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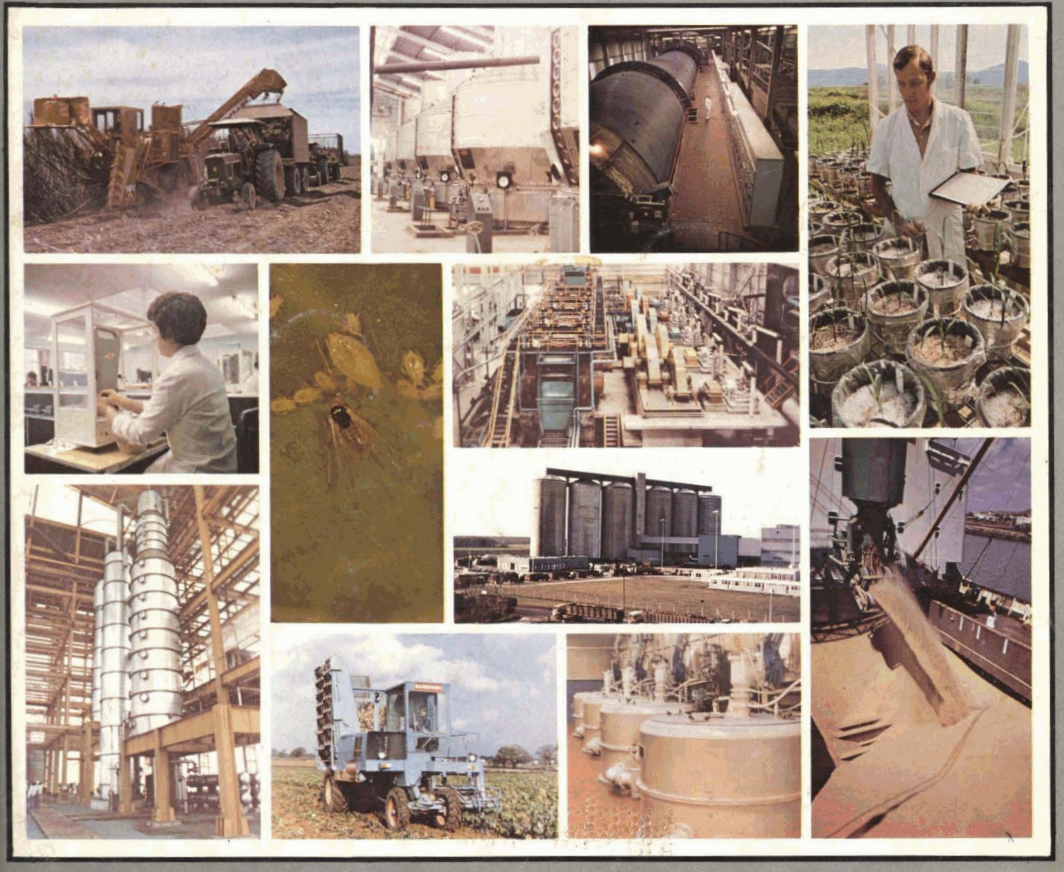

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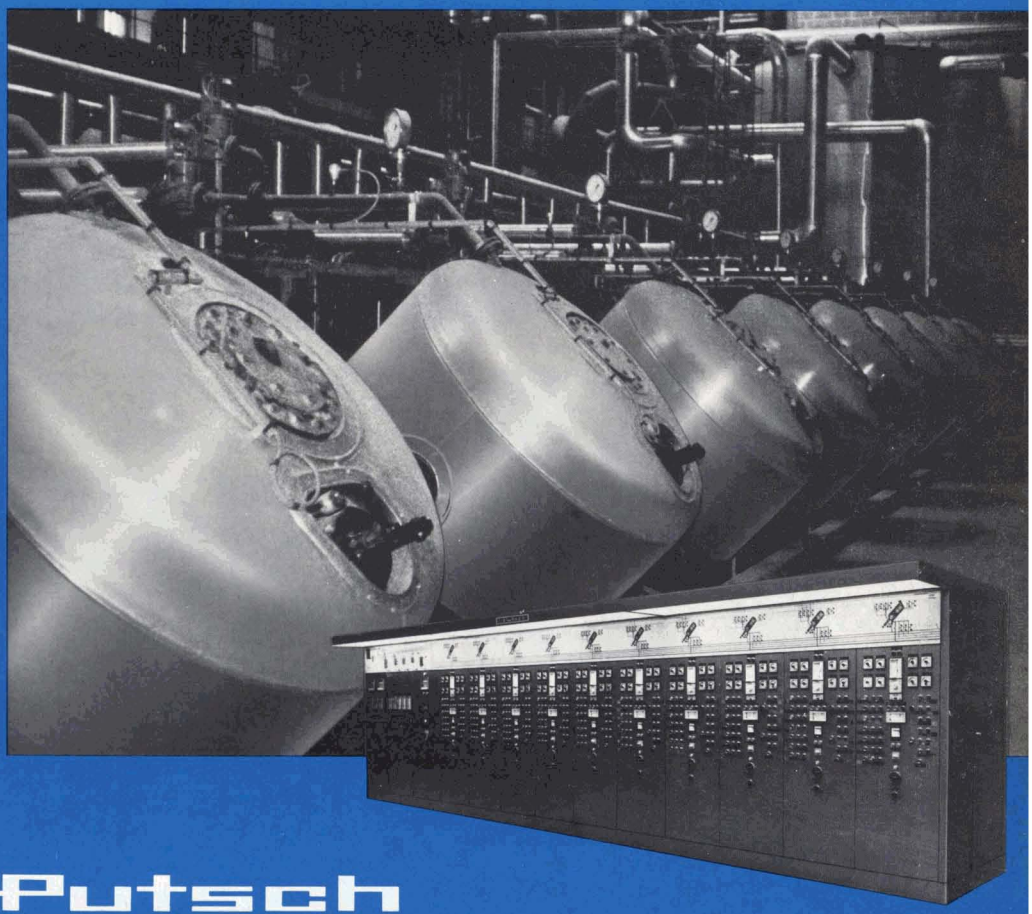

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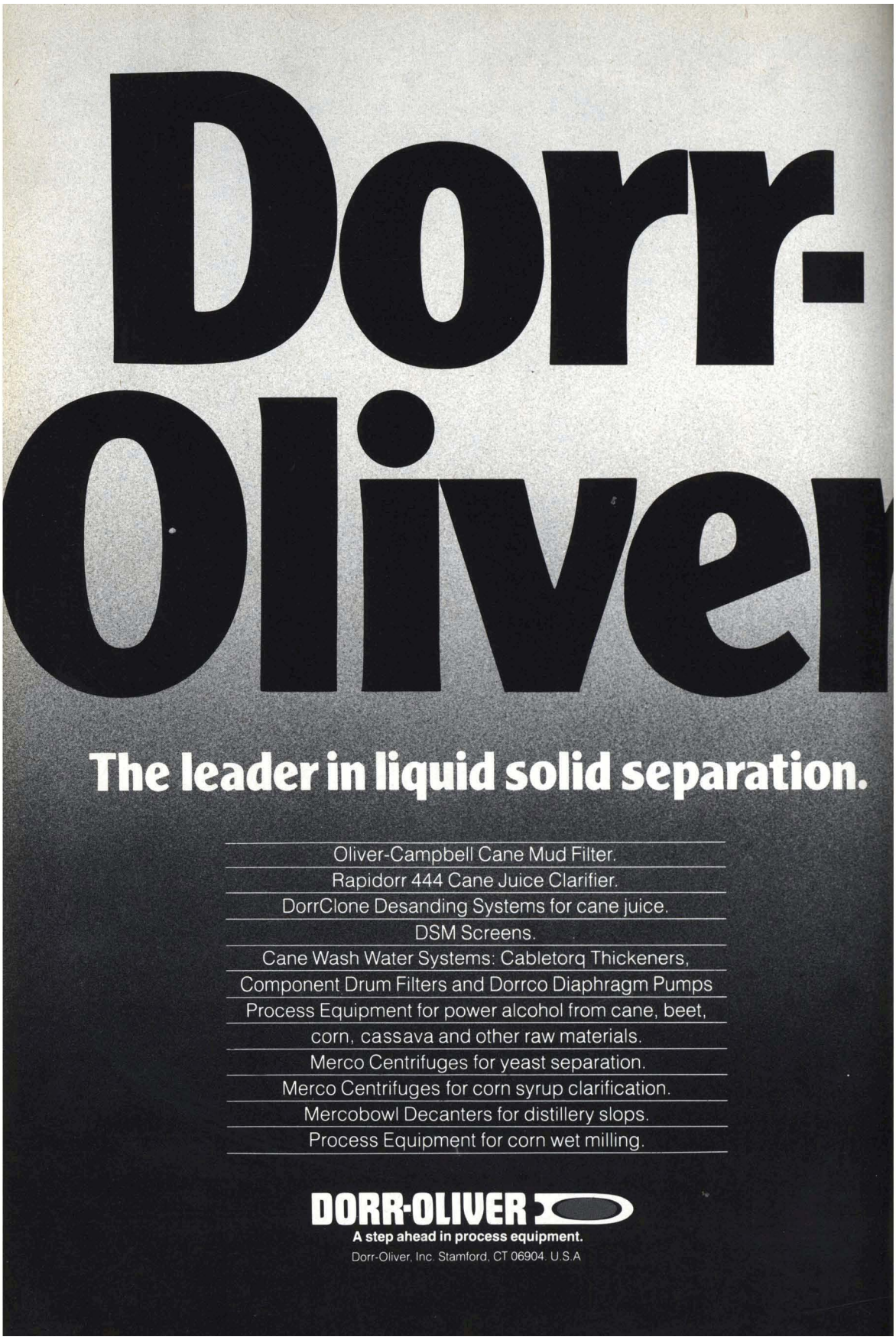
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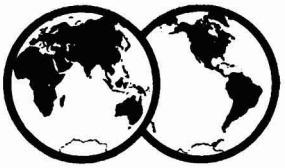

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NOTES AND COMMENTS

World sugar prices

During the month of May the London Daily Price for raw sugar fell to its lowest level since January 1980, when it reached £168 per tonne on May 12. A dip from the £175 of May 1 to £171 was followed on May 7 with an increase to £178 on reports of beet damage by frost in Germany and the likely application of quotas to ISA members. The news that the frost damage was slight and reports of low-priced sales dampened sentiment and the price fell to £168.

Imposition of quotas and relative strengthening and weakening of currencies caused the LDP to fluctuate but the trend was upwards during the remainder of the month. With few speculators left in the market, price movements were dictated by physical sugar and sales to Venezuela and India stimulated the market, the LDP reaching £200 on May 27 but falling back to £199 at the end of the month.

There was much less variation in white sugar prices during the month; from a level of £200 per tonne on May 1, the LDP(W) fell to £188 on May 6 but recovered to £196 by May 11 before falling to £190 the following day. Thereafter the price trend was upwards through the rest of the month, ending at £214 per tonne on May 29.

Mr. Jose Lago, of the marketing and statistics branch of GEPLACEA, the cane sugar exporters group, claimed that prices should start to rise in June because lower prices were resulting from the free availability of sugar from crops in major exporting countries which ended in the second quarter of the year. After May, however, with fresh supplies limited, the deficit in world production *vs.* consumption would become apparent. Further, many producing countries sold off reserve stocks when the price was high, and their need to rebuild these stocks would keep supplies relatively tight in the future, strengthening prices.

International Sugar Agreement

As anticipated, export quotas under the Agreement came into effect on May 14, when the I.S.O. Prevailing Price had been below 16 cents per pound for five consecutive days. However, sugar shipped between the start of 1981 and up to 90 days from May 14 do not count towards the individual countries' quotas provided the ISO is notified of such business. Consequently, the exporting members have less than half a year in which to sell a year's quota and the reimposition will thus have little effect on limiting supplies during 1981.

The Executive Committee and various sub-committees of the International Sugar Council met in London during the following week and the full Council met on May 22, when a problem became apparent in respect of the quotas to be set, however theoretical their effect. On a temporary basis, pending the settlement of claims of *force majeure* affecting their 1980 exports made by certain exporting members[1], quotas had been set on a basis of the Basic Export Tonnages estimated in November 1980. However, under the Agreement's formula whereby past export performances are taken into consideration, the total is much larger and, even when a 5% cut is applied with continuation of the fall in prices, the cut does not take effect if it reduces a quota to below 85% of the B.E.T.; thus the 5% quota cut on May 27 did not result in any reduction of individual quotas. This may not be of any significance in 1981 but could foreshadow considerable difficulty in 1982.

As C. Czarnikow Ltd. note[2]: It seems probable that with the passing of the years the formula procedure, under which basic export tonnages are established, will result in the total growing larger and larger. Consequently it could well happen that it will be impossible to establish effective quotas next year, should they be required. To some extent it might be possible to delay setting Basic Export Tonnages for 1982. Provisionally, quotas could be established on the basis of 1981 figures, which would presumably be less excessive. This would only be a temporary palliative, however, and would probably still result in unrealistically high quotas. The only other way which would seem likely to allow the Council to retain the confidence of the market in its quota mechanism would be for it to announce in advance that shortfalls would not be reallocated until such time as quotas in effect did not exceed the global quota and then only to the extent needed to raise the total to the total of the global quota."

Basic export tonnages and quotas in effect, i.e. reduced by 15% except for those at the minimum, are as follows:

	B.E.T.	Quotas in effect
	tonnes, raw value	
Argentina	510,809	434,188
Australia	2,605,142	2,214,371
Austria	109,976	93,480
Bolivia	122,809	104,388
Brazil	2,749,196	2,336,817
Colombia	326,189	277,261
Costa Rica	103,653	88,105
Cuba	2,648,543	2,251,262
Dominican Republic	1,144,436	972,771
Ecuador	84,525	71,846
Fiji	313,498	266,473
Guatemala	262,163	222,839
Guyana	160,954	136,811
Jamaica	89,902	76,417
India	857,353	728,750
Malawi	110,000	93,500
Mauritius	184,427	156,763
Mexico	70,000	70,000
Mozambique	84,638	71,942
Nicaragua	131,908	112,122
Panama	176,462	149,993
Peru	283,842	241,266
Philippine	1,750,828	1,488,204
Salvador	187,418	159,305
South Africa	968,187	822,959
Swaziland	175,753	149,390
Thailand	1,253,400	1,065,390
Trinidad and Tobago	70,000	70,000
Zimbabwe	262,242	222,906
	17,798,253	15,149,519

The Council decided that, as specified in the Agreement, 40% of the Special Stocks, amounting to 1,000,000 tonnes, raw value, should be accumulated in the year from July 1981. To finance this the stock fee is to be increased from $0.50 to $1.65 per tonne as from

[1] *I.S.J.*, 1981, **83**, 161.
[2] *Sugar Review*, 1981, (1546), 87.

July 1. Again, arguments were presented for a further increase in the lower and upper limits of the price range of the Agreement, currently 13 to 23 cents/lb, but the Council took no action on the matter.

A group was appointed to consider whether it would be better to negotiate a new Agreement or to extend the the current one by one or two years; it will convene in September and report back to the Council at its meeting in November.

Berisford bid for the British Sugar Corporation

B.S.C. published its interim report for the half-year to end-March 1981 on May 12 indicating profits before tax 30% up on the equivalent period of the previous year. The increase was attributed to reaping the benefit of the £150 million investment program of the previous few years, and to the fact that the Corporation has not been affected by the recession which has harmed many other industries.

These results, and the letter from 69 of the company's 73 senior managers, expressing opposition to the proposed bid for the ordinary shares by S. & W. Berisford Ltd., may have influenced the shareholders who decisively rejected the bid. By closing date for the offer — May 26 — Berisford had acquired only 0.21% of the shares to bring their holding to 9.49%. The offer was then extended to June 9 and was raised to £3.35 per share in loan stock — almost exactly the market valuation — with a premium of about 30p if the Berisford shares alternative were chosen. Although this is obviously more attractive than the inadequate original offer, British Sugar Corporation management have rejected it as too low. The UK Government, which owns 24% of the Corporation, has said it will be guided by the wishes of a majority of the other shareholders.

US sugar loan program proposals

When the US Farm Bill for 1981 was introduced by the US Department of Agriculture it included no provision for a sugar loan program; the Administration is strongly opposed to a mandated price support system since prices are high enough not to require loans and the law currently gives the Secretary of Agriculture discretion to offer loans if these are deemed necessary. However, both the House Agriculture Sub-Committee and the Senate Agriculture Committee have approved plans calling for a loan program for the 1982-85 beet and cane crops at levels of at least 44% of parity; these have been calculated as 19.62 cents/lb, raw value, in 1982, 21.72 cents in 1983, 23.34 cents in 1984 and 22.17 cents in 1985.

Australian sugar crop, 1980

In Queensland 274,331 hectares were harvested for milling, 6118 or 2.2% less than the record 280,449 ha harvested in 1977, the last comparable year of full acquisition[1]. The cane crushed amounted to 22,540,963 tonnes or 210,196 tonnes (0.94%) more than the record crush of 22,330,767 tonnes in 1977 and 2,681,372 tonnes or 1.35% more than the 1979 harvest which was restricted owing to the imposition of ISA quotas. With 1,509,762 tonnes crushed in New South Wales, Australia's 33 mills handled a total of 24,050,724 tonnes of cane.

Production of sugar in Queensland amounted to 3,146,917 tonnes, 94 net titre, 339,440 tonnes (12.09%) up on the restricted 1979 season and, despite the record tonnage of cane, was down 62,338 tonnes (1.94%) on the 1977 record sugar production of 3,209,255 tonnes 94 n.t. New South Wales produced 181,330 tonnes 94 n.t., which brought the Australian 1980 production to 3,328,247 tonnes. The Queensland cane and sugar yields were 82.17 tonnes and 11.47 tonnes 94 n.t. sugar, respectively, per hectare, with 7.16 tonnes of cane required to produce 1 tonne of sugar. The weighted Queensland average c.c.s. figure of 13.68 was down 0.24 units on the previous season and compared less than favourably with the 1977 figure of 14.33. The lower quality of the 1980 crop reflected the milling of standover cane and the impact of unfavourable growing conditions on one-year cane, drought having taken severe toll of unirrigated cane in the southern districts.

The 1981 crop is developing satisfactorily and, provided a normal wet season were experienced, the tonnage of cane available for harvest should be well up on the 1980 season. However, torrential rainfall early in 1981 caused widespread flooding in parts of Queensland with some cane submerged for more than eight days, and the consequent crop loss by cane damage, leaching of fertilizer and soil erosion has yet to be determined[2].

A future International Sugar Agreement

At a meeting of the World Sugar Research Organization in March, the Director of the International Sugar Organization, Mr. William K. Miller, spoke on the future of the I.S.A.[3] The present Agreement is due to expire at the end of next year and it must be decided in November next whether it is to be renegotiated or extended for a further two years. Mr. Miller said that if a new Agreement is sought, serious thought should be given to incorporation of an Intervention Fund which would keep excess sugar off the market when prices are low and improve the chances of defending the lower price ranges in combination with the export quota system. The resulting intervention stocks, together with the present special stocks, could cool a rapidly rising market more effectively than special stocks alone.

Whether the present agreement is extended or a new agreement negotiated, the most important aim must be EEC participation. The Community's very large exports were the most important single factor in the weakness of the world sugar market in 1978 and 1979 and the EEC's absence is the most important ISA weakness, he said. It is difficult for the ISA to control prices adequately through export regulation when a non-member is dumping large and uncontrolled quantities of subsidized exports on the world market, he added. Mr. Miller said that the EEC's participation in the ISA will require real give and take from both sides; he added that the ISA is prepared for this and he hoped the Community would be.

The ISA also needs greater powers to have the best chance of meeting its objectives, the most obvious of which is greater scope for reduction of export quotas and larger special stocks to help keep prices from falling too low or rising too high. In working out a new Agreement it would be worth considering greater quota-cutting ability, at least on a discretionary basis. Under the present Agreement the level of basic export tonnages, in combination with use of maximum quota cuts, did not reduce supplies anticipated on the market enough to lift prices to the Agreement price range for two years. In addition the band of prices activating increases or falls in the global export quota is too narrow, as is that which activates release of special stocks; Mr. Miller refused to indicate what new price bands he believes suitable, however.

[1] *Australian Canegrower*, 1981, **3**, (1), 14-15.
[2] *Australian Sugar J.*, 1981, **72**, 509.
[3] *Reuter Sugar Newsletter*, March 25, 1981.

Analysis of sugars and organic acids

Cane sugar refinery experience with liquid chromatography on a sulphonic acid cation exchange resin

By DONALD F. CHARLES
(California and Hawaiian Sugar Company, Crockett, California, USA)

PART II

Dextrose and levulose quantitative measurement

Dextrose and levulose determination is also desired; in most of our process streams the dextrose and levulose are in very small proportion to sucrose. Fig. 8 illustrates the situation for evaporator syrup in a raw sugar factory with sucrose near 90% and glucose and fructose each about 1%. This is near the limit of usefulness of the particular column for studying small variations in dextrose or levulose. If we inject more sample to get larger dextrose and levulose peaks, the sucrose broadens into the dextrose peak and the latter becomes a rider on the side of the sucrose. So, for low levels of invert components in the presence of large sucrose, we must seek other methods. For higher proportions of the invert components, as in molasses, in raw sugar film, in affination syrup as well as in soft sugar production, dextrose and levulose analyses may prove valuable.

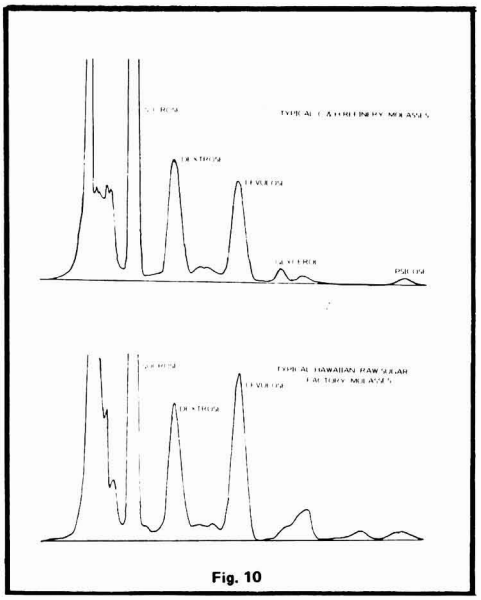

Fig. 10

Illustrative chromatograms

Fig. 10 is a comparison of what are thought to be typical refinery and raw sugar factory molasses. The refinery molasses generally shows slightly more dextrose than levulose, whereas the mill molasses generally seems to show more levulose. This is consistent with suggestions of Reinefeld *et al.*[1] that the types of reactions between carbonyl and amino compounds are dependent on the water content. In early stages of milling, dextrose tends to predominate; in the reboilings at higher concentration levulose tends to predominate. Both molasses show small amounts of psicose. Fig. 11 shows the result of heating levulose in pyridine, a procedure described by Doner[2]. The alkaline rearrangement gives dextrose, but also favours formation of mannose and psicose. The conductivity trace also suggests formation of at least three organic acids.

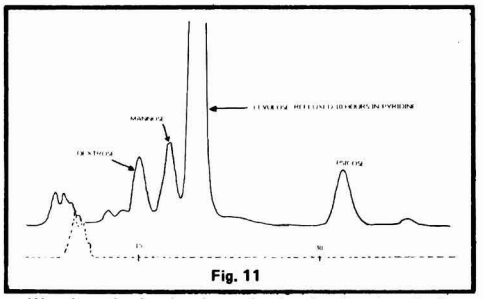

Fig. 11

We also obtained psicose by leaving levulose in lime water at room temperature.

Raw sugar film analysis

Because the liquid chromatographic method requires such a small volume of sample for injection it is a good match for a process of washing a raw sugar with a minimum volume of methanol to give a sample of the film. We have applied the following washing procedure to a number of raw sugars.

Weigh out 30 grams of raw sugar into a beaker. Rapidly pour in 20 cm^3 of methanol and swirl for two or three seconds or until all the sugar is wet. Immediately decant about 5 cm^3 of wash methanol, then decant again into a 10 cm^3 conical-bottom evaporating flask to assure that no crystals come over. Evaporate to dryness on a rotating evaporator with water bath temperature no higher than 60°C. Add about two cm^3 of water to give a solution about 3 to 5° Brix. Filter through 0.45 micron millipore pad.

Fig. 12 shows the distribution of substances in a typical raw sugar film. The initial ionic peaks have slight shoulders owing to the presence of organic acids. A significant trisaccharides peak precedes the sucrose. Dextrose and levulose peaks are about equal and are well separated from other major peaks although small amounts of other substances appear between peaks and it can be assumed that some other substances elute under the dextrose and levulose peaks. Characteristically, there is a small peak which we have labelled glycerol.

Table II shows the average analysis for 16 raw sugars considered typical of Hawaiian production. The normalized refractive index area was used. This assumes that the refractive index response is the same for all the components. The early peak is mostly inorganic but includes some organic acids and high molecular weight constituents such as starch and dextran.

[1] *Zuckerindustrie*, 1978, **103**, 20-28.
[2] *Carbohydrate Res.*, 1979, **70**, (2), 209-216.

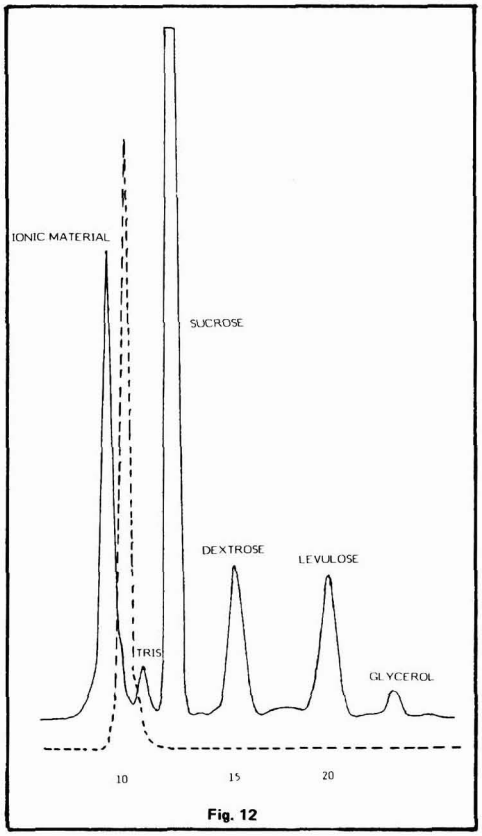

Fig. 12

Table II. Average film analysis for 12 typical Hawaiian raw sugars

	% of Area
Early	14.0
Trisaccharides	2.1
Sucrose	60.3
Dextrose	12.1
Levulose	10.4
Glycerol	0.9
Other	0.2
	100.0

The relatively high sucrose proportion is noteworthy; the opinion is frequently expressed that the raw sugar film can be expected to have a composition similar to molasses and thus we might have expected a purity near 40. There are several factors which might contribute to a higher sucrose content and it is difficult to assess their relative importance. First, of course, it may be that our washing procedure, brief as it is, dissolves some crystalline sucrose. Actually, one can use quite a bit more methanol with very little change in sucrose proportion. Characteristically, the sucrose by the normalized R.I. area method is high compared with the standard purity analysis. For molasses it may be 5 to 8% greater. The reasons for this are still uncertain. From the known refractive index data dextrose and levulose should give a refractive index only 1% less than sucrose. Potassium chloride, probably most representative of the inorganic content, also gives a similar refractive index response. The organic acids and other ions may have lower response leaving the sucrose with a relative high response. What appears likely is that the inorganics peak gives a low measurement because of the anomalous refraction discussed before and illustrated in Fig. 5 where the potassium chloride peak shows a slow rise and fast drop. Another likelihood is that the film purity stays close to that of the mother liquor spun off from the raw sugar which has a higher purity than molasses. As the sugar dries out and cools the viscosity increases and diffusion of sucrose to the crystal surface may become quite slow.

Fig. 13 shows a raw sugar film from a shipment of sugar which smelled sour. The deterioration factor was in the dangerous region. Note the high ratio of dextrose to levulose, the relatively large trisaccharide peak, the small mannose peak and the large peak marked as glycerol. Known glycerol co-eluted with this peak. We collected this peak; it was found to co-elute with glycerol by gas chromatography on a Porapak Q column. An infrared spectrum was consistent with that of glycerol.

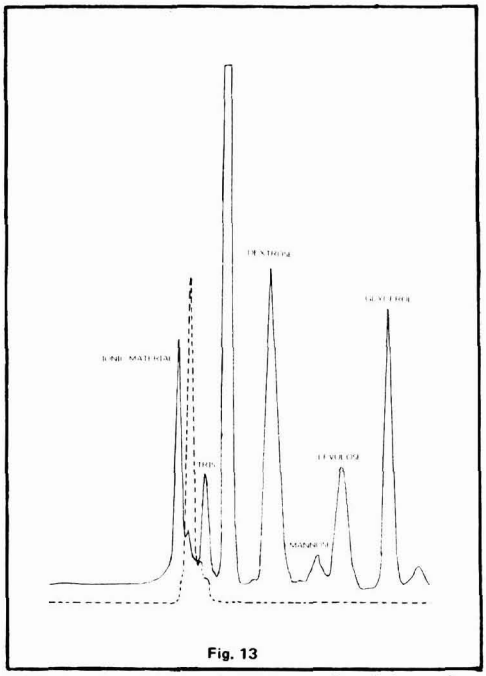

Fig. 13

We have not seen glycerol mentioned heretofore as a significant constituent of raw sugar. However, the microbiological literature includes references to the manufacture of glycerol by controlling conditions of yeast metabolism[3]. Nickerson & Carroll described a glycolytic fermentation for a yeast, *Zygosaccharomyces acidifaciens,* which produces glycerol[4]. Glycerol appears to be present in variable amounts in most Hawaiian raw sugars. Thus it may serve as an indicator of microbiological degradation of a certain type. There are frequently other small peaks following

[3] Cook: "The Chemistry and Biology of Yeasts", (Academic Press, New York), 1958, p.339.
[4] *Arch. Biochem.*, 1945, 7, 257.

closely on the glycerol region. We have not identified these, but among the substances that elute here are methanol, ethanol, *iso*-propanol, ethylene glycol and acetone.

Fig. 14 is another example from a sour-smelling raw sugar. In this case the ionic material content was quite low, trisaccharides were high and dextrose to levulose ratio was high. It appears that the organism produces enzymes which invert sucrose and also transferases which attach levulose to sucrose to make the kestoses. We have prepared kestoses by procedures outlined by Gross[5] and Pazur[6] and found them to elute in this region just before sucrose, but we have not as yet distinguished specific kestoses in our products. This identification is on our agenda. The small peak just before the trisaccharides is probably a tetrasaccharide.

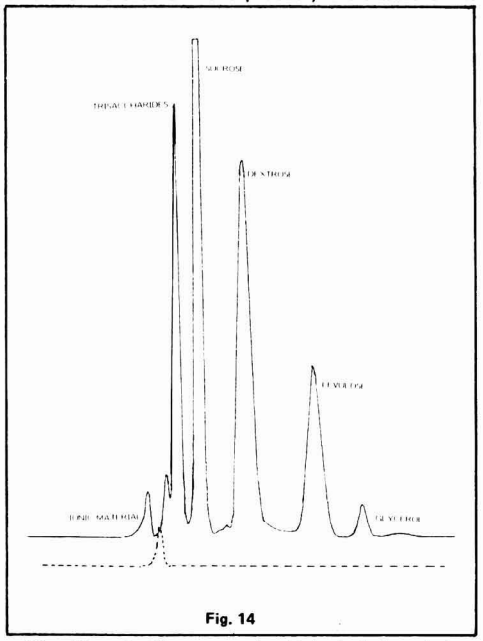

Fig. 14

Fig. 15 again illustrates microbiological degradation, this time in a refined product, originally about 99.5% sucrose on solids. A customer found his liquid sugar behaving differently from usual. He sent us back a sample from his storage tank which we ran on the liquid chromatograph and got this analysis. Again it appears that enzymatic inversion was being followed by formation of kestoses. The sample continued to degrade in the bottle. Fig. 16 shows the process pretty well along at the time we sampled the bottle when we used its contents to inoculate new material. Inoculation and incubation of fresh liquid sugar product gave a continuing degradation. For comparison we also inoculated some fresh liquid sugar with Difco invertase. On inoculation we got a similar pattern, though the production of trisaccharide was less, only 3% when dextrose was 38% and levulose was 35%. This raises questions about the accuracy of double polarization analyses based on invertase inversion.

Organic acids by elution with sulphuric acid

The results discussed above refer to the use of water as eluent with the HPX-87 column in the calcium form. We use another HPX-87 column in the hydrogen form to separate organic acids which are of interest as possible indicators of sugar degradation reactions. Our usual eluent is 0.05N sulphuric acid. However, the chromatograms shown here were run at $0.4 cm^3.min^{-1}$ with 0.002N sulphuric acid as eluent.

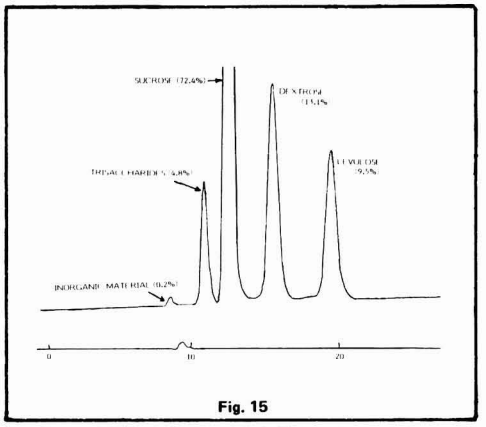

Fig. 15

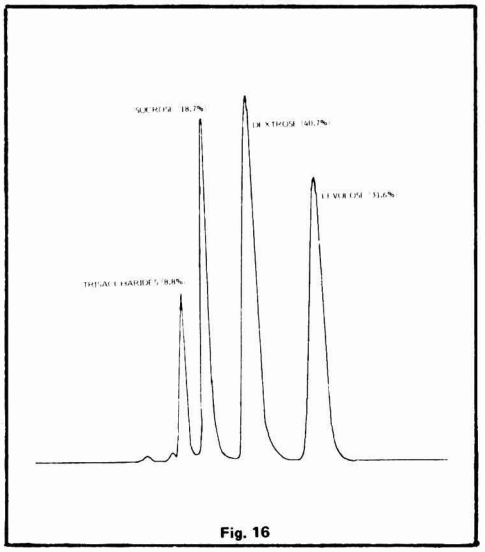

Fig. 16

Fig. 17 shows the series of common volatile fatty acids. It can be seen that the peak height ratio of refractive index to conductivity increases as we increase the length of the carbon chain. This ratio can be a help in measurement as well as in identification. Thus, although lactic acid and propionic acid nearly coincide using 0.002N acid as eluent, Fig. 17 shows that for propionic acid the ratio of R.I. to conductivity is about 20 to 1. Lactic acid, under the same conditions, exhibits a ratio of 3.8 to 1. Thus, in Fig. 18, the peak labelled lactic acid appears to be little influenced by the presence of propionic acid. Fig. 18, for refinery molasses, shows how the conductivity trace can be used to determine acids even in the presence of the sugars having high

[5] "Methods in Carbohydrate Chemistry", Vol. 1 (Academic Press, New York), 1962, p.360.
[6] *ibid.*, 365.

refractive index. Normally one injects more sample to measure the acids because of their low concentrations. Only where the ratio of sugars to acids is extremely high does the viscosity of the sugar decrease the conductivity of the acid.

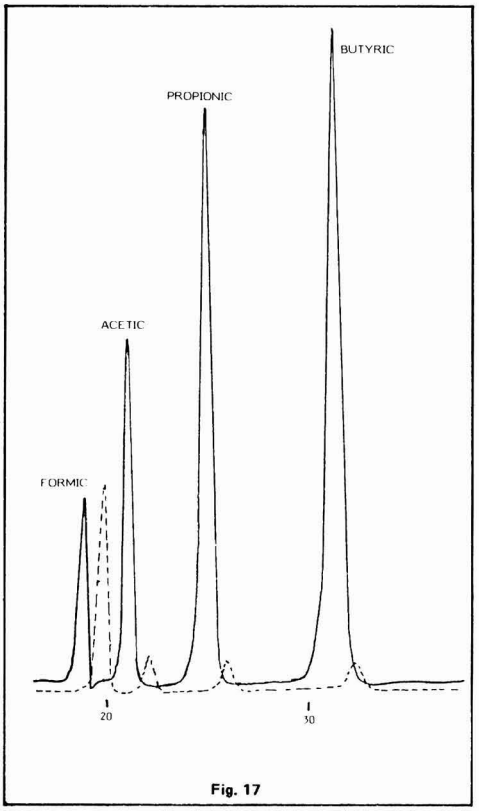

Fig. 17

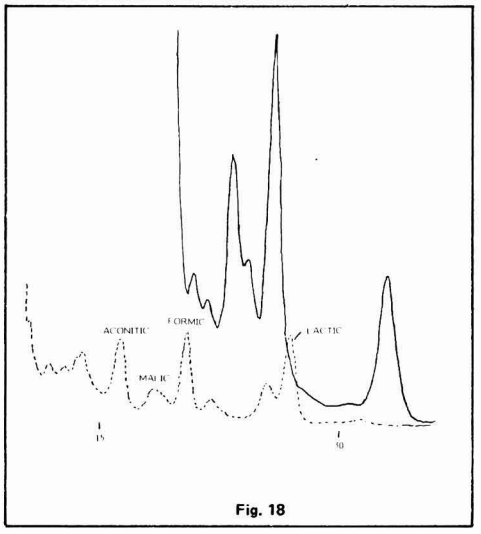

Fig. 18

Both temperature and concentration of acid eluent affect the relative retentions of the acids. This provides considerable flexibility and suggests that any two acids can be separated by finding the right conditions.

Fig. 19 shows the acids in a typical raw sugar film and in a particular raw sugar film which showed quite high lactic acid.

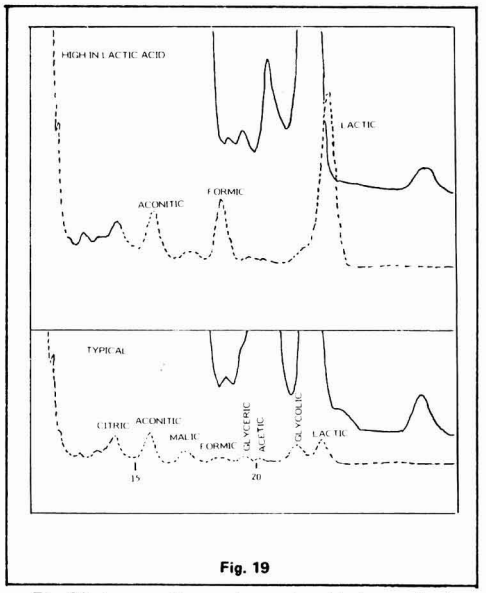

Fig. 19

Fig. 20 shows patterns of organic acids in sweetwaters from the clarifier scums treatment system. Phosphoric acid and lime form a precipitate which occludes impurities from the main stream of liquor using air flotation to separate the flocculant scum and the clear liquor. The scum is then treated with lime and heat in several steps to remove the sugars. The appearance of lactic acid at first was thought due to microbiological

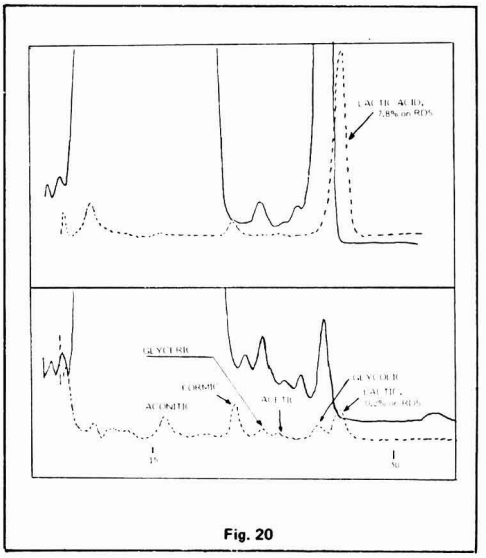

Fig. 20

action, but several tests indicated that the combination of high pH, heat and extreme dilution resulted in chemical degradation to give lots of lactic acid with a particular pattern of formic, glyceric and glycolic acids. We have not yet run carefully calibrated standards. However, it is striking how the hydroxy acids such as glyceric and glycolic show up more than acetic acid.

Summary

An account is given of the application of liquid chromatography on a cation exchange resin, using water and dilute sulphuric acid as eluents, for quantitative analysis of sugars and organic acids, etc. in juices, syrups, molasses and raw sugar.

Analyse de sucres et d'acides organiques. Expérience en raffinerie de sucre de canne avec la chromatographie en phase liquide sur résine d'échange de cations à l'acide sulfonique

Un rapport est établi concernant l'application de la chromatographie en phase liquide sur résine échangeuse de cations, avec emploi d'eau et d'acide sulfurique dilué comme éluants, pour l'analyse quantitative de sucres et acides organiques etc. dans les jus, sirops, mélasses et sucre brut.

Analyse von Zuckern und organischen Säuren. Erfahrungen in einer Rohrzuckerraffinerie mit Flüssigkeits-Chromatographie auf schwefelsaurem Kationenaustauscherharz

Berichtet wird über die Anwendung der Flüssigkeits-Chromatographie mit Kationenaustauscherharz, wobei Wasser und verdünnte Schwefelsäure als Eluant für die quantitative Analyse von Zuckern und organischen Säuren usw. in Säften, Sirupen, Melasse und Rohzucker verwendet werden.

Análisis de azucares y ácidos orgánicos. Experiencia en una refinería de azúcar de caña con cromatografía líquida sobre una resina del tipo ácido sulfónico para cambio de cationes

Se presenta un examen de la aplicación de cromatografía líquida sobre una resina para cambio de cationes, usando agua y ácido sulfúrico diluido como eluentes, para análisis cuantitativo de azúcares y ácidos orgánicos, etc., en jugos, siropes, melazas y azúcar crudo.

Modern instrumental techniques of analysis and the sugar industry

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(The Research Laboratories, British Sugar Corporation Ltd., Colney Lane, Colney, Norwich, NR4 7UB)

Introduction

Developments in analytical methods often originate in the research laboratories of industry and eventually find application in process control and routine analysis. In both the beet and cane sugar industries, however, many factory laboratories still use only the traditional analytical methods which, whilst generally producing adequate results, tend to be labour-intensive.

Many of these traditional methods, e.g. polarimetry, have been, and indeed still are, used mainly for the purpose of buying the sugar entering the factory, in the form of sugar cane, sugar beet or raw sugar, and then accounting for it as the final product sugar, in the co-product molasses and as known losses through the process. Other techniques such as titrimetric and conductimetric methods and pH measurements have mainly been used for setting and monitoring various empirically derived process parameters.

However, in order to increase the sugar yield with best economic efficiency, there is within the industry an increasing need for more rigorous control of the process chemistry in order to identify and control losses of sucrose resulting from chemical and bacterial actions, production of colouring matter and other materials deleterious to high quality sugar production, and also the excess use of process materials. New processes are also being introduced[e.g.1] which tend to be wholly reliant on more critical monitoring and control of relevant process parameters.

M. Shore

D. Sargent

In addition, the introduction of computer control of the processing plant demands reliable analytical data without the delay associated with laboratory methods. Such a demand can only be met by means of instrumentation continuously sampling the juice flows through the process, monitoring the essential parameters and reporting directly, in digital format, to the controlling computer.

There will therefore inevitably be an increase in the demand on the factory laboratory and also a requirement for more sophisticated on-line monitoring of process variables.

Clinical laboratories have already experienced this type of increased load and have turned to automation to increase the throughput and reduce the processing time of samples without a concomitant increase in labour requirements. But, while automatic analysis itself is often a combination of traditional sample preparation with modern analytical instrumentation, some changes in working practice and the training and skills of laboratory personnel may be required.

This article describes some of the more recent instrumental analytical techniques used in research in the sugar industry and discusses their advantages over traditional methods before suggesting where they may best be applied for more routine use in the industry. It is

[1] Hongisto: *I.S.J.*, 1977, **79**, 100–104, 131–134.

not intended to be an exhaustive review of the techniques and applications which are discussed.

SPECIFIC APPLICATIONS

Sucrose determination

Many techniques exist for the quantitative determination of sucrose in solution and recent reviews of the subject [2,3] describe all the modern methods. For process control in both cane and beet sugar factories the measurement of "pol" is most commonly used and provides the most convenient and rapid routine method at present, but it is only in the beet sugar factory, where the invert sugar content of juices and syrups is low, that the sucrose content is reliably indicated by this measurement. Modern automatic polarimeters provide sufficiently accurate results relative to the normal instrument and can often operate on more highly coloured solutions; this can be useful in molasses analysis (Figs. 1, 2).

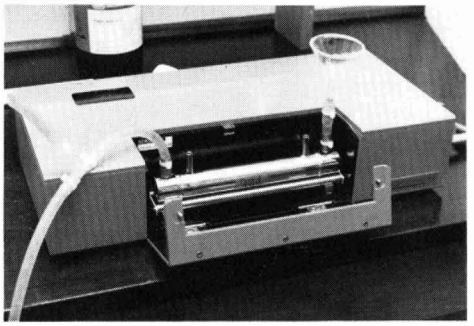

Photo: Courtesy Optical Activity Ltd.
Fig. 1

Photo: Courtesy Thorn Automation Ltd.
Fig. 2

However, as is well known, the presence of other optically active substances in the process juices introduces an error into the determination of sucrose by direct polarimetry [2,4,5] For research purposes it is often necessary to eliminate these errors and a truly specific technique is required.

The isotope dilution method probably has the potential to become the most accurate method for the determination of sucrose[2,6] although the costs of each determination are high if the labelled sucrose is used in sufficient quantity to avoid significant errors in the radioactive assay of the isolated sucrose. In practice a small quantity of ^{14}C-labelled sucrose is added to the sample containing the sucrose to be determined. A fraction of the total sucrose is then isolated from the solution, usually by precipitation, and after purification by crystallization the amount of radioactivity in the isolated portion is measured. The extent of the dilution of the radio-activity indicates the amount of sucrose originally present.

In recent collaborative tests on beet molasses[2] the major practical difficulty was the purification of the isolated sucrose, and it was shown that raffinose was the most significant impurity. The considerable time necessary for the isolation and purification stages will probably prevent routine application of the method although it may eventually become a reference standard.

Monosaccharides, disaccharides and trisaccharides can be determined simultaneously by means of gas-liquid chromatography using trehalose as an internal standard[7,8,9]. The sugars are determined as their trimethylsilyl ethers using an instrument with a flame ionization detector and electronic integration facilities. Measurements on beet molasses with a sucrose content of approximately 47.7g/100g showed the standard deviation of the sucrose content to be 0.11g/100g molasses with a coefficient of variation of sucrose content of 0.23%[10]. For research purposes the method is considered to be completely specific for sucrose and is convenient and rapid. It is probable that GLC will become a routine tool for the factory laboratory in the future because of its versatility.

Sucrose has also been quantitatively determined in process juices by means of proton nuclear magnetic resonance [2]. One major obstacle to the application of NMR to aqueous solutions has been the large water resonance experienced, but modern Fourier transform techniques have eliminated errors likely to emanate from this source, allowing a stated accuracy for sucrose analysis in sugar beet juices of 0.5% (absolute) relative to GLC analysis[11]. Another difficulty in the application of the method to such juices, the interference by dextrose, raffinose and kestoses, has not been overcome[2] and will be significant if the technique is used for molasses. At present, however, the expense and operational requirements of such instruments prevent their application for routine purposes.

Several other techniques which have application to sucrose measurement are described later under separate headings.

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[2] *Proc. 17th Session ICUMSA*, 1978, 89–135.
[3] Schneider: "Sugar Analysis" (ICUMSA) 1980.
[4] Maag & Sisler: *J. Amer. Soc. Sugar Beet Tech.*, 1975, **18**, 257–263.
[5] Meade & Chen: "Cane Sugar Handbook", 10th Edn. (Wiley, New York) 1977, 515–550.
[6] Mauch: *Zeitsch. Zuckerind.*, 1970, **95**, 76–79.
[7] Karr & Norman: *J. Amer. Soc. Sugar Beet Tech.*, 1974, **18**, 53–59.
[8] Brobst & Lott: *Cereal Chem.*, 1966, **43**, 35–43.
[9] Morel du Boil & Schaffler: *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 1–10.
[10] Oldfield, Shore, Parslow & Williams: *Paper presented to the 25th Tech. Conf. British Sugar Corporation*, 1980.
[11] Lowman: *J. Amer. Soc. Sugar Beet Tech.*, 1979, **20**, 233–250.

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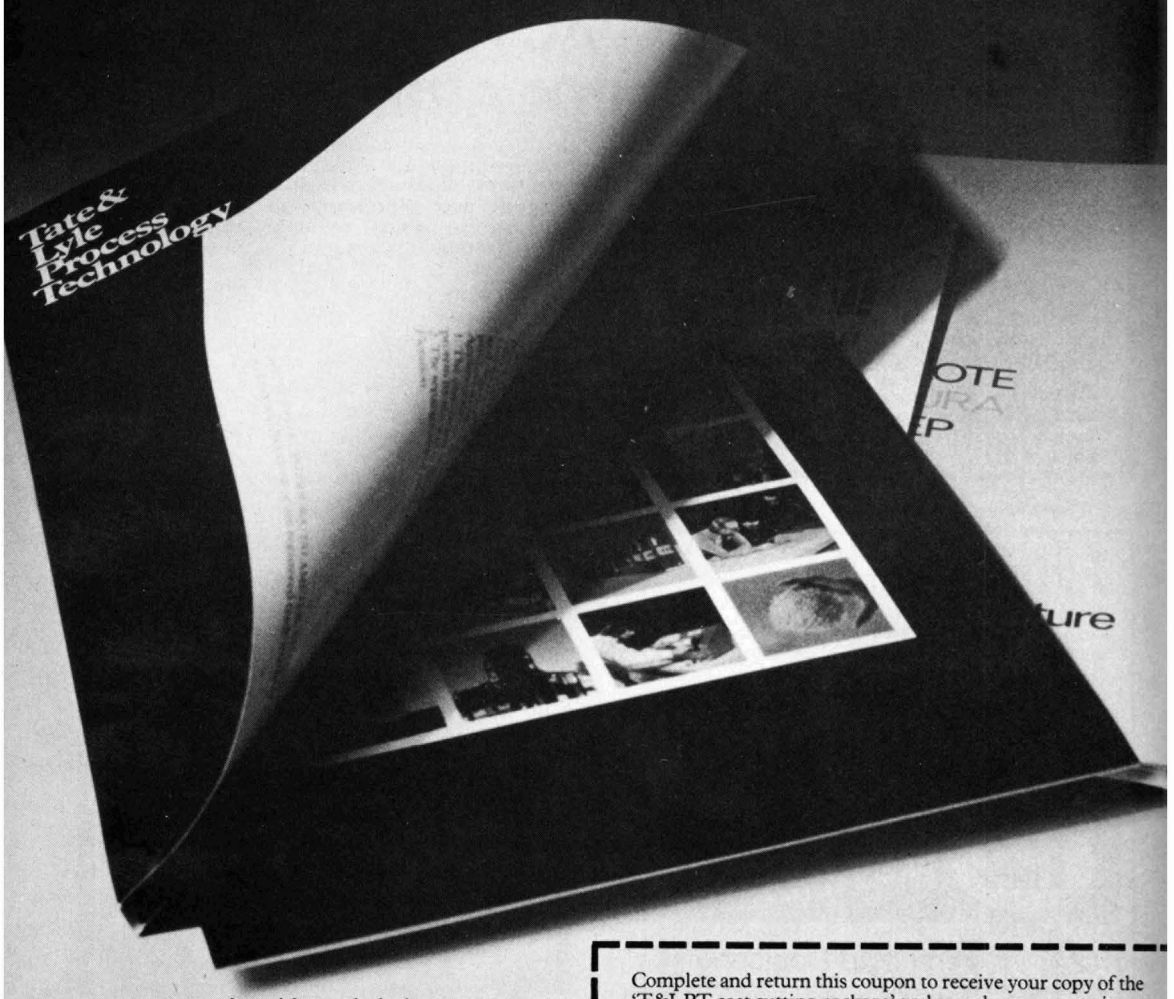

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Dry substance determination

The dry substance (dissolved solids content) of cane and beet process juices and syrups is usually determined by an indirect method, for example by means of refractive index or solution density measurement. These methods are described in detail in many of the standard texts[e.g.3]. Most refractometers or hydrometers are calibrated directly in % w/w apparent solids or °Bx but this calibration has been obtained from Standard Tables relating dry substance to refractive index or apparent density and it should be noted that these tables are based on measurements carried out on pure sucrose solutions. The use of such tables will therefore introduce an error, which increases as the purity of the sample decreases, depending on the relative proportions of the soluble non-sugars.

Refractometry still largely relies on the simple, manually-operated optical instruments for laboratory analytical work although automatic equipment is available for on-line process measurement.

In the sugar factory laboratory, solution density is frequently determined by means of hydrometers directly calibrated in °Bx[e.g.12] but it is now possible to obtain automatic density meters capable of measurement to better than 4 decimal places[13]. Such instruments normally operate by measuring the resonant frequency of a small pipe section filled with the test sample. The technique has direct application in the factory laboratory but is slow to gain acceptance because of the inherent simplicity and relative cheapness of the alternative hydrometers. In process control, however, the on-line density meter working on the same principle is now frequently used, often replacing the refractometer with its easily damaged prism face.

For solids and for some materials which have very high Brix, oven drying techniques are the traditional method of dry substance determination[e.g.14]. Unfortunately such methods, although simple to carry out, have an inherent substantial time delay before the result is obtained and are difficult to inter-compare. If the method is to remain simple and convenient, a combination of time and temperature has often to be selected which will allow virtually complete removal of moisture without causing decomposition of the sample. In general, unless some form of correction is applied, such methods produce a result which should only be described as 'weight loss on drying' which is also the case where volatiles other than water are present and are also lost on heating. "Dry substance" or "water content" should be reserved for more specific techniques.

The major technique for the direct determination of moisture is the Karl Fischer method[15] whereby water in the sample is chemically reacted with the Karl Fischer reagent in a titration apparatus. A recent comparative study of this method with vacuum oven drying for the determination of the dry substance of molasses concluded that the former was the more accurate[16] (Fig. 3).

From another recent study on beet molasses of about 75g solids/100g molasses, the standard deviation of the mean dry substance by the Karl Fischer procedure was typically 0.1g/100g molasses with a coefficient of variation of 0.13%[10].

At present ICUMSA has recommended a modified Karl Fischer titration for the determination of the water content of molasses and is undertaking collaborative work to establish an ideal procedure for this purpose[3].

Several manufacturers offer semi-automatic Karl Fischer titration apparatus in which the operator is required only to load the sample into the titration cell and some minutes later to obtain the result and to continue with the next sample. Calibration of the instruments is by titration of a known amount of water either directly by means of accurately dispensed aliquots from a syringe or by means of inorganic salts containing water of crystallization. Where the sample is difficult to accommodate directly, e.g. dried beet pulp products or granulated sugar[17], it is possible first to extract the moisture into a suitable solvent such as anhydrous methanol and then to determine the water content of an aliquot of the solvent.

The moisture content of dried beet pulp has been determined by means of infra-red reflection spectrophotometry. This technique, which was formerly a research tool, is being introduced into many industries where the moisture content of a relatively uniform material is to be measured. The method used is to illuminate the material with infra-red radiation at two wavelengths. One wavelength is chosen to be an absorption wavelength of the water molecule and thus some of this radiation is adsorbed by the moisture present in the surface layers of the material and therefore cannot be reflected back to the instrument. The second wavelength used is chosen such that none of the energy is specifically absorbed by water nor by any other quantitatively significant component of the material. Therefore this second wavelength is used as a reference showing the reflectivity of the surface of the material. The ratio of the amounts of each wavelength returning to the instrument is taken as a measure of the surface moisture content. This technique appears to work well where the moisture content of the surface layers indicates the true average moisture content and it has been found to be useful in assessing the moisture content of dried molassed beet pulp[18] but was unsuccessful when used for bagasse[19].

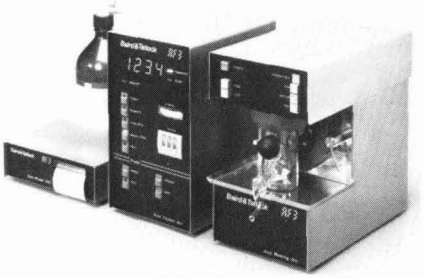

Photo: Courtesy Baird & Tatlock Ltd.

Fig. 3. Model AF3 direct reading Karl Fischer titration system

Particle size analysis

The most obvious situation where particle size analysis is of importance to the sugar technologist is in the quality control of his main product – granulated sugar. The conventional method for this purpose is to use sieve

[12] "Laboratory Manual for Queensland Sugar Mills", 5th Edn. 1970, 65–67.
[13] Heffelfinger: *Food Prod. Develop.*, 1977, **11**, (5) 18–29.
[14] "Laboratory Manual for South African Sugar Factories", 2nd Edn. 1977, Sections 5.17 and 5.18.
[15] Fischer: *Angew. Chem.*, 1935, **48**, 394.
[16] *Proc. 17th Session ICUMSA*, 1978, 182.
[17] Schneider, Emmerich & Ticmanis: *Zucker*, 1971, **24**, 245–249.
[18] Shore, Dutton & Teague: *Internal Report, British Sugar Corporation 29th Works Electrical Engineers' Conference*, 1976.
[19] Partridge & Reichard: *Proc. 42nd Conf. Queensland Soc. Sugar Cane Tech.*, 1975, 153–156.

Photo: Courtesy Pye Unicam Ltd.
Fig. 4. SP3 infra-red spectrophotometer data centre

analysis on the dry product and for most purposes this is both convenient and satisfactory[3]. For some materials, e.g. massecuite, dry sieving is not possible and a method of wet sieving in methanol or *iso*-propanol is used[20]. This method is both tedious and unpleasant, although effective.

There are currently many different approaches to particle size analysis involving purely instrumental techniques. The most widely established method uses the Coulter principle[21]. Here the particles are suspended in a conducting liquid, which for sucrose can be *iso*-propanol saturated with sucrose and containing ammonium thiocyanate. The suspension is then caused to pass through an orifice on either side of which is immersed an electrode.

The changes in resistance as particles pass through the orifice are converted into voltage pulses the amplitudes of which are proportional to the volumes of the particles. The pulses are then separated according to pulse height, and counted. The size limits for the technique have been quoted as being from 0.6 to 400 microns[22].

Recently instruments have become available which couple conventional microscopy, to produce a magnified image of the particle suspension, with computer-based analysis of this image. One such instrument uses closed circuit television scanning of the image and can also be used for analysis of dry powders. These methods have been reviewed[23].

Laser technology has introduced new possibilities for applying the phenomenon of light-scattering by small particles. Previously, light-scattering had been used only to detect and quantify the presence of particles in suspension in a fluid. Modern high-intensity laser diodes and light-sensitive diodes with wide response ranges have made possible more complex analysis of the scattering effect and if the energy distribution of scattered light is correlated with the scattering angle the particle size distribution can be determined. Commercial instruments are available and the use of the technique, for instance to follow the progress of the seed crystals when introduced into the vacuum pan, can be envisaged. Particles down to submicron size at the 0.5 ppm level can be detected by this method, which would enable monitoring of, for example, oil droplets in condensates and perhaps particle leakage in thick juice filters.

Trace element determinations

Sugar products and by-products have to meet rigorous specifications for heavy metal impurities. Traditionally such metals have usually been determined, after separation from the organic matter, by colorimetric methods. The main disadvantage of such methods lies in the difficulty in achieving a truly specific analysis and, because of this, the time taken to process the samples. The introduction of atomic absorption spectroscopy has facilitated the rapid measurement of specific trace metals in many types of material, and several authors have reviewed the technique[24,25].

In practice a preliminary step of separating the inorganic components from the organic material is still necessary and this can be achieved by either wet or dry oxidation methods. For each sample, a single solution is then prepared, which contains all the elements to be determined. In general the concentration of the element may be far less than 1 ppm up to more than 10% and still be acceptable for analysis and accuracies of better than 1% are possible.

The procedure is suitable to replace traditional methods for the determination of calcium, magnesium, copper, lead, cadmium and many other elements[26,27,28,29]. A major advantage of the method is that, once a solution has been prepared from the sample, each element in turn can be determined on the same solution (Fig. 5).

Polarographic methods can be of use in trace metal determination although there is little reference within the sugar industry. In essence, the polarographic curve is a record of the electrolysis current flowing in the sample solution as the potential applied between two electrodes is varied. This curve, when interpreted, can show both the qualitative and the quantitative compositions of the solution. In most cases oxidative elimination of the organic components is necessary as for atomic absorption work.

Where the metals are present in very small amounts, e.g. much less than 1 ppm, the technique of anodic stripping voltametry can be used, in which the cations are concentrated by a preliminary electrolysis stage[30]. In the sugar industry, this technique has recently found application for the determination of such elements as lead, copper, cadmium and zinc in raw and refined

[20] West & Gaddie: *J. Amer. Soc. Sugar Beet Tech.*, 1962, **12**, 251–253.
[21] Coulter: *Proc. National Electronic Conf.*, 1956, **12**, 1034.
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[24] Slavin: *Appl. Spectrosc.*, 1966, **20**, 281.
[25] Reynolds: *Lab. Equip. Dig.*, 1968, **6**, 79.
[26] Tomobe & Nagasaka: *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1978, **28**, 1–8.
[27] Lew: *J. Amer. Soc. Sugar Beet Tech.*, 1972, **17**, 144–153.
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[29] Pommez & Clarke: *Proc. 1972 Tech. Sess. Cane Sugar Refining Res.*, 40–46.
[30] Hume: *Anal. Chem., Fundamental Review*, 1968, 174R–184R.

sugars[31,32,33].

Polarography has also been of use in the determination of surface active constituents in refined sugar by their effect on the polarographic oxygen maximum[34,35,36], and this principle has been made use of in assessing the suitability of white sugar for low floc applications[37].

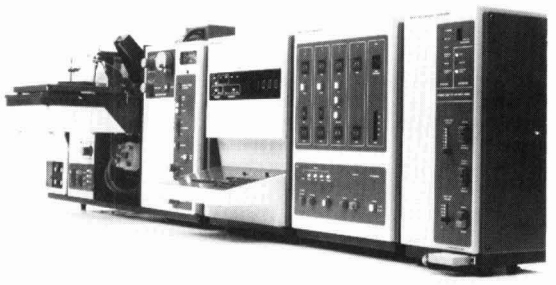

Photo: Courtesy Pye Unicam Ltd.

Fig. 5. Series SP9 atomic absorption spectrometer

Gas analysis

The analysis of gaseous mixtures is a routine procedure in the sugar industry in connexion with the correct operation of the boiler house and the lime kiln using chemical absorption techniques such as in an Orsat apparatus[38]. However, modern instrumental methods rely on the measurement of the physical properties of the gases. For example, recent studies on sugar beet respiration[39] have used a gas chromatograph to separate the required gases followed by a detection system which responds to the different thermal conductivities of the gases. Such an instrument could be used for continuous monitoring of flue or kiln gases with little modification.

Techniques which are not yet established for routine use include infra-red absorption spectrometry, which can be used to identify carbon dioxide and carbon monoxide in a mixture and can monitor levels of hydrocarbons, whilst mass spectrometry, a most useful research tool, could be used to provide a complete quantitative analysis for any gaseous mixture (Fig. 6).

Sulphur dioxide emission can be monitored in flue gases on a continuous basis[40] whilst light scattering techniques can be used to monitor particulate emission[41].

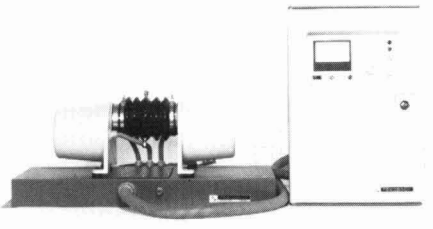

Photo: Courtesy Anatek Instruments Ltd.

Fig. 6. PSA infra-red gas analyser

GENERAL TECHNIQUES

Gas-liquid chromatography

Since the introduction of this technique in 1952 GLC methods have been described for many of the determinations of interest to the sugar chemist. A modern instrument is shown in Figure 7. The application of GLC to the determination of sugars has already been mentioned; in the research laboratory the technique has been of great value in the quantitative determination of trace amounts of organic impurities which are present in sugar beet and in products derived from sugar beet as a result of the application of herbicides, fungicides and pesticides[42]. The fate of permitted products in the factory process has been followed and the use of non-permitted products detected.

A similar application is in the detection

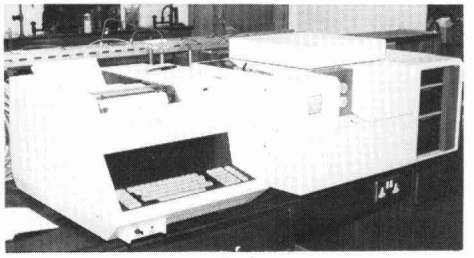

Fig. 7

and measurement of undesirable contaminants in wrapping materials used for sugar products. Icing sugar, for instance, can absorb such contaminants in situations where the sensitive GLC methods are the only method of detection available other than the human nose.

Of more practical interest to the factory chemist is the determination of volatile and non-volatile fatty acids. Lactic acid, for instance, is regarded as a significant indicator of sugar loss in the beet sugar diffusion process[43] as a result of the thermophilic microbial action. A GLC technique[44] is one of several methods which

[31] Pommez & Cormier: *Proc. 1974 Tech. Sess. Cane Sugar Refining Res.*, 125–137.
[32] Cormier, Mai & d'Antico: *Proc. 1976 Tech. Sess. Cane Sugar Refining Res.*, 162–174.
[33] Sourek, Flanderkova & Stalik: *Chem. Listy.*, 1975, **69**, 1207–1210.
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[36] Heyrovksy & Zuman: "Practical Polarography" (Academic Press, New York), 1968, 171–172.
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[39] Oldfield, Shore, Dutton & Houghton: *Paper presented to 43rd Winter Congr. I.I.R.B.*, 1980.
[40] Schunk: *DECHEMA-Monogr.*, 1976, **80**, 753–761.
[41] Coles & Shak: *British Steel Corp. Eng. Lab. Rpt.*, (CEL/CH/29/73).
[42] Parslow: *J.I.I.R.B.*, 1973, **6**, (3), 138–153.
[43] Oldfield, Dutton & Shore: *I.S.J.*, 1974, **76**, 260–263, 301–305.
[44] Oldfield, Parslow & Shore: *ibid.*, 1970, **72**, 35–40.

Photo: Courtesy Pye Unicam Ltd.

Fig. 8. Typical liquid chromatography system

exist for its determination, and it is particularly suitable for levels lower than 100 mg per litre. As other examples, more volatile acids such as propionic, butyric and valeric acids are important constituents of the odour of the mud settling ponds in beet sugar factories[45] whilst acetic acid is a major constituent of dried molassed beet pulp dryer outfall gases[46]. A recent study of the volatile products formed during the drying of molassed pressed pulp used a combination of GLC with mass spectrometry[47] for positive identification of compounds present in low concentrations; these minor constituents were first separated by GLC and then identified by mass spectrometry. This same technique is often used for the identification of compounds which contribute to the characteristic odour of some food products, e.g. cane molassses[48].

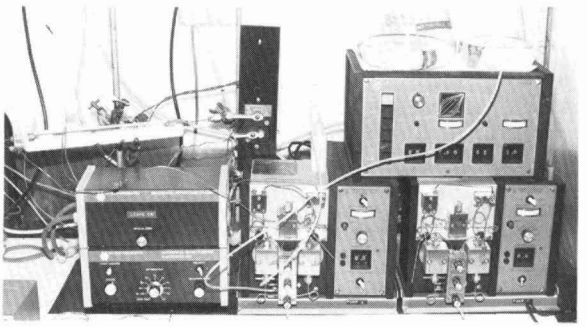

Fig. 9

High performance liquid chromatography (HPLC)

This technique is a modern development of the established method of separating compounds in solution by utilizing their different partition properties between a solid support and the moving solvent[49]. Long, narrow columns of finely divided material are used as the stationary phase, resulting in the need for high pressures to force the solvent through at reasonable rates. Advantages claimed for the method include re-use of the columns many times without regeneration and a high resolution, far exceeding that of earlier chromatographic techniques, with improved reproducibility. HPLC is an analogue of gas liquid chromatography and often either technique can be used for analysis, HPLC being preferred when the compounds being analysed are thermally unstable or insufficiently volatile to be readily handled by GLC[50]. Identification of the compounds as they leave the column is usually by means of refractive index variation, but ultraviolet light absorption or by fluorescence methods although an automatic polarimeter, e.g. using the Faraday effect, can be used for sugars[51]. Figure 9 shows a modern HPLC set-up.

In the Radial compression separation system shown in Fig. 10, instead of stainless steel columns, a flexible walled cartridge is employed, held under radial compression in the RCM-100 compression module, thereby forming an extremely efficient and regular packed bed. Among the packing materials available is a newly introduced Dextropak cartridge specifically optimized for oligosaccharide separations using pure water as the mobile phase at ambient temperature.

The main application of HPLC in the sugar industry could be in the field of sucrose and invert sugar measurement. Because the method can be used on the sample with minimal pre-treatment it may be suitable for on-line control and monitoring applications. However, when the technique was applied to molasses there was rapid fouling of the columns, leading to a fall off in performance[2].

Enzymatic techniques

Enzymes are proteins which catalyse the chemical reactions which are essential to the metabolic processes of living organisms. When extracted from cell matter and purified they are capable of catalysing specific chemical reactions under suitable conditions. The main advantage of the use of enzymes is their specificity which enables them to cause the chemical reaction of one type of molecule in the presence of other molecules with the same functional groups. For example, whereas a chemical oxidizing agent would oxidize many hexose sugars indiscriminately, the enzyme dextrose oxidase will only oxidize dextrose even though, for example, levulose is also present. Enzymatic analysis has already found application in the sugar industry for the determination of sucrose,

[45] Lescure & Bourlet: *Sucr. Franç.*, 1979, **120**, 369–375.
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[51] Wenking: *Zucker*, 1958 **11**, 283–286.
[52] Bergmeyer & Bernt: "Methods of Enzymatic Analysis", (Academic Press, New York), 1974, *Vol. 3*, 1172-1179.
[53] Devillers, Detavernier & Roger: *Sucr. Franç.*, 1975, **116**, 299–307.
[54] Schoenrock & Costesso: *J. Amer. Soc. Sugar Beet Tech.*, 1975, **18**, 349–359.

invert sugar and raffinose[52,53,54] and for the determination of lactic acid[55,56]. Instruments are now available which automatically carry out an analysis for sucrose and dextrose on a sample aliquot and one such instrument has been evaluated[57].

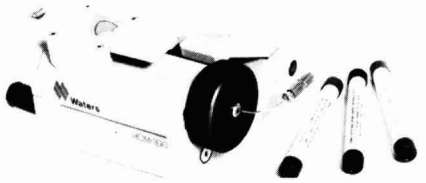

Photo: Courtesy Water Associates (Instruments) Ltd.
Fig. 10

Automatic systems

Automatic analysis systems are now available for many of the routine chemical determinations which formerly occupied the time of the laboratory technician. As suggested in the introduction, these systems are likely to find increasing use in the sugar industry, both on-line in the process and in the factory laboratory[58,59,60]. They enable more rapid analysis with reduced dependence upon the skill of the operator. In addition, where the laboratory is only staffed during the normal daytime working hours the automatic analysers can be in use overnight to increase the capacity of the laboratory.

In order to eliminate instrument errors it is advisable to incorporate many determinations of standard solutions into the schedule, sometimes as often as every alternate sample. In addition, some repetition of the analysis may be necessary when the concentration of the unknown to be determined falls outside the range which was anticipated.

In general the precision and accuracy obtainable is at least as good as that expected from the average technician and this is mainly due to the frequent reference to standards.

A typical system would include an automatic sampler, from which the unknown and standard solutions are introduced at regular intervals into the analyser, an arrangement of coiled tubing where sample and reagents are mixed, often at elevated temperatures, and a spectrophotometer where the intensity of colour produced in the colorimetric reaction is measured. The results are normally displayed either on a chart recorder or via a micro computer and a printer. For example, sugar in factory wash waters has been determined by an automated colorimetric technique[61]. Colorimetric methods have also been used for the measurement of sucrose and monosaccharides in foodstuffs[62], and the extension of these procedures to the analysis of factory juices can be envisaged. Kjeldahl nitrogen has been measured by an automated continuous flow method which incorporates digestion, neutralization and colour development[63], and this principle could be of use where products such as molasses are sold for animal feed or fermentation.

Automation can be extended to other analytical methods besides colorimetric procedures. Fluorescence has been used for automated detection of sugar in boiler feed waters[64]. An automatic polarimeter has been coupled with an automatic refractometer through a computer to calculate juice purities in the laboratory and the factory[65]. Automatic sample injectors are available for GLC instruments which enable the processing of samples to continue outside normal working hours, and scintillation counters used in such radiochemical work as isotope dilution studies also incorporate automatic sample loading so that once a batch of samples is prepared all of the following analysis is fully automatic.

The introduction of automatic analysis to sugar factory laboratories should relieve the technician of the tedium of routine analyses, provide a means of increasing the throughput of the laboratory and increase the overall accuracy of the work being undertaken. The increased throughput will itself enable more detailed study of the factory process which in turn can be used to increase the efficiency of the factory.

Conclusions

Research in the beet and cane sugar industries employs a wide range of modern analytical techniques. Some of these have already begun to be used for routine analyses in sugar factory laboratories, where they offer such advantages over the traditional techniques as greater speed, improved specificity and higher precision. The trend is likely to continue, both in the factory laboratories and for on-line process measurements. Gas liquid chromatography and enzymatic analyses are examples of techniques which are already being adopted, and high pressure liquid chromatography, atomic absorption spectroscopy and laser light scattering are among the modern techniques with potential for future applications in sugar factories and their laboratories.

Acknowledgements

The authors wish to thank Messrs. J.V. Dutton and N.W. Broughton, and Mrs. A.C. Houghton, for their help in the preparation of this article.

Summary

A survey is presented of instrumental techniques which have originated in research laboratories for analytical measurements and their industrial application for process and chemical control is assessed.

Les techniques instrumentales modernes d'analyse et l'industrie du sucre

On effectue un rélevé de techniques instrumentales qui ont trouvé leur origine dans les laboratoires de recherches pour mesures analytiques et on évalue leur application aux contrôles de fabrication et chimique.

Moderne instrumentelle Analysentechniken und die Zuckerindustrie

Ein Überblick über instrumentelle Techniken, die in Forschungslaboratorien für analytische Bestimmungen entwickelt wurden, und deren industrielle Anwendung für Verfahrensüberwachung und chemische Kontrolle wird gegeben.

Modernas técnicas instrumentales de análisis y la industria azucarera

Se presenta un examen de técnicas instrumentales para mediciones analíticas que han originado en laboratorios investigatorios, y se considera su aplicación industrial en la fabricación y control químico.

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[56] Schiweck & Busching: *ibid.,* 1972, **25**, 7–12.
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SUGAR CANE AGRONOMY

Environment, flowering, rainfall and dosage rate as factors affecting response to ripener Polaris. M. H. R. Julien, G. C. Soopramenien and M. A. L. d'Espagnac. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. – Analysis by gas-liquid chromatography confirmed that increases in pol % cane following application of Polaris to cane represented true increases in sucrose content. The dextrose and levulose contents were both reduced by the ripener. The extent of the response to Polaris depended largely on the area of Mauritius in which the tests were carried out but was not largely influenced by soil type. Rain up to 5 mm during or just after spraying reduced the response, but flowered and vegetative stalks responded equally well in the case of application to the high flowering variety S 17. Parameters which must be considered when determining the optimum dosage are the cost of Polaris and its application, its effect on sucrose content and the yields of the treated crop and that following.

Ripener efficiency as affected by ratoon stunting disease. F. A. Martin, R. J. Steib and G. M. Dill. *Paper presented to the 17th Congr. ISSCT,* 1980, 3 pp. – Trials over three years showed that while Glyphosine increased the sucrose content of both uninfected cane and cane infected with ratoon stunting disease, the effect on the latter was smaller and there was a net reduction of sugar yield per hectare, as against an increase in the case of uninfected cane.

The use of Asulam as a sucrose enhancer in sugar cane. J. A. Hardisty. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. – In trials in the Caribbean, Central and South America and in East Africa, Asulam at 4.5 $kg.ha^{-1}$ applied 5–10 weeks before harvest has increased sugar yield as a consequence of increased growth and yield of cane, improvement of juice quality, or a combination of these. Improvements in sugar yield occurred at the beginning and end of the harvesting cycle, in irrigated and non-irrigated crops and in both plant cane and ratoons. No undesirable side-effects in the crop were produced and the speed of burn prior to harvest was slightly improved.

Some aspects of Mon 8000 as a sugar cane ripener to replace Polaris. H. W. Hilton, R. V. Osgood and A. Maretzki. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. – Mon 8000, a glyphosate sodium salt formulation, applied at 0.25 – 1.0 kg acid equivalent per hectare, has shown cane ripening activity at least equivalent to that of 4.5 $kg.ha^{-1}$ of Polaris, a glyphosine formulation. The response is also more consistent in different climates and depends on the amount and concentration of Mon 8000 applied to the foliage and the interval between treatment and harvest. Most of the observed climatic and varietal differences in response to Mon 8000 were probably due to the maturity of the treated stalks in relation to temperature, nutrients and water at the time of application and during the ripening period from application to harvest.

Ripening activity of the glyphosate salts Mon 8000 and Roundup. M. S. J. Clowes. *Paper presented to the 17th Congr. ISSCT,* 1980, 19 pp. – Mon 8000 and Roundup, solid and liquid formulations of glyphosate salts, produced similar ripening responses when compared at approximately the same level of application of active ingredient. Improvement in cane quality persisted for 20 weeks but the increase in recoverable sugar generally diminished after 6 weeks from spraying because of a reduction in the stalk mass brought about by inhibition of apical growth. Trials in the three main ecological regions of the South African sugar industry produced between October and April a mean increase of 1.5 units of sucrose resulting in a 14.4% increase in estimated recoverable sugar. During the winter months of May – September, appreciable and consistent responses were obtained in the hotter northern irrigated region while the responses in the cooler coastal and midlands rain-fed regions were generally poor and inconsistent. Stalk analysis confirmed that the glyphosates increased the sugar yield of mature, actively-growing cane by loading sucrose into the lower and more mature parts of the stalk. Measurements of regrowth of the subsequent ratoon crop showed that over-application must be avoided and that the early signs of chlorosis, and stunting when it occurred, tended to diminish with time.

Causative factors for the occurrence of chlorosis in sugar cane grown in red loamy soils. K. M. Naidu, S. Ramakrishnan and K. V. Bhagyalakshmi. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. – Investigation of chlorotic and healthy plants and the soils in which they were growing showed that the chlorosis was associated with iron deficiency and not lack of manganese. Spray application of iron as ferrous sulphate or an iron chelate compound cured the chlorosis. The availability of iron from the soil was reduced to below a critical level by the presence of excess calcium carbonate, and the iron that was absorbed by the plant accumulated in the upper stalk and sheath bearing the chlorotic leaves. The problem is aggravated by the use of highly brackish water used for irrigation, which is relatively high in bicarbonate content. A number of measures have been suggested to overcome the chlorosis but the only practical one at present appears to be the use of a $FeSO_4$ spray for the leaves.

Effects of Embark and Ethrel on sugar cane quality, yield and ratoon growth. P. C. Yang and F. W. Ho. *Paper presented to the 17th Congr. ISSCT,* 1980, 14 pp. Four field trials with aerial spraying of the two ripeners at four locations during 1975-77 evaluated their effects on cane quality, yield and ratoon regrowth. Brix, growth rate and ratoon regrowth were measured in the field and stalk samples and crusher juice analysed for Brix, pol % cane, purity and recoverable sugar. The results indicated that both gave substantial improvement in juice quality between 4 and 10 weeks after spraying, the extent of this improvement depending on variety and age of the cane. Embark gave better response with 10-months-old ratoon cane than a 15-months autumn-planted crop. It raised recoverable sugar by 7% after 6 weeks in F 167 cane variety and by 28% after 10 weeks; the corresponding increase for F 172 variety was 15% after 10 weeks. Embark at 2.5 $l.\ ha^{-1}$ prevented the decline of sucrose

content of F 160 cane at the end of the milling season. Ethrel also demonstrated good ripening effects on autumn-planted F 167, F 172 and F 177 cane at 8-10 weeks after spraying; addition of urea to the Ethrel had no advantage. Embark suppressed growth rate more than Ethrel but no substantial difference was observed between treated and control plots. Neither ripener had any apparent adverse effect on ratoon regrowth; Ethrel appeared to have a great potential for stimulating shoot regrowth.

Influence of K/N relationship in fertilization upon some foliar indicators and yields of sugar cane. R. de Armas and N. Musienko. *Paper presented to the 17th Congr. ISSCT,* 1980, 7 pp. — Initial fertilization with different K:N ratios and one or two later applications of N and P (see de Armas *et al.*[1]) were applied to cane and the effects studied on green weight, moisture, N, P, and K-H_2O using leaves 3-6 as indicator tissue. In general, rise of K:N up to a level of 1 increased the green weight and moisture content of cane and reduced total sugars significantly. The K-H_2O increased significantly up to a K:N ratio of 2 but there was no significant change in N or P. Sugar yield showed a significant difference up to K:N = 1 in plant cane and up to K:N = 1.5 in the first ratoon crop. High or medium correlations between foliar K and yield were obtained at the different stages of plant development. The K:N ratio behaved in a very similar manner at the various stages, showing very high correlation coefficients.

Effect of Glyphosate ripener on growth response and sugar yield of sugar cane. A. P. Tianco and M. Y. Gonzales. *Paper presented to the 17th Congr. ISSCT,* 1980, 15 pp. Spraying 6 weeks before harvest of 8-months-old Phil 56-226 cane with 0.3 kg a.i. per hectare of Mon 2139, a Glyphosate formulation, produced an average increase of 26% in the stalk sucrose content, unaccompanied by any loss in stalk weight. Spraying with 0.6 kg. ha^{-1} 8 weeks before harvest gave a 21% increase in sucrose per stalk but the stalk weight was 4% less. While the increases in pol % cane were greatest in the top of the cane stalk, the sucrose increase was largely (30-70%) due to accumulation of sugar in the lower, more mature parts. There was no adverse effect on ratoon regrowth, tillering or height with the lower treatment rate at one site and no problem was expected at the other.

Diagnosis and Recommendation Integrated System (DRIS) applied to various sugar cane tissues. E. Zambello and J. Orlando. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — N-P-K fertilizer trials were carried out with cane grown on land previously used for pasturage and the DRIS system applied to determining the required dosages. There was a marked response to both N and P. The system proved satisfactory whether the tissue used was the +3 leaf or the 8th, 9th or 10th internodes and since the first is easier to collect, prepare and sample early, it is the preferred tissue.

Physiologically active phosphoric compounds distribution in sugar cane in relation to phosphoric nutrition. E. Ortega and N. N. Musienko. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. — Three levels of phosphate were applied to cane (0, 150 and 250 kg P_2O_5 per ha) and the effects noted on the contents of nucleic acids, phospholipids, "macroenergy P", phytin, hexose phosphate esters and inorganic phosphorus. The last, at 17.06 g per 100 g fresh cane weight, was the fraction with the highest level and nucleic acids were the fraction of organic P with the highest concentration. The majority of P compounds were found at their highest concentrations in the meristem tissue, exceptions being phytin and inorganic P. Concentrations were higher in leaf blades than in leaf sheaths, internodes or roots.

Maturity pattern in fields irrigated with filter cake water. S. Valdivia V., J. Pinna C. and H. Tello A. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — Filter cake water applied to cane in Peru provided the equivalent of 60 and 145 kg. ha^{-1} of N at two different locations and studies on pol and reducing sugar contents showed that the ripening process was not affected by the continuous supply of nutrients in the irrigation water.

Sites of sugar cane callus formation in young leaf and stem tip explants. M. C. Liu, W. H. Chen and S. C. Shih. *Paper presented to the 17th Congr. ISSCT,* 1980, 14 pp. Young leaf and stem tip explants from F 168 cane were cultured in a modified Murashige & Skoog medium containing 3 ppm 2, 4-D and callus tissue formed on the wounded regions exposed to the medium. Microscopic examination showed that the callus cells arose from the cambium-like cells, phloem, parenchyma and the primary xylem in the vascular bundles of the leaf and stem tip explants. The newly formed callus cells are large and vacuolated in appearance but some of them soon grow into a meristemoid. Pressure from the centrifugal growth of the meristemoids results in the appearance of many nodule-like structures along the peripheral regions of the explants.

Chemical ripening of variety B 41227 in Trinidad. G. F. Mason. *Paper presented to the 17th Congr. ISSCT,* 1980, 13 pp. — Nine micro-plot cane ripener trials were conducted during 1976-79 in Trinidad in order to screen products for enhancing sucrose content and undesirable side-effects. Mon 2139, XHH 148 and Mon 8000, all Glyphosate-based products, were all found to be superior to Polaris as indicated by pol % cane. Embark-2-S and Ethrel were less effective than Polaris while FR 600/1 was ineffective. Growth cessation, reductions in cane weight and desiccation were all found to occur to small extents with most ripeners but were not always associated with sucrose enhancement. Untreated cane also underwent similar changes but to smaller extents. Ratoon regrowth was not adversely affected by any ripener.

Root development of the sugar cane cultivars H 32-8560 and H 57-5174 under normal conditions of cultivation and irrigation in the Chicama valley. J. E. Paz-Vergara, A. Vasquez, W. Iglesias and J. C. Sevilla. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — A study was made of the distribution of roots within the soil profile of representative and commercial cane fields of the Casa Grande Cooperative in Peru. Examination was made of specimen canes from both plant and ratoon crops from 4 to 19 months of age. The results show that roots grow down to 180 cm deep, with approximately 85% in the first 60 cm. Root development is influenced by irrigation, large volumes encouraging deeper roots and light applications superficial roots. Under the conditions of the study it was found that age is not an additional factor in the distribution of roots, nor is the variety or the number of the harvest.

Studies on the effect of soil water stress and levels of nitrogen on spring-planted sugar cane. K. S. Parashar, S. B. Hukkeri, M. N. Sadaphal and R. P. Sharma. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. Cane was grown during two crops and subjected to water stress during the three stages of growth (pre-monsoon

[1] *I.S.J.*, 1981, **83**, 177.

germination and establishment, monsoon rapid growth, and post-monsoon maturation). A simultaneous trial was made to determine the effect of different rates of nitrogen application. Yield of cane was adversely affected by soil water stress at any stage, the extent of the reduction differing between the two crops. Nitrogen application increased cane yield but the juice purity was lowered during one crop (although virtually unchanged in the other) and the increase in sugar yield was not proportional.

Use of gibberellic acid to increase sugar cane yields in Hawaii. P. H. Moore. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. — Previous work had indicated the conditions under which response to gibberellic acid could best be achieved and these were adhered to during field tests in Hawaii, viz. treatment was applied to the best-responding varieties, the higher elevation fields of lowland varieties were treated preferentially, the gibberellic acid applications were timed to coincide with the fall in growth rate during the winter, sufficient time was allowed to elapse between the last application and harvesting to permit ripening of the gibberellic acid-induced growth, and the treatments were made serially in doses of 1 mg or less of gibberellic acid per stalk at 15-30 day intervals. Significant gains were made in fresh weight per stalk without a reduction in cane quality and were equivalent to an additional 1.75 tonnes of sugar per hectare.

Calibration of copper in sugar in north-east Brazil. M. A. C. dos Santos and A. F. de Sobral. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. — Soil in the Pernambuco cane area includes areas of low fertility where deficiencies of micro-nutrients, particularly copper, retard cane growth. This is corrected by addition of copper and, in order to be able to judge the quantity needed, a study was made of the correlation between soil analysis for copper and that of the +3 leaf of the cane plant. The soil extractant used is 0.05N HCl + 0.025N H_2SO_4 and gave more consistent results than leaf analysis; the copper content was classified as low (up to 0.6 ppm), medium (0.61-0.9 ppm) and high (over 0.9 ppm). Further, the possibility of using the same extract for P and K analysis would be of advantage. Cu in the leaf was analysed by atomic absorption spectrophotometry after a nitric-perchloric acid ashing. The correlation coefficient was low ($r = 0.29$) but as preliminary information a critical level of 6 ppm of Cu is suggested.

The role of side shoots in flowered stalks of sugar cane. M. H. R. Julien, G. C. Soopramanien, J. F. Martine and H. Medan. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. — Sugar yield and its components are compared from 6 to 27 weeks after anthesis in vegetative canes induced to flower artificially and flowered canes on which the side shoots were continually defoliated. The results confirm earlier reports that flowered canes had higher sugar yield than vegetative canes early after anthesis, and that these differences gradually decreased. The difference in sugar yield between the two types of stalks was due primarily to the dry weight component and not to sugar content. Flowered stalks on which side shoots were defoliated showed an increasing loss of dry weight from 13 to 27 weeks after anthesis and consequently yielded significantly less sugar than normal flowered stalks. The reduction in dry weight was due solely to the dry matter % of cane component, as no difference in fresh weight was detected between the two types of flowered stalks. The reduction of dry weight in defoliated stalks was due to losses of both sugar and fibre in the proportion of 2:1. The investigation reported confirms the role of side shoots in maintaining sugar yield and the sugar content of flowered stalks. The physiological, agronomic and breeding implications of the results are discussed.

Effects of photoperiod and temperature on initiation and development of flowers in sugar cane. K. J. Nuss. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. Factors influencing different phases of the flowering process were investigated. The rate of decline in daylength and temperature were found to affect the proportions of the initiating stalks and emerging tassels, time of anthesis and number of flowers shedding pollen. Natural sunsets, as against artificial sunsets, improved flower initiation.

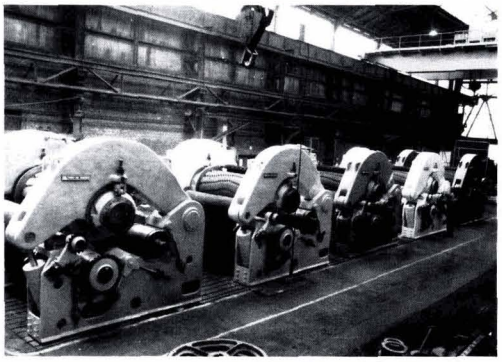
Soil aeration, nutrient uptake and yield of sugar cane as affected by tile drainage. S. J. Yang and P. L. Wang. *Paper presented to the 17th Congr. ISSCT,* 1980, 16 pp. — The response of cane to tile drainage in a low humic gley soil was evaluated using tile drains at 0.8 and 1.2 metres below the soil surface and spacings of 15, 20 and 25 metres. A surface drained plot was used as the control. After heavy rain the water table dropped much faster in the tile-drained plots than that with surface drainage (63-104 cm against 21 cm after 48 hr). Oxygen concentration in the upper 30 cm of the soil never exceeded 5% in the surface-drained plot but seldom dropped below 10% in the tile-drained plots. Root development, nutrient uptake and ratoon regrowth were substantially better in the tile-drained plots while cane yield was improved by 15-19% in plant cane, 24-53% in first ratoon cane and 28-42% in second ratoons. The use of different depths and spacing of the tile drains gave irregular and non-significant differences in yield.

Advance prediction models and infiltration in sugar cane irrigation. W. Silva, A. Vásquez, E. Paz-Vergara and A. Hoekstra. *Paper presented to the 17th Congr. ISSCT,* 1980, 8 pp. — An account is given of studies which led to the establishment of mathematical models of the advance of irrigation water along furrows and infiltration in three types of soil — sandy, loam and clay. The advance model took into consideration the irrigation volume, age of the cane, slope of the furrow bottom and initial soil moisture level, while only the soil texture was a variable in the infiltration model. The results obtained are considered sufficiently reliable because of their high confidence and statistical significance.

Sugar cane systems synchronization opportunities and production input models. A. C. Early and M. K. Ayub. *Paper presented to the 17th Congr. ISSCT,* 1980, 23 pp. — A sugar factory and associated cane area in Pakistan was used to provide historical data on which to develop yield and mill performance models as inputs to a larger management optimization model for the scheduling of milling operations and harvesting of the crop. The study indicated that the area planted and harvested was responsive to the mill performance in terms of transportation, weighing and pricing at the purchase centres.

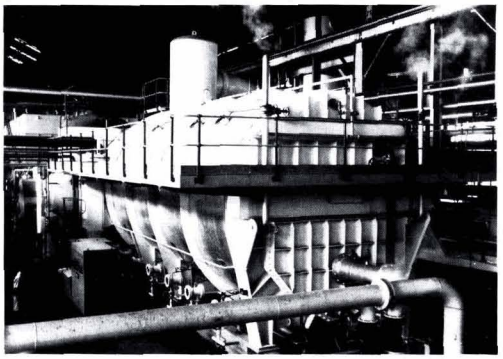
Effect of water table level on cane production. J. C. Sevilla, E. Angulo and J. E. Paz-Vergara. *Paper presented to the 17th Congr. ISSCT,* 1980, 5 pp. — Field experiments showed that there were significant correlations between cane production in tonnes.ha^{-1} and the persistence of water table levels at depths of 60, 80, 100, 120 and 160 cm, and a highly significant correlation at 140 cm. Maximum cane yields were obtained when groundwater levels were kept below 140 cm depth.

The main feature of the FCB self-setting mill is that the top roller is solidary with top housing members acting as lever arms and having the top roller describe an arc of a circle when setting the feed opening. This particular design incorporates the following advantages among others: easy setting of mill ratio; constant mill ratio; increased capacity; higher extraction; reduced power peak; higher permissible roller wear; etc.
For the drive of their mills, FCB offer an elaborate range of steam turbines, reducers and transmission gears. FCB are also specialized in the drive of mills by electric motors. (Brochure N° 21091 upon request).



Assembly, in our works, of a tandem of five 1050 x 2100 mm (42" x 83") self-setting mills.

FCB must be given full credit for being the first manufacturers to offer their customers the possibility of performing continuous boiling. Today, FCB continuous pans are in operation in cane and beet sugar factories and in refineries for all the boiling strikes, and their production range covers the plant operators' full requirements. Other advantages are: heat saving; complete automation; improved sugar and exhaustion quality; reduced overall dimensions; low-cost investment, etc...
About 40 FCB continuous pans have already been sold in France, Reunion, Mauricius, South Africa, the Cameroons, Belgium, Chad, Thailand, Morocco, Senegal, etc. (Brochures N° 21103-Beet, or N° 21110-Cane upon request).



Continuous vacuum pan of 1040 hl capacity, for cane C strike, at the Gledhow sugar factory (South Africa).

- "COMPACT" automatic batch centrifugals are mainly used for processing high-purity products. They are constantly updated through the incorporation of state-of-the-art features (e.g., microprocessors allowing complete automation of crystallisation shops). They are produced in 3 versions with basket sizes 48" x 30", 48" x 42" and 54" x 42" and respective load capacities of 700, 1000 and 1300 kg. (Brