.

A membrane-liquid density meter for syrup. V. I. Zablotskii and A. F. Kravchuck. *Sakhar. Prom.,* 1982, (6), 42-44 *(Russian).* — In the system described, two separating vessels are located 900 mm apart in branch pipes connected to the main pipeline carrying syrup to holding tanks for the vacuum pans. Each vessel has a relaxed diaphragm across the middle; syrup is fed to the upper section, while the lower section, under vacuum, is connected via a pulse tube to a differential manometer. Brix measurement is based on the pressure difference between the two vessels. Maximum error is ± 2.5%, as established by tests in which measured values were compared with laboratory refractometer values covering the Brix range 40-57°.

Studies on modifications of a continuous centrifugal for low-grade massecuite. K. Masumitsu and K. Kubowaki. *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **30,** 102-116 *(Japanese).* — A Hein, Lehmann HZ/HL low-grade continuous centrifugal was modified in order to increase sugar purity and reduce the amount of non-sugars recycled to boiling. The massecuite feed pipe was jacketed so as to allow maintenance of temperature by steam and/or hot water, while the accelerator was converted to a multi-stage type instead of the conventional simple cup. The massecuite in the accelerator was sprayed with steam and/or hot water and thus uniformly heated and diluted. Results of tests showed that, at a feed rate of 650 $kg.hr^{-1}$, sugar purity was increased without crystal dissolution, while the feed rate could be substantially increased at constant sugar purity by replacing screen of 90 μm mesh with screen of 60 μm mesh. An accelerator without a disc-type baffle proved superior to one with this arrangement, in terms of heating efficiency and elimination of clogging.

Treatment of beet sugar factory waste water by the activated sludge process — ultra-aeration system. K. Kato, K. Maruyama, T. Nakae, K. Maekawa and Y. Saito, *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **30,** 117-126 *(Japanese).* — Details are given of the waste water treatment system adopted at Memuro factory, which in 1977 was modified and expanded to a daily slicing rate of 5600 tonnes of beet. The Hitachi ultra-aeration system is a type of deep tank aeration-activated sludge process which has removed more than 95% of the BOD, even with a high load of 12 kg $BOD.m^{-3}$/day. Other advantages of the system include a high oxygen transfer rate, a high dissolved oxygen content in the aeration tanks of 4.1-5.1 ppm, and a low electricity consumption (half that used in other systems). The sludge microflora were predominantly in the form of zoogloea and there was no filamentous bulking, while the sludge volume index was maintained stable. Although the factory is located in a district where temperatures may fall to −30°C, ambient temperatures were above 20°C, so that the system could be operated effectively. Physical or chemical defoaming was essential because of violent foaming in the aeration tanks; vigorous mixing of the sludge with small air bubbles that could not be easily separated necessitated the installation of degasification equipment before sludge settling. An excess sludge of 40-45% on BOD removed was discarded.

Concentration of Steffen filtrate. Y. Yokoi, N. Michishita, K. Sasaki and S. Kanno. *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **30,** 127-131 *(Japanese).* Concentration of Steffen filtrate has been used at Kitami factory since the beginning of the 1977 campaign. In order to reduce energy costs and investment, the RT continuous saccharate process was introduced in 1973, the volume of Steffen filtrate halved and its Brix raised. Double-effect evaporators were added to the existing quadruple-effect evaporator in order to handle the concentrated filtrate, for which 4th effect vapoour and flash vapour were used. Descaling problems were solved by recirculating the filtrate without any chemical additives. CO_2 exhaust from the normal carbonatation vessels was used to carbonate the Steffen filtrate.

Sucrose losses in diffusion. Residence time of cossettes in the diffuser. V. Maurandi, A. Rossi, G. Mantovani and G. Vaccari. *Paper presented at 26th Tech. Conf. British Sugar plc,* 1982, 30 pp. — Beet diffusion studies are reported, the aim of which was to establish optimum conditions for tower diffusers where losses were minimized. The theory of diffusion based on Vukov's formula[2] was applied to experimental research in which the tracer technique was used to determine residence time distribution; values obtained agreed well with theoretical curves based on division of the diffuser into a cascade of sections in which the contents were completely mixed, demonstrating that the diffusers behaved as plug flow models with unavoidable counter-diffusion. Application of the diffusion efficiency results and cossettes residence times, in appropriate formulation, to establishment of optimum parameters was highly successful in reducing diffusion losses.

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1 Pushanko *et al.: I.S.J.,* 1979, **81,** 249.

2 "Physics and chemistry of sugar beet in sugar manufacture" (Elsevier, Amsterdam) 1977.

NEW BOOKS

Annual report 1980-81. (Taiwan Sugar Research Institute, 54 Sheng Chan Rd., Tainan, Taiwan.) 1982.

This is a 54-page report describing the activities of the Taiwan Sugar Research Institute, including cane breeding, cultivation, weed control, irrigation and drainage, plant physiology, soil and plant nutrition, plant pathology, entomology, sugar technology and by-product utilization. A number of diagrams, tables and colour photographs are reproduced.

Annual report 1981-82. (South African Sugar Association Experiment Station, Mount Edgecombe, Natal, South Africa.) 1982.

The 82 pages of this report describe the numerous aspects of cane research conducted at Mount Edgecombe, covering agricultural engineering; agronomy, chemistry and soils; basic research; biometry; entomology, plant breeding and pathology; and various fields of associated work.

Annual report 1981. (Experiment Station, Hawaiian Sugar Planters' Association, 99-193 Aiea Heights Drive, Aiea, HI 96701, USA.) 1982.

This is a 67-page report detailing work in Hawaii on: cane breeding and selection; water studies and irrigation; fertilization and nutrition; growth and metabolism; pests and their control; preparation, planting and harvesting; cane and juice processing; energy; environmental quality; and miscellaneous activities.

Annual report 1980. (Instituto do Açúcar e do Alcool, Brazil.) 1982.

The report, comprising a total of 116 pages, is split into a Portuguese section and an English translation of this section, and gives information on the activities of the Institute within the framework of the Programa Nacional de Melhoramento da Cana-de-Açúcar (National Cane Improvement Program), or Planalsucar, including both cane research and some factory investigations, including work on alcohol manufacture. Colour photographs are reproduced in the Portuguese section.

Le sucre — Mémo statistique 1982. 16 pp; 10.4 x 20.5 cm. (Centre de'Etudes et de Documentation du sucre, 30 rue de Lübeck, 75116 Paris, France.) 1982.

This folder provides a collection of statistics concerning the French sugar industry and trade in the form of tables of supplies and consumption in Metropolitan France, the French West Indies and Réunion, the progress of beet cultivation between 1955/56 and 1981/82, the 1982/83 beet area by Department; French production, consumption and exports as a block diagram; the number of French sugar factories classified by beet slice; the numbers of factories and sugar production from 1955/56 to 1981/82 plus 1939/40; development of sugar consumption — total and per caput — since 1960/61; analysis of the types of sugar sold; sugar usage for indirect consumption e.g. in confectionery, biscuits, etc.; EEC data on quotas, prices, production, consumption and trade, etc.; and world sugar balances for 1981/82 and two previous seasons; production in a number of countries, growth of production of beet and cane sugar since 1900 at 10-year intervals to 1970 and then annually, and similar consumption data, and annual per caput consumption for a number of countries, the highest being Barbados (59.1 kg white value) and the lowest Rwanda (0.4 kg white value).

Ramu Sugar Limited. 10 pp; 21 x 21 cm. (Ramu Sugar Ltd., P.O. Box 2183, Lae, Papua New Guinea.) 1982.

Ramu Sugar Ltd. was incorporated in Papua New Guinea in October 1978 to develop a new sugar industry at Gusap in Madang Province, 180 km north-west of Lae. This followed a feasibility study by Booker Agriculture International, who were subsequently appointed to implement the project. Commercial operations started in the latter half of 1982, and production is expected to reach 40,000 tonnes of mill white sugar per year by the mid-1980's. This colourful brochure describes the project, in English and the language of Papua New Guinea, which involves the development of some 6000 ha of land for the growing of rain-fed cane, and a 2800 tcd sugar factory plus the infrastructure. It is the largest agricultural development in the country and will provide employment for more than 2000 people.

Queensland Canegrowers annual report 1983. (The Queensland Cane Growers' Council, GPO Box 1032, Brisbane, Queensland, Australia 4001.) 1983.

A 56-page report of the QCGC describes the activities involving the Council in cane growing and processing, and contains many excellent colour photographs, most of which were submitted to the *Australian Canegrower* as entries in a photographic competition.

Tätigkeitsbericht (Activity report) **1981/82.** (Zuckerforschungs-Institut, Zaunergasse 1-3, A-1030 Wien, Austria.) 1982.

This is a 45-page report on the activities carried on by the Austrian Sugar Research Institute in the fields of beet agronomy, sugar technology and medical aspects of carbohydrates.

The South African sugar year book 1981-1982. 196 pp; 20.8 x 29.6 cm. (The South African Sugar Journal, P.O. Box 1209, Durban, South Africa.) 1983. Price: R9.50.

The latest edition of this well-known sugar year book contains the annual report of the South African Sugar Association, reports on the activities of the Sugar Industry Central Board, the Cane Growers' Association, the Sugar Millers' Association, the Experiment Station of the SASA, the Sugar Milling Research Institute and the South African Sugar Technologists' Association. These, plus various individual items concerning the South African sugar industry, go to make up a highly readable survey, while a directory of sugar companies and factories in South Africa and neighbouring countries adds to the value of this publication.

Annual report 1981-82. (Taiwan Sugar Research Institute, 54 Sheng Chan Road, Tainan, Taiwan.) 1983.

A 44-page account is presented of the various aspects of research on cane, sugar technology and by-products utilization carried out at the Taiwan Sugar Research Institute. The clearly printed text is interspersed with tables, graphs and colour photographs, a 2-page collection of photographs showing natural enemies of some cane pests being particularly interesting.

LABORATORY STUDIES

Determination of the lime salts and magnesium content in sugar factory products using a calcium ion-selective electrode. V. S. Shterman. I. Shakhovtseva and A. R. Sapronov. *Sakhar. Prom.*, 1982, (5), 42-44 *(Russian)*. Details are given of a method based on potentiometric titration using a Ca ion-selective electrode. Lime salts and Mg were determined, separately and together, by this method; results for 1st and 2nd carbonatation juice, evaporator thick juice and molasses showed close agreement with but better reproducibility than methods using titration with EDTA and chromogen blue or chalcone carboxylic acid as indicator.

Effect of adsorbents on the properties of colloidal dispersion substances in refinery molasses. V. A. Loseva, E. B. Ishchenko and S. Z. Ivanov. *Izv. Vuzov, Pishch. Tekh.*, 1982, (2), 32-34 *(Russian)*. – Molasses was diluted to 20-25°Bx and treated for separation of the colloids; from the reversible colloids fraction was prepared a solution of 0.5% ash concentration which was then treated with various adsorbents. Results showed that high-molecular substances of small particle size were more readily removed than those of large particle size, explaining why both the refractive index and viscosity rose while surface tension fell. Granular active carbon was the most effective adsorbent as regards surfactant removal, while anion exchange resins were the least effective. The other adsorbents tested were powdered active carbon, bone char and cation exhange resins.

Testing, evaluation and payment systems. J. R. Hudson. *Proc. 1st World Sugar Farmers' Conf.*, 1981, III.1-III.8. In an examination of the general approach to cane analysis, sugar yield prediction and payment, the author suggests that the trend toward greater sophistication in analysis, and increased incentives for improved cane quality may not be to the farmer's benefit, since the costs of testing could then outweigh any improvement. Moreover, with the changing emphasis on cane composition, sugar recovery could lose its importance, while impurities and fibre could gain in value; hence, formulae for evaluation must be flexible and able to reflect the changing situation, while the level of incentives for improvement in cane quality must be carefully watched, so that they are seen to contribute to an overall economic optimum rather than exploit competition to the detriment of one sector and disproportionate benefit of the other.

Atomic adsorption spectrophotometric determination of Cd, Pb and Cu in sugars using the iodide-MIBK extraction method. G. Ueno. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **30**, 11-17 *(Japanese)*. Heavy metals in raw, granulated, soft white and soft brown sugars may be determined by atomic adsorption spectrophotometry after dry ashing or wet combustion as pre-treatment. Since this pre-treatment is time-consuming and suffers from interference by impurities present in samples and reagents used, pre-treatment by an iodide-MIBK extraction method was examined. The recommended procedure, which permitted successful determination of Cd, Pb and Cu, was as follows: 10-20 g of sugar is dissolved in 10-20 ml of water in a beaker and then transferred to a separating funnel with a small amount of water; 4 ml of 50% KI solution and 15 ml of H_3PO_4 are added, and the contents diluted to 50 ml with water and shaken for 5 minutes with 10 ml of methyl isobutyl ketone. The MIBK phase (upper layer) is separated and extracted with 10 ml of N HCl; the aqueous phase (lower layer) is separated and diluted to 50 ml with water for analysis by atomic absorption spectrophotometry.

Studies on the measurement of turbidity of white sugar solution. H. Miyaguchi, Y. Oyamada and A. Hanzawa. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **30**, 18-25 *(Japanese)*. – A simple and rapid method for white sugar turbidity determination is necessary for routine work. The colorimetric method of ICUMSA[1], in which absorbancy is measured at 420 nm, is suitable for white sugar and light-coloured products. By filtering the sample solution under vacuum through a membrane filter of 0.45 μm pore size before absorbancy determination, the effect on absorption of light scattering by the particles contributing to turbidity is made negligible, whereas omission of filtration in the examination of turbid solutions will give results that are dependent both on absorption and on scattering. Hence, the difference between absorbancies determined before and after filtration should correlate with the turbidity of the test solution; investigations showed that the difference was in reasonable agreement with results of turbidity measurement by nephelometry.

On the desalination of sugar solutions by electrodialysis using neutral membranes. M. Sugiyama, Y. Takatori, Y. Touyama, A. Nakamura and T. Yamauchi. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **30**, 26-32 *(Japanese)*. – Two methods of sugar solution desalination have been tested extensively, one using granular ion exchange resin and the other using electrodialysis with ion exchange resin membranes. These methods have not been used industrially because of their many defects. The first method suffers from deterioration of anion exchange resin by fouling, sucrose inversion by H^+ ions during cation exchange, and the large quantity of resin regenerant needed. The second method has two major disadvantages: organic fouling of the anion membranes, with consequent shortening of their life, and sucrose degradation as a result of fall in pH caused by polarization at the surface of the anion membranes. Effective desalination of low-grade syrups was achieved by a method based on use of cation exchange resin membranes and non-selective ion-permeable membranes. A correlation was established between the degree of desalination and sugar recovery, whereby recovery increased gradually up to about 30% desalination, after which the increase was much steeper. Combining the electro-desalination process with conventional refinery processes such as carbonatation and bone char, granular active carbon and ion exchange treatment had a multiplicative effect, best results being given by carbonatation combined with desalination. Since desalination removed the bitter taste of low-grade syrup, it was possible to produce edible syrup from final molasses. PVA (polyvinyl acetate) film was found to have a number of excellent properties as a neutral membrane in electrodesalination.

[1] *Proc. 15th Session ICUMSA*, 1970, 255.

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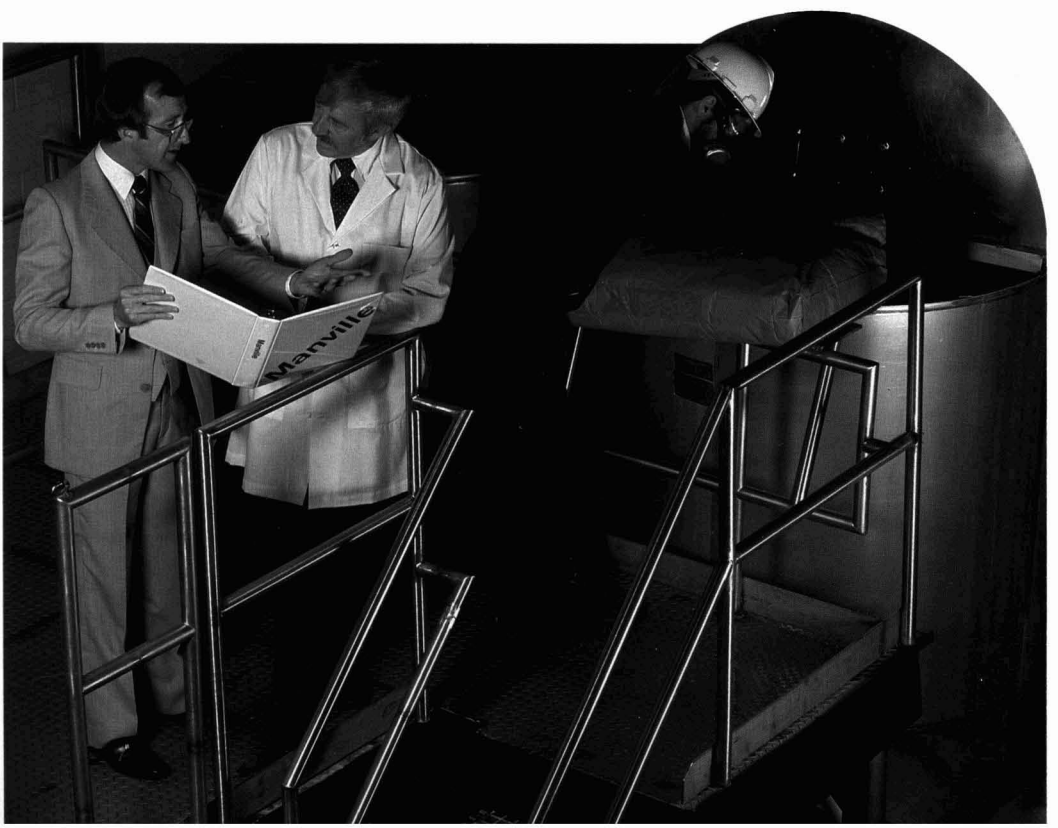

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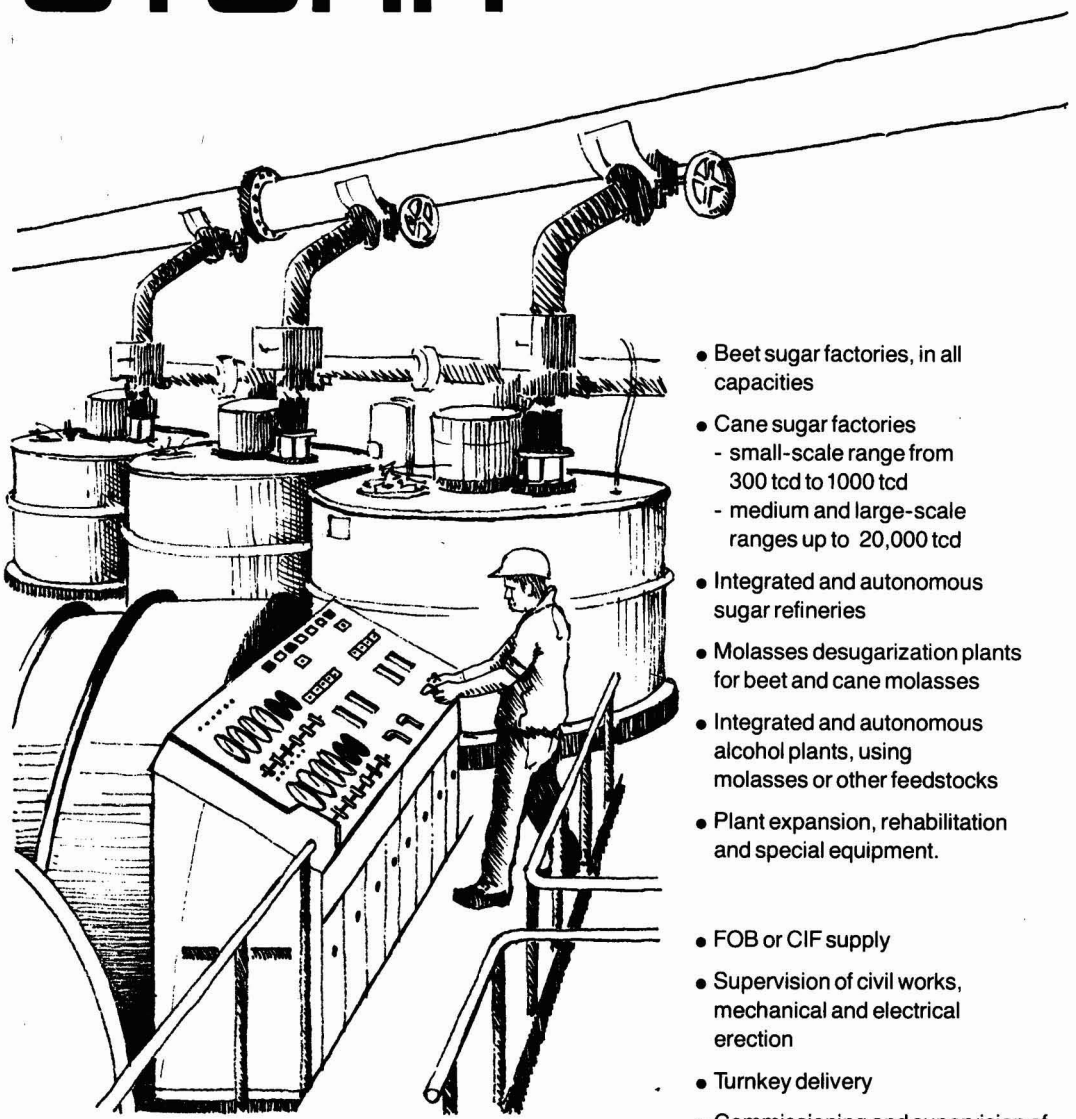

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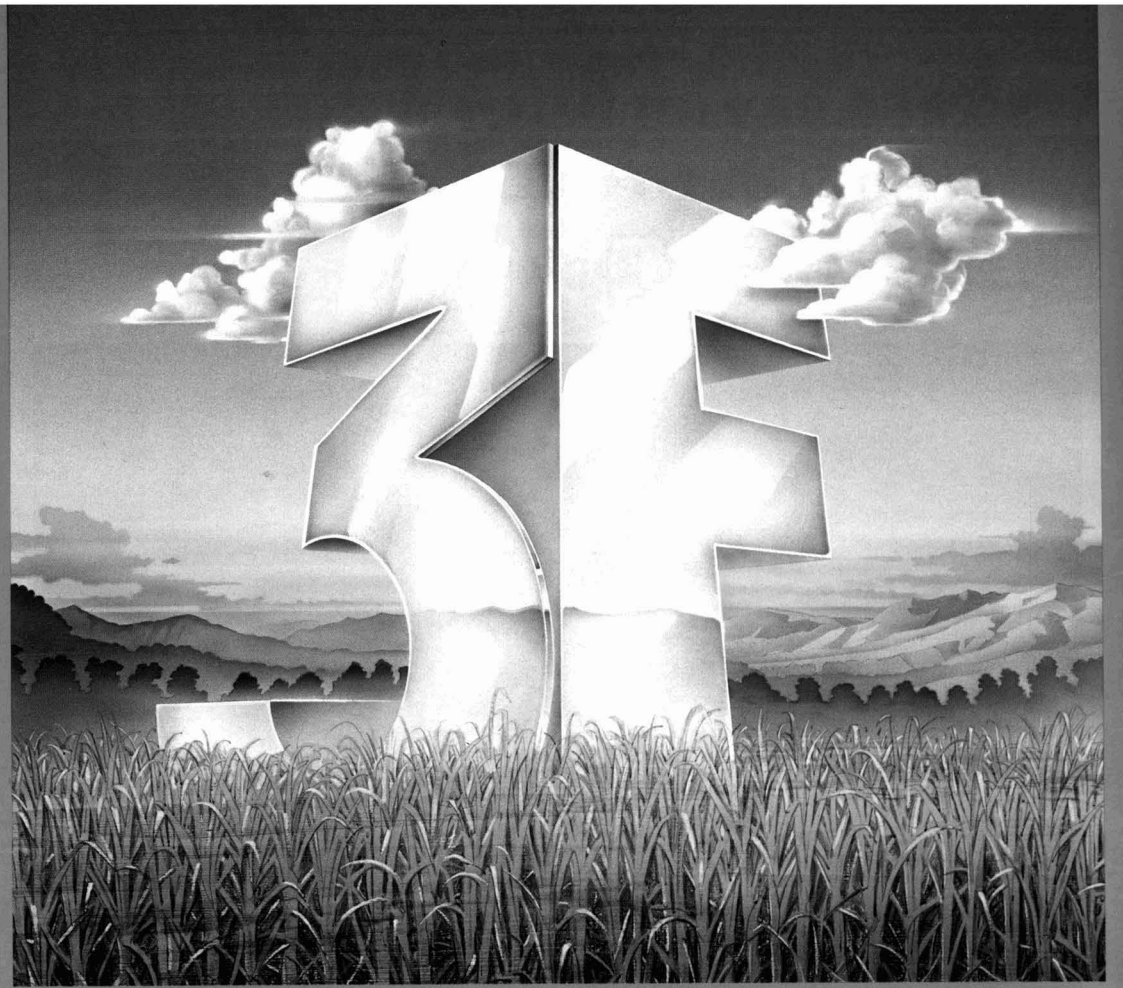

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BY-PRODUCTS

Alcohol from cellulosics: the autohydrolysis-extraction process. M. Wayman. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 79-87. — A process for the preparation of glucose from cellulosics (including bagasse) for alcohol fermentation is described. Important aspects include suitable pretreatment (preferably auto-hydrolysis) followed by removal of solvents (NaOH or dioxane monohydrate) added for dissolution of lignin, and dilute acid or enzymic hydrolysis. Utilization of hemicellulose and lignin is discussed.

Industrial efficiency of alcohol fermentation: a comparative study. S. E. Ferrari, J. J. C. Lopes, J. R. A. Leme and E. R. de Oliveira. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 139-141. — The industrial efficiency of different yeast strains currently used for alcohol manufacture in Brazil was determined in trials under laboratory conditions. Best proved to be IZ-1904, which gave a maximum alcohol content in the wine from cane juice of 8.5% by volume at 20°C within 9½ hours' fermentation, permitting a yield of 91%.

Improving the scenario for ethanol production: the new ethanol producers. W. Vergara. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 143-150. Besides improvements in the technology of alcohol manufacture by fermentation and distillation, it is considered possible to bring about improvements in productivity, energy consumption and economics through use of micro-organisms superior to *Saccharomyces* spp. Comparison of *S. cerevisiae* with *Zymomonas subtilis* showed that the latter gave a higher alcohol yield at a calculated 21% reduction in continuous fermentation costs and a 30% reduction in fixed investment for a plant of 150 m^3 daily capacity. While cellulolytic bacteria may have future potential for ethanol manufacture from cellulose, *Clostridium thermocellum* gave the lowest ethanol yield of the three micro-organisms tested and suffered from low ethanol tolerance and difficulties associated with continuous cultivation at high dilution rates, so that production costs were higher.

Description of a full-scale ethanol production plant for direct processing of sugar cane and sweet sorghum according to a thermal treatment process — technical and economic aspects. H. Brüschke, G. F. Tusel and A. H. Ballweg. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 153-156. — In the process described, cane and/or sorghum is chopped and shredded, heated with injected low-pressure steam to about 110°C whereby most of the sucrose is inverted, the insoluble solids then washed and the resultant bagasse dewatered to 50-55% moisture for use as fuel. The liquid fraction obtained after the steam heating and washing is filtered, cooled by partial evaporation, and then fermented in the conventional way. The process consumes less energy for production of fermentable juice than does normal milling.

Some notes on studies of alcohol slops treatment in Taiwan. S. L. Sang *et al. Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 797-800. — See *I.S.J.*, 1982, **84**, 218.

Liquid fuels from biomass in Hawaii. R. L. Ritschard and A. G. Ghirardi. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 875-880. — From examination of the feasibility of producing alcohol from cane juice, molasses, bagasse or other plant materials, it is concluded that molasses, in the short term, would be the most suitable feedstock in Hawaii, but that a long-term assessment of the potential for alcohol manufacture is difficult. The economics of alcohol manufacture are discussed, and the situation in Hawaii compared with that in Brazil. Generally, it is felt that use of alcohol fuel would have to be on a more modest basis than in Brazil.

The Brazilian biomass utilization program, with emphasis on Proálcool. J. I. Vargas. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 919-933. — The author, who is the Secretary for Industrial Technology at the Ministry of Industry and Commerce in Brazil and Professor of Physics and Chemistry at Minas Gerais Federal University, discusses energy consumption in Brazil by sector and its consequences and indicates measures adopted by the Brazilian government to achieve short- and medium-term solutions. Long-term programs are analysed, with emphasis on liquid fuels. An extensive description is given of the national alcohol program and its technological, social and polito-economic effects, and reasons are given for the preference for spark-ignition engines. The number of alcohol distilleries that have been built and are planned for each year up to and including 1984 and the accumulated increase in ethanol production by 1988 are shown. Apart from use of vinasse as fertilizer, investigations are being conducted on economical production of protein or methane from vinasse, which would lead to increased sugar cane productivity. Production forecasts are given for a number of fuels that could be substituted for oil, including bagasse.

Microbiological control of ethanol fermentation on an industrial scale. G. E. Serra *et al. Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 1051-1054. — Investigation of batch fermentation of a mash composed of cane juice and molasses showed a negative correlation between bacterial counts and the number of live yeast cells, wine acidity and ethanol yield. Throughout the 1979/80 season, when the investigations were carried out, the average number of dead yeast cells was approx. 60%; however, this could have been a consequence of more rigorous treatment of the yeast suspension when the bacterial counts were high.

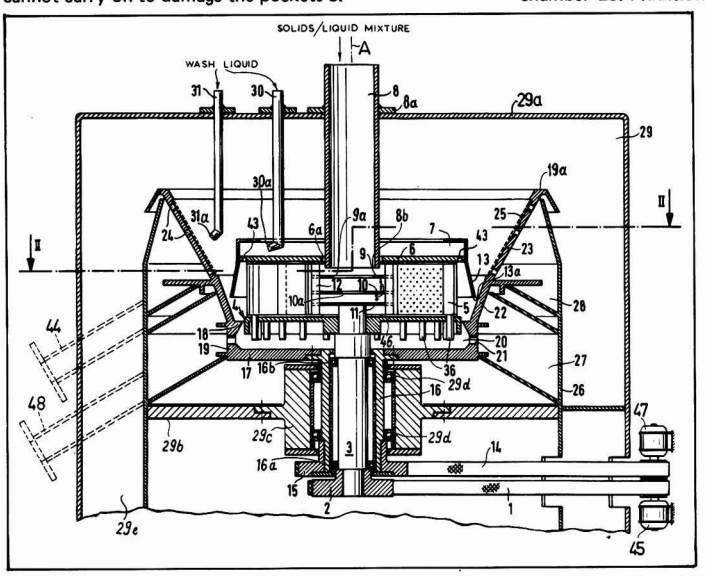
An analysis of possible yield improvement in the industrial processing of sugar cane to alcohol. P. A. Doin, A. O. B. Neto, A. G. Pinto and B. R. V. Concone. *Proc. 4th Int. Symposium on Alcohol Fuels Technol.* (Brazil), 1980, 1055-1059. — The more important parameters in ethanol manufacture from cane are evaluated and compared with values that are theoretically attainable as a result of medium- and long-term improvements in the technology. It was found possible to achieve a considerable increase in alcohol yield by comparison with current performances, and recommendations are made regarding various aspects of the research and development programs related to ethanol manufacture in Brazil.

PATENTS

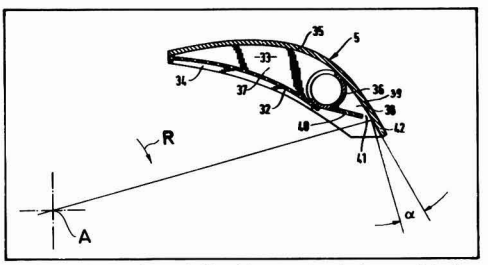
UNITED STATES

Pocket-type centrifugal. P. Ostermeyer and G. Hultsch, *assrs.* Krauss-Maffei AG, of Munich, Germany. **4,254,904.** August 7, 1979; March 10, 1981.

The device is intended for extraction of all soluble matter from sugar cane or sugar beet which has been converted into a pulp or mash. It comprises a housing within which is located a bottom driven shaft 3 carrying a rotor 4 in the form of a top plate 6 and a base plate 46 carrying between them a series of scoop shaped webs or ribs 12 supporting three discs 9, 10 and 11. A central hole 6a in the top plate accommodates a feed tube 8 through which the beet or cane pulp passes and is distributed by the discs; the upper two have holes of reducing size and disc 11 is solid. Any material bigger than the dimension s between 9 and 10 is held back and so cannot carry on to damage the pockets 5.



These pockets have arcuate inner screen surfaces 32 supported by ribs 33 from the solid surfaces 35 and, as the rotor spins, feed material passes onto the surface 32 and the bulk of the juice content passes through into compartment 37 and so into vertical pipe 36. From the pipes 36 the juice drains into the compartment 20 formed between plate 46 and plate 17 carried by a second coaxial rotor sleeve 16 (which may be driven at a different speed from shaft 3). From this compartment it leaves through apertures 21 into chamber 27 and so out through pipe 48. The solids content of the pulp is sent by centrifugal force along the solid extension 40 of the inner surface of pocket 5 and is discharged onto the inner surface of the skirt 13. This is supported from plate 6 which also carries a cover 7. Wash liquid admitted through pipe 30 and spray head 30a passes through apertures 43 in plate 6 and so mixes with the pulp on skirt 13. As an alternative, the apertures 43 may be closer to the rotor axis and discharge into the space 38 in the pocket 5, so mixing with the pulp as it passes over the gap 41.

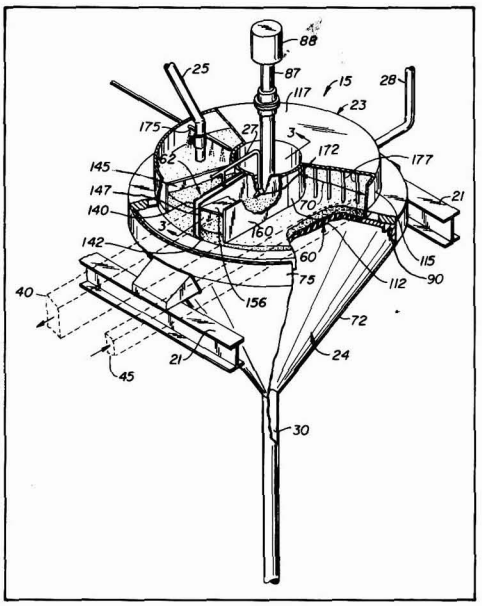


The pulp and wash liquid are mixed thoroughly by passage along the skirt and onto the solid frustoconical section 22 attached to plate 17. The mixture passes onto the screen section 23 where the wash liquid, carrying further soluble solids, is separated and passes into chamber 28. Additional wash liquid is sprayed onto the pulp through pipe 31 and spray head 31a and washes further solids out of the pulp before passing into chamber 28. This diluted liquid is discharged through pipe 44 while the exhausted and relatively dry pulp is discharged over the upper edge 19a of the basket and out of the machine through collector 29e.

Continuous separation system (for crystals from massecuite). J. C. V. Ducasse, of Martinez, CA, USA. **4,256,582.** August 15, 1979; March 17, 1981.

Crystals are separated from a massecuite admitted to the upper section 23 of the separator 15. This is achieved by delivering the massecuite by pipe 25 through a hole in the cover 117 into an inlet chamber formed between stationary plates 140 and 145 and inner and outer annular plates 112 and 115, which has as its base a section of the annular screen which is supported by a disc 60 having an annular perforated section beneath the screen. The disc is rotated by motor 88 which drives its attached shaft 87 and is supported at its periphery by wheels 90 which run on rails. These form part of the cylindrical section 75 of the lower compartment 24, most of which is a frustoconical section 72. Suitable seals are provided at the inner and outer edges of section 23 so that the only connexion between it and compartment 24 is via the perforations in the screen and plate.

Copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price £1.45 each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).



From section 75 of compartment 24, a pipe 28 leads to a barometric condenser or other vacuum-creating device while a pipe 30 leads from the base of compartment 24 to a seal and pump for removal of molasses separating from the massecuite through the screen and plate 60. The plate 145 extends to near the plate and, as the latter rotates, forms a thin layer of massecuite. The molasses is sucked down into compartment 24, and the crystals retained by the screen. As the disc continues its rotation, the crystals pass beneath the washing sprays 175 and eventually as a layer thinner than the original one because of the loss of molasses. This is broken up to aid drying by the rakes 177 and eventually passes under plate 160. The bottom of plate 140 is horizontal, forming a plough blade 142 and a small clearance is provided between this and the end of plate 147. Steam is admitted through pipe 27 and passes upwards through this small clearance, fluidizing the sugar in the compartment between plates 147 and 160. A guide plate 156 slopes downwards to the lower part of the inner hub 112 of section 23 and jets 172, also supplied with steam through pipe 27, blow the fluidized sugar radially into a duct 40. This leads to a receiver in which the sugar crystals are separated from the steam and discharged while the steam is recycled through duct 45 into the space above the blanket of crystals in section 23, helping to dry them.

Paper pulp production from bagasse. H. Krüger, W. Berndt, U. Schwartzkopff, F. J. Reitter, T. Höpner and H. J. Mühlig. **4,260,452.** November 24, 1978; April 7, 1981. – Bagasse is treated to remove about two-thirds of its pith content and wet bulk-stored [in the presence of (an acid-producing bacterial culture and) (0.01-0.03 g/litre of) a preservative (a C_1-C_5 aliphatic acid, an amino- or halogen-substituted C_1-C_5 aliphatic acid, a C_1-C_6 hydroxy acid, an alkali metal, Al or Al phosphate salt or an amide of one of these acids) (lactic acid, Na lactate, propionic acid, mono-Na maleinate, di-Na citrate or Al monoacetate phosphate)]. An aqueous suspension is made of the stored bagasse and this wet-depithed (removing up to 80% of the residual pith) by hydraulic shearing while simultaneously adding, per 100 parts of suspension, 0.5-10 parts of a carbonate, sulphate, hydroxide, phosphate, polyphosphate, chlorite or hypochlorite of an alkali metal, Mg, Ca or Al. The product is pulped by a neutral sulphite semi-chemical process (using Na_2CO_3 buffer at 140°-185°C for 2-60 min) or thermomechanical defibration, the product then mechanically pulped, washed, screened, cleaned and dewatered [and bleached (in a medium containing 1-5% H_2O_2, 1-5% NaOH and 1-5% Na silicate, all w/w)].

Saccharification of (bagasse) cellulose. M. Pilipski, of Clifton, NJ, USA, *assr.* M. Pilipski, M. G. Sturman and M. Ebert. **4,260,685.** August 2, 1979; April 7, 1981. Raw stock which is rich in cellulose (e.g. bagasse) is immersed in a bath of anhydrous liquid hydrogen chloride (containing a catalyst, e.g. $AlCl_3$) to hydrolyse the cellulose to glucose and the reaction products separated so as to recover the glucose; alternatively, the latter may be subjected to fermentation to give alcohol. The reaction may be carried out by introducing the raw stock, carried by a liquid which does not react with the HCl (e.g. *n*-octane or a perfluorocarbon), into a vertical columnar chamber, separating the products continuously and recycling the carrier and HCl.

Production of fructose and useful by-products. S. E. Bichsel, Y. Wang and A. M. Sandre, *assrs.* American Crystal Sugar Co., of Moorhead, MN, USA. **4,263,052.** October 12, 1979; April 21, 1981. – Raw material (cane or beet molasses) containing a fructofuranoside compound (sucrose, raffinose) is treated (with invertase enzyme) to hydrolyse the compound and so liberate its fructose component. A calcium base [CaO or $Ca(OH)_2$] is added (at $< 20°C$) to precipitate a mixture of Ca-sugar complexes comprising at least 85% (at least 90%) Ca-fructose complex. The precipitate is separated from the glucose-rich mother liquor (blended with water) and treated with phosphoric acid under temperature conditions (at $< 20°C$) such as to avoid raising the temperature by heat of reaction to $> 40°C$ and maximizing the recovery of $CaHPO_4$ precipitate (with entrapped colour bodies) by keeping the pH between 7 and 9. The precipitate is separated, leaving a solution of at least 85% (at least 90%) pure fructose, the pH of which is adjusted to 3-7 by passage through an ion exchanger whereby Ca^{++} ions present are exchanged for H^+ ions. Solid fructose may be recovered from this solution.

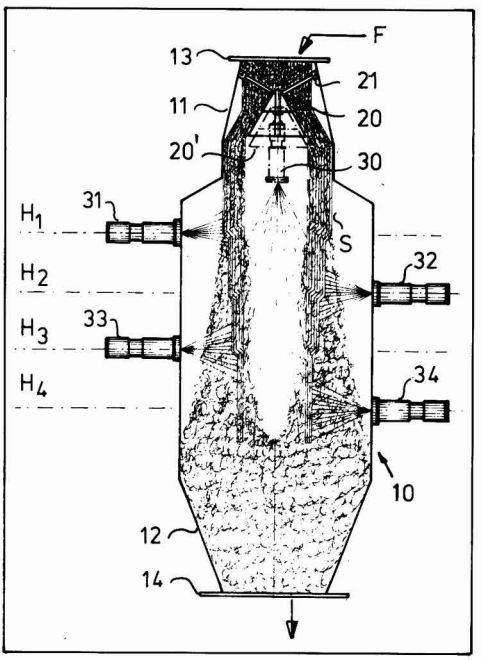
Immobilized enzymes. S. Uchiro, of Kokubunji, Japan, *assr.* CPC International Inc. **4,263,400.** January 11, 1979; April 21, 1981. – A crude glucose isomerase preparation [obtained from a *Streptomyces* microorganism (*S. olivochromogenes*)] containing a high M.W. non-dialysable polysaccharide which inhibits adsorption of the enzyme on an ion exchange resin, has this polysaccharide removed by contact with an (anion) ion exchange resin which selectively adsorbs it. Alternatively, the glucose isomerase may be selectively precipitated from solution by addition of an organic solvent (methyl alcohol, ethyl alcohol, *n*-propyl alcohol, *iso*-propyl alcohol, butyl alcohol, acetone, *p*-dioxane or mixtures of these) or by addition of a salt [$(NH_4)_2SO_4$, Na_2SO_4, $MgSO_4$ or mixtures of these]. It is then redisssolved to give an enzyme solution essentially free of the polysaccharide from which the enzyme is immobilized by adsorption on an ion exchange resin.

Beet topper. W. Kloppenburg, of Munnekezijl, Holland, *assr.* Landbouwmechanisatiebedrijf W. Kloppenburg. **4,263,773.** April 16, 1979; April 28, 1981.

UNITED KINGDOM

Adding liquid components to pourable powdered or granular materials. M. Kaiser-Wirz, of Magden, Switzerland. **2,020,988.** May 9, 1979; November 28, 1979.

The vessel for mixing e.g. molasses with animal fodder, is in the form of a hollow cylinder 10 with an upper opening 13 through which the feed F is delivered onto a deflector 20 supported by stays 21. The position of the deflector is adjustable and an alternative position 20' is indicated. It produces a continuous flow in the form of a hollow cylinder and the molasses is sprayed onto the inside surface by nozzle 30.

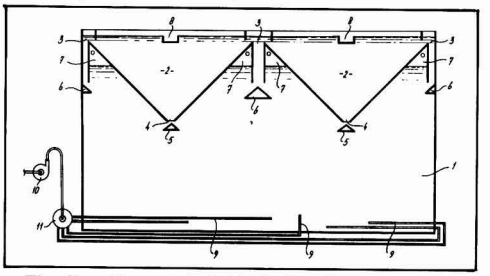


Four banks ($H_1 - H_4$), each of three nozzles spaced equidistantly around the vessel 10, deliver molasses to the outside of the feed stream, the banks being offset by 60° from the nozzles above and below. The position of the deflector and the choice of numbers of sprays to be used are adjusted to produce the correct mixture.

Anaerobic purification of waste water. N. V. Central Suiker Mij., of Amsterdam, Holland. (A) **2,021,549.** May 23, 1979; December 5, 1979; September 29, 1982. (B) **2,021,550.** May 23, 1979; December 5, 1979.

(A) See US Patent 4,253,956[1].

(B) Feed of waste water into an anaerobic fermentation tank should be gentle enough to prevent break-up of sludge flocs but vigorous enough to ensure circulation. Channelling of flow through the sludge should also be avoided since this reduces purification efficiency. In order to ensure this the feed is supplied by pump 10 to a switching device 11 which sends it through the feed pipes 9 which are distributed so that they discharge into different parts of the tank 1.

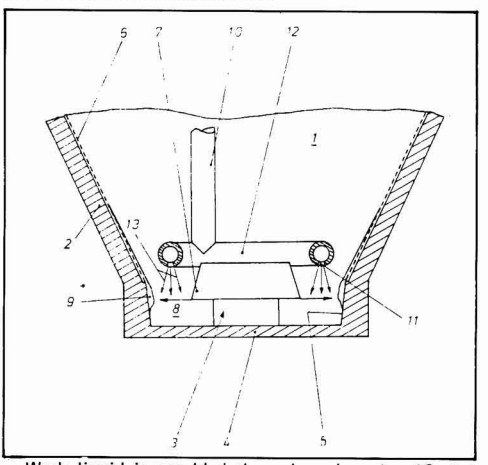


The flow through individual pipes is varied or interrupted so that it causes circulation and prevents stagnant zones of sludge after which the cutting of the flow permits the flocs to eliminate short-circuits. The gas formed rises to spaces 7 from which it is removed while the mixture of sludge and water passes baffles 5 and 6 and overflows weirs 3 to enter the clarifying chambers 2. The sludge settles and slides down the sides of these chambers and returns to the lower chamber 1 while purified water overflows into troughs 8 from which it discharges.

Sugar syrup purification. Ecodyne Corporation, of Lincolnshire, IL, USA. **2,022,135.** May 22, 1979; December 12, 1979. – See US Patent 4,187,120[2].

Continuous sugar centrifugal. Hein, Lehmann AG, of Düsseldorf, Germany. **2,024,639.** April 25, 1979; January 16, 1980; May 19, 1982.

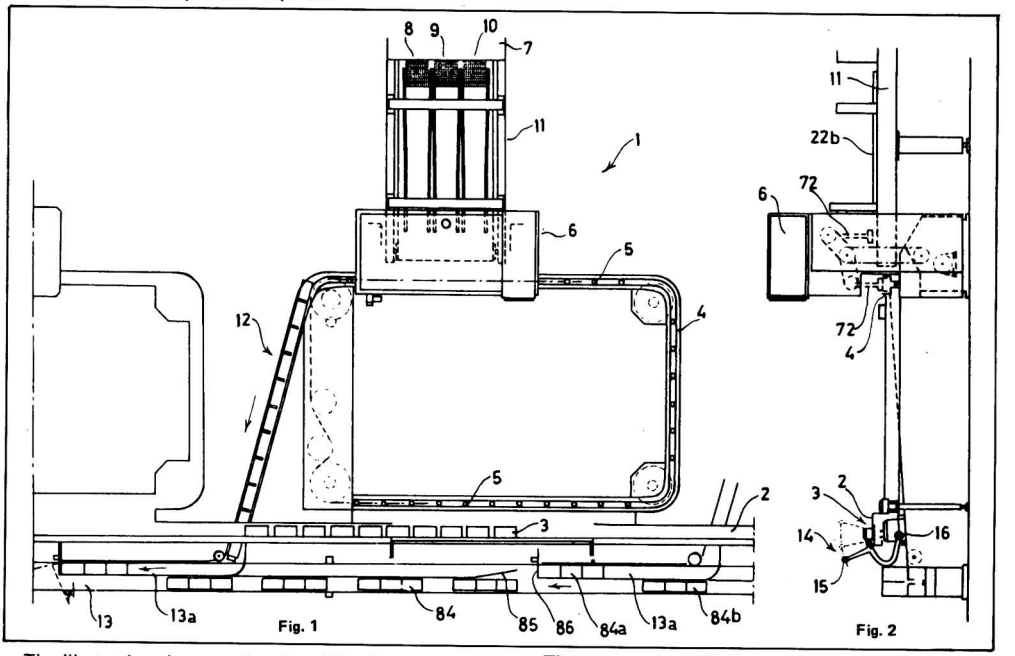
Massecuite is delivered onto the bell 7 mounted on the central hub 3 which forms the acceleration device of the centrifugal 1. It moves outwardly and downwardly and is flung off as a thin stream across the gap 8 between the edge of the bell and the wall 5, before continuing outwards and upwards as a flow 9 which is separated into its constituents on screen 2.



Wash liquid is provided through a ring pipe 12, fed by pipe 10, and is delivered as a uniform spray across the whole width of the gap 8, so uniformly coating the stream of massecuite and diluting it on the wall 5.

[1] *I.S.J.*, 1983, **85**, 126.
[2] *ibid.*, 1981, **83**, 317.

(Cube sugar) Container filling installation. Stork Bepak B.V., of Utrecht, Holland. **2,024,763.** June 26, 1979; January 16, 1980; September 15, 1982.

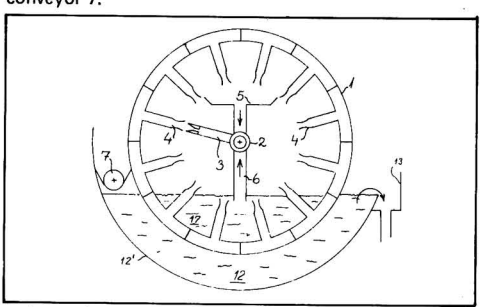


The illustration shows a plan view (Fig. 1) and a side view (Fig. 2) of one station of a cube sugar filling installation. Empty containers 3 are supplied to each station on a conveyor 2 and an operator moves a lever 15 to its first inward position and, when three containers are together, to its second inward position, when the three containers are delivered onto the endless conveyor 4, spaced by raised stops 5. The containers are carried round to the filling unit 6 which is supplied with cubes from conveyor 7. The cubes are compacted by horizontal reciprocating movement of the guides 22b, actuated hydraulically, and are delivered uniformly beneath a vacuum gripper 72 in the filling unit.

By means of a suitable wheel and arm arrangement, reciprocating movement is imparted to the chain drive to a toothed wheel carrying the arm from which gripper is suspended. The gripper thus moves from one to the other position shown in Fig. 2, at one location picking up the required cubes and at the other depositing them in the containers. Suitable means are provided for filling the container with as many layers of cubes as required, when the filled containers move along conveyor 4 and a further three containers take their place. The filled containers are delivered onto conveyor 12 and to conveyor 13a from which they slide on a sloping section onto conveyor 13. Filled containers 84a from other stations also arrive on conveyor 13 and the operator can hold these up by a stop 86 until a space in the line of containers 84b is available. The conveyor 13 delivers the containers first to a drying station and then a packaging station.

Rotary filter. A/S De Danske Sukkerfabrikker, of Copenhagen, Denmark. **2,025,248.** June 25, 1979; January 23, 1980; September 2, 1982.

The rotary drum filter is subdivided into cells and covered with a cloth, perforated sheet or suitable septum and rotates about a stationary shaft 2. Vacuum is maintained within the drum and filtrate is withdrawn through extractor 6 and a conduit in shaft 2. Wash water applied to the cake on the drum surface is collected by tray 5 and leaves by a separate conduit in shaft 2. The cells are connnected to the interior of the drum through pipes 4 having venturi openings and as they pass in close proximity to the nozzle 3 a jet of steam is delivered, by operation of a suitable valve mechanism, which raises the pressure within pipe 4 and blows off the cake, which falls into a trough from which it is removed by screw conveyor 7.



A nozzle may be provided for a number of segments along the length of each cell in the drum; alternatively, the segments may be provided with a manifold which has a single pipe 4 into which steam is injected by a single nozzle. In the case of a disc filter the various disc sectors may be provided with conduits to a manifold and nozzle arrangement for delivery of steam to the filter surface for cake discharge.

TRADE NOTICES

Centrifugal controls. CompAir Maxam Ltd., Pool, Redruth, Cornwall TR15 3PR, England.

The CompAir Maxam Isomax pneumatically operated valve is basically in two parts: a sub-base to which connexions are made, and the body housing the moving spool. The range of Isomax valves offers 4-way, 5-port designs with typical flow rates at 6 bar of between 21 and 155 $dm^3.sec^{-1}$. Maximum operating pressure is 10 bar, and the valves are suitable for use at temperatures ranging from $-20°C$ to $+80°C$. They are available as pressure- or solenoid-operated types, all units incorporating a manual over-ride facility which is fully recessed to eliminate accidental operation. These valves were chosen by Tate & Lyle for use in automatic control of the centrifugals at Thames refinery as part of a modernization scheme. Since all centrifugal controls mounted on the machines have gradually become corroded by adhering syrup, which made routine maintenance and repair difficult, it was stipulated that all new controls should be contained in a cabinet some distance from the appropriate centrifugal, and to date CompAir Maxam have supplied 12 such control cabinets.

BMA equipment for the sugar industry. BMA Braunschweigische Maschinenbauanstalt AG, Postfach 3225, D-3300 Braunschweig, Germany.

Details have been provided by BMA of machinery and equipment put into operation in 1982, including a flume water settling tank of 60-m diameter at Aarberg refinery in Switzerland, a tower diffuser of 8000 tonnes of beet daily capacity installed at Vierverlaten sugar factory in Holland, a vertical prelimer, a falling-film evaporator station of four units installed at Uelzen in West Germany which is so designed as to occupy a minimum of floor space, and new G series batch centrifugals installed at four West German factories for *A*- and *B*-massecuite and white sugar treatment.

Waste water treatment. Kennicott Water Treatment, Spring Road, Ettingshall, Wolverhampton, West Midlands WV4 6JX, England.

The Megox system of waste water treatment, originally developed by BOC Ltd., is a single-tank arrangement designed to handle material of high BOD and intended for a number of industries, including the sugar industry. Effluent entering the feed pipe is mixed with bacterial sludge from the reaction zone in the tank above, and flows at a controlled rate to a point at which oxygen is injected in an amount based on the dissolved oxygen content in the effluent (the measuring sensor transmits this value to a process controller governing oxygen injection). The waste water then passes to a downflow oxygenator in which undissolved oxygen re-coalesces to form gas bubbles and yield a liquid of high dissolved oxygen concentration. The effluent enters the tank through a side feed port in the upper central area which forms a conventional stilling well where a gradual downflow is maintained. The liquid descends to the mixed reaction zone near the bottom of the tank where there is controlled turbulence and the heavier bacterial sludge falls evenly over the tank floor to form a blanket; a slowly rotating scraper collects sludge for recycling or removal. Typically, the system can achieve a 90% reduction in BOD, even where the initial level is greater than 5000 $mg.l^{-1}$. The plant is available only from Kennicott Water Treatment, an operating division of NEI-Thompson Ltd.

Beet washer and centrifugal screens. Hutter & Schrantz Siebtechnik Ges.mbH, Postfach 21, A-1105 Wien, Austria.

Novoral rubber screens or K4 screens (the latter made of synthetic material) are designed for use in beet washers where steel screens increase the amount of beet injury and hence sugar losses. Brass or stainless steel screens from Hutter & Schrantz help reduce energy consumption in centrifugalling. The brass screens are very robust and do not buckle during operaion, while stainless steel screens 0.5 mm thick have a long life extending over several campaigns, and a large open area which permits the purging cycle to be shortened, thus saving energy.

PUBLICATIONS RECEIVED

"World of flow". Kent Industrial Measurements Ltd., Flow Products, Oldends Lane, Stonehouse, Glos. GL10 3TA, England.

The first of a new, regular series of leaflets entitled the "World of flow" is now available from Kent Industrial Measurements Ltd., a member of the Brown Boveri Kent Group. The leaflets will concentrate on the technical and applicational aspects of flow measurement, and No. 1 gives details of a new, high-performance, low-cost turbine flowmeter of up to 40:1 flow range which is easy to install.

Gears. David Brown Gear Industries Ltd., Park Gear Works, Huddersfield HD4 5DD, England.

Available from David Brown Gear Industries is a pictorial broadsheet showing their full range of standard product power transmission equipment, including Radicon worm gear speed reducers, helicon geared motor units, the helical shaft-mounted D.B. Sala torque arm unit, heavy-duty H Series gear units, and a comprehensive range of flexible and fluid couplings and torque limiters. The H Series of gear units is also featured in a separate brochure recently published and describing the salient features of the units as well as giving full details of mechanical and thermal capacities and dimensions.

Bagasse pulp plant in Thailand. Ishikawajima-Harima Heavy Industries Co. Ltd., New Ohtemachi Bldg., 2-1, 2-chome, Ohtemachi, Chiyoda-ku, Tokyo 100, Japan.

The October 1982 issue of IHI Bulletin describes the new IHI bagasse pulp plant erected in Thailand for the Siam Pulp & Paper Co. for a designed output of 72 tonnes of pulp per day at a moisture content of 50%, a brightness of 85°GE or above, and a speck content of less than 10 mm^2 per m^2. The pulp is intended for production of kraft paper, liners, mill boards, etc. Full details are given of the equipment and processes.

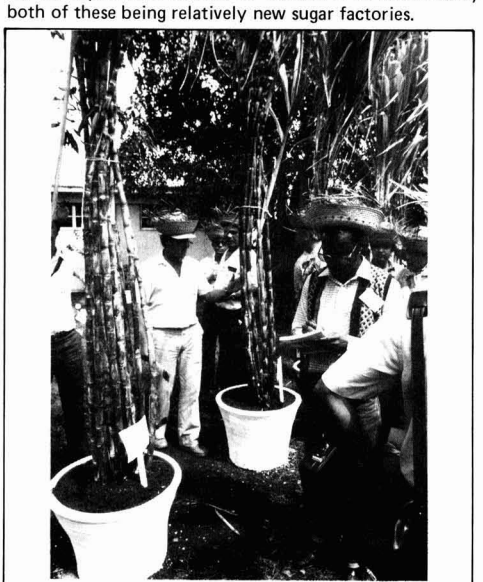
Continuous alcohol manufacture. — The first commercial-scale plant using the Alfa-Laval Biostil process for continuous manufacture of industrial alcohol went on stream in August 1982 at São Luís distillery in Southern Brazil. it is designed to produce 150,000 litres of 96% ethanol per day from a feedstock consisting of about 30% final molasses and 70% cane syrup. In the first season of operation, the distillery achieved 94.7% of theoretical yield as opposed to 86% for a batch plant of conventional design operating in parallel. Vinasse volume was only 0.8 litres per litre of alcohol, compared with 10-12 litres/litre for the batch plant.

Distribution switchboard order. — Arcontrol Ltd. has recently delivered six low-voltage distribution switchboards, under a contract worth £100,000, to Bardney sugar factory of British Sugar plc. Part of a major up-grading project, the switchboards are rated at 50 kW for 1 sec, with switch fuses varying from 125 to 800 A and air circuit-breakers of 2500 A rating to control the incoming supply and switch-fuses.

Boiler contract. — Foster Wheeler Power Products Ltd. have been awarded a contract worth about £3 million for the supply of two coal-fired boilers to the Allscott factory of British Sugar plc. Each boiler will have a rated output of 20.4 tonnes of steam per hr at a pressure of 19 bar and a temperature of 316°C. The boilers are to be complete with all necessary ancillary equipment including feed pumps, piping and valves.

International Society of Sugar Cane Technologists 18th Congress 1983

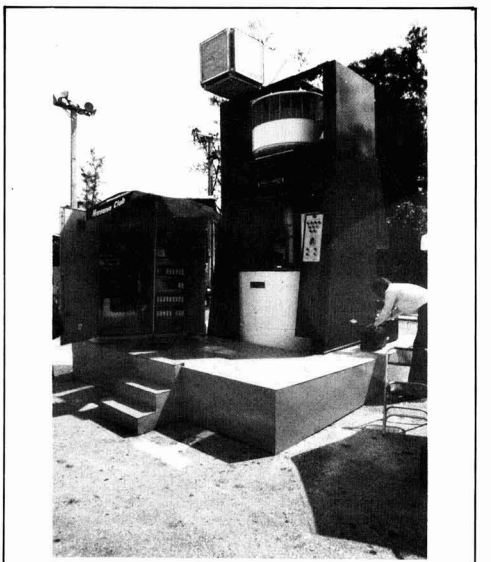
The ISSCT held its latest Congress in Havana, Cuba, in February 1983 largely in accordance with the program set out in our Supplement published in the same month. A minor hurricane had struck the island just before the Congress began so that delegates arriving at José Marti International Airport could see damaged aircraft and uprooted palm trees. It also had the effect of making cane fields in Havana Province very wet, with tangled and lodged cane; demonstrations of field equipment were understandably hampered by such conditions, and it was decided that the factory visit should be to Central 30 de Septiembre instead of Central 5 de Noviembre, both of these being relatively new sugar factories.



Delegates inspecting new varieties at Jovellanos

During the period of the Congress proper, a new introduction was a "poster" display in which papers which had not been accepted for presentation were nevertheless mounted on frames for inspection and reading by members. Also during the congress, delegates were able to visit, after the daytime sessions, the stands of a number of manufacturers in the Exhibition halls of the Havana Libre hotel. No less than 48 firms were represented, some under the aegis of others, from 14 foreign countries as well as the host country, Cuba. Some of the larger products of these firms were displayed in an open area close to the Palace of Conventions where the Congress sessions took place.

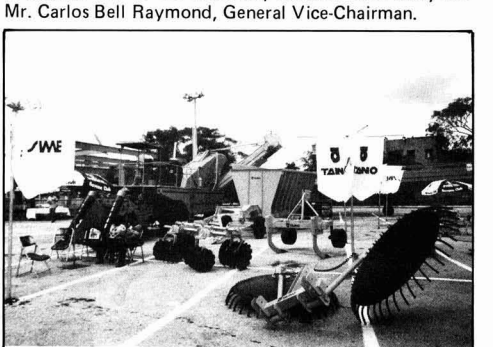
It was in this Palace of Conventions that members were addressed by Mr. Enrique Estremadoiro, Executive Secretary of GEPLACEA, on the functions and objectives of that organization, with an assessment of the future of the sugar industry in developing countries and a plea for the cooperation necessary to overcome the industry's present and future problems. A second address was given later in the Congress by Dr. A. J. Vlitos, Executive Director-elect of the World Sugar Research Organization, who described the WSRO and its membership and functions. He also presented a survey of work sponsored and encouraged by the WSRO, much of it



Broadbent automatic centrifugal in the static exhibition

concerned with refutation of attacks on sugar as a health hazard and utilization of sucrose. He spoke of the growing use of synthetic and starch-based sweeteners and the need for research and more effective education of the public to ensure that sugar's role in the diet is restored.

During the final plenary session, it was announced that membership of the Society, including individual, affiliated, institutional, incorporated and honorary members, had reached 2129, of whom 1140 had attended the Congress. Naturally, the Cuba delegation was the largest but there were more than 700 foreign members, accompanied by 116 ladies. Four members were elected Life Members: Oscar Almazán (Cuba), Robert Antoine (Mauritius), John Clayton (Australia) and Geoff Cleasby (South Africa). The invitation of the Indonesian Society of Sugar Cane Technologists to hold the 1986 Congress in their country was accepted and the proposed officials confirmed, viz.: Mr. R. M. Hadipoero, General Secretary-Treasurer; Mr. S. Kartasasmita, General Chairman, and Mr. Carlos Bell Raymond, General Vice-Chairman.



Cuban sugar cane machinery in the static exhibition

Japan sugar imports, 1982[1]

	1982	1981	1980
		tonnes, tel quel	
Australia	563,765	595,299	768,639
Brazil	17,918	0	0
Cuba	304,190	245,106	289,073
Fiji	14,766	52,990	25,059
Philippines	270,541	137,507	403,845
South Africa	494,947	365,710	469,775
Taiwan	130,644	97,624	154,109
Thailand	370,966	95,649	154,829
Other countries	1,130	1,663	180
	2,168,867	1,591,548	2,265,509

New Polish sugar factories[2]. — The Polish government is reported to be planning to construct three new sugar factories in order to reduce the campaign from 90 to 85 days.

Booker McConnel PLC 1982 results. — Preliminary results for the year ended December 31, 1982 showed that the Engineering Division showed a profit of £3.7 million against a loss of £900,000 in 1981. The loss-making sugar machinery factory in Derby is being closed, while the machinery design and supply activity of Fletcher and Stewart has been transferred to Booker Agriculture International and is now profitable.

Silo design conference. — A three-day conference is to be held in November 1983 on the design of silos for strength and flow, under the sponsorship of a number of trade and professional bodies including the American Concrete Institute, The British Constructional Steelwork Association Ltd., the Institution of Civil Engineers, The Japan Society of Civil Engineers, etc. Some 50 papers have been submitted from engineers and scientists in many countries although, while some papers refer to specific stored materials such as coal or grain, none is specifically concerned with sugar silos. Details of the Conference and papers may be obtained from the Powder Advisory Centre, P.O. Box 78, London NW11 0PG, England.

Alcohol pilot plant in West Germany[3]. — A pilot plant developed by Zuckerfabrik Franken GmbH and Süddeutsche Zucker-AG can produce 2500 tonnes of alcohol per year, according to the Ministry of Agriculture. The plant, which was opened on January 21 by the Agriculture Minister, Josef Ertl, will also produce up to 15,000 m^3 of biogas per year from the residues from normal sugar production. The process used in the plant achieves large energy savings because the alcohol recovery by distillation uses excess heat from the sugar factory, while the factory simultaneously utilizes the biogas produced.

Swaziland sugar production, 1982/83[4]. — The Swaziland sugar season ended with a total production of 376,577 tonnes of sugar from 3,459,811 tonnes of cane.

Pakistan refined sugar export possibility[5]. — According to a USDA report, Pakistan may export about 300,000 tonnes of refined sugar this year, of which a third is expected to go to Iran under a barter agreement signed last year, and the balance to Sudan and Nigeria.

New Indian sugar and by-products complex[6]. — Belapur Industries Ltd. is proposing to build a 10-million rupee (US$ 1,000,000) complex near Dhuri, in Sangrur District, in the Punjab, which will have a cane crushing capacity of 75,000 tonnes per year, from which it will produce sugar and bagasse, the latter being used as one of the raw materials for a paper plant. A distillery will also produce 16 million litres of alcohol per year from the molasses and a chemical unit for downstream utilization of the alcohol is envisaged.

Alcohol/corn sweetener project in US[7]. — Ultrasystems Inc., of Irvine, California, have announced that the US Department of Energy has granted the company a $45 million loan guarantee to build a geothermal-powered HFCS plant. It will be located at Heber, California, close to the Mexican border, and will process 16,000 bushels of corn per day, manufacturing alcohol and approximately 91,000 short tons, dry weight, of 42% and/or 55% HFCS. Start-up is scheduled for late 1984 or early 1985.

Italy beet area reduction[8]. — Beet sowings in 1983 are likely to be cut to 200,000 hectares, against 254,000 ha last year and some 312,000 ha in 1981, according to the National Beet Growers Association.

Australia sugar exports, 1982[9]

	1982	1981	1980
		tonnes, raw value	
Canada	410,120	361,065	340,331
China	402,281	367,239	300,590
Finland	41,323	0	0
Japan	555,334	597,244	762,479
Korea, South	264,594	266,650	227,087
Malaysia	289,954	326,897	276,399
Morocco	0	30,147	0
New Zealand	78,839	94,573	109,028
Papua New Guinea	19,814	15,198	19,068
Saudi Arabia	2,156	0	0
Singapore	95,517	83,346	51,951
US	129,547	811,047	314,103
USSR	209,076	21,235	0
Other countries	5,289	7,416	9,520
	2,503,844	2,982,057	2,410,556

Seminar on EEC raw sugar supplies after 1985. — A seminar was held in London during April 26-29 under the title "The Challenge to Cane Sugar in the 1980's", but concerned with the supply of sugar from the ACP countries to the European Economic Community. A condition of UK entry to the Community in 1973 was the preservation of access for sugar previously imported under the Commonwealth Sugar Agreement (except for the Australian supplies). The sugar protocol of the Lomé Convention is due for re-examination in 1985 and representatives of the ACP suppliers, anxious to ensure that trade in cane sugar is not put at risk by the increase in the Community's beet sugar production, organized the Seminar to discuss the problems facing them. Countries participating included Barbados, Belize, Fiji, Guyana, Jamaica, Mauritius, St. Kitts, Swaziland, Trinidad and Zimbabwe, and a series of papers were presented during the four days of the seminar by their representatives, by British Sugar plc and Tate & Lyle representatives, etc. During the seminar a visit was arranged to the Tate & Lyle Thames refinery at Silvertown.

UK beet campaign results, 1982/83[10]. — The record-breaking 1982/83 campaign in the UK ended on February 16 with a final output of sugar a little in excess of 1.4 million tonnes, white value. This compares with 1,092,000 tonnes produced in 1981/82 and the previous record of 1,154,000 tonnes attained in 1979/80. The crop was grown on 201,000 hectares and it is expected that a comparable area will be sown this year.

Ethiopian sugar project[11]. — Preliminary feasibility and engineering studies for the Fincha sugar project were completed in 1981 but little further progress was made because of difficulties in raising finance. Libyan interest in the scheme was obtained and an Ethio-Libyan Joint Sugar Company (Elsuco) has been formed which is to continue the project. This comprises a 6000 ha cane estate and a sugar factory of 4000 t.c.d. capacity, as well as associated irrigation works, housing and infrastructure. Construction is scheduled to begin in Autumn 1983 with start-up in October/November 1986. Overall cost of the scheme has been estimated at $200-$300 million, with a foreign exchange component of 60%.

Sudan sugar industry rehabilitation contracts[12]. — Fletcher and Stewart Ltd. has been awarded a management contract for the Hajar Assalaya sugar scheme, HVA Holland Agro-Industries B.V. another for the Sennar scheme and Arkel Industries Inc. contracts for New Halfa and Guneid. The rehabilitation and modernization program includes provision of vital inputs, rectification of construction defects in some schemes and some changes in farming systems, mainly rearranging the cane cycle. The total cost is put at $168 million; however, final figures and details of the program will be determined by recommendations made by Tate & Lyle Technical Services Ltd., as will finance from the World Bank and West German sources and the Arab Fund for Economic and Social Development.

1 C. Czarnikow Ltd., *Sugar Review*, 1983, (1637), 37.
2 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 94.
3 *Westway Newsletter*, 1983, (111), 14.
4 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 96.
5 *Public Ledger*, January 14, 1983.
6 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 99.
7 *Sweetener News* (McKeany-Flavell), January 31, 1983.
8 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 112.
9 *I.S.O. Stat. Bull.*, 1983, **42**, (2), 2.
10 C. Czarnikow Ltd., *Sugar Review*, 1983, (1636), 31.
11 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 115-116.
12 *World Sugar J.*, 1983, **5**, (8), 33.

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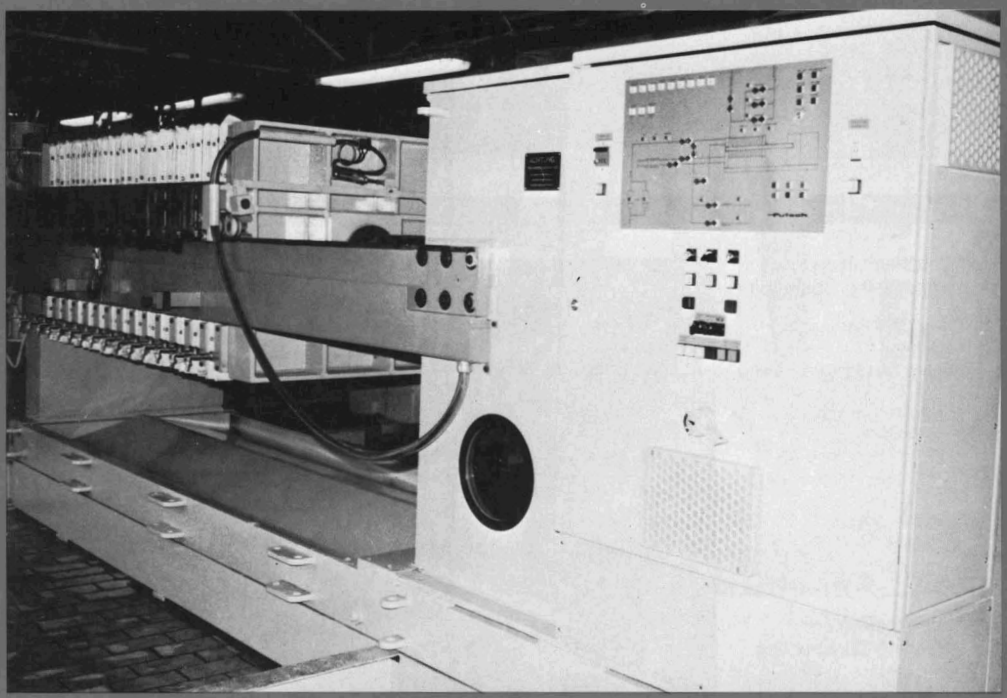

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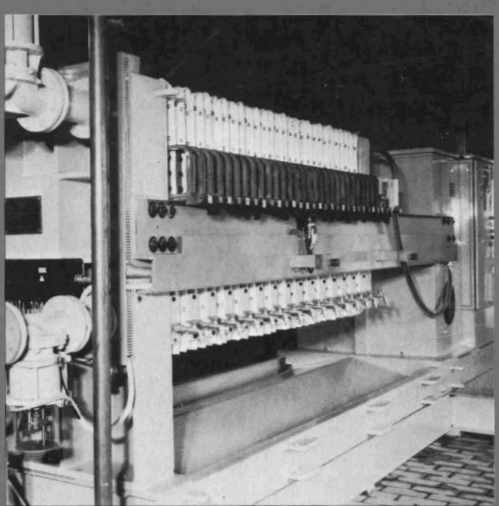

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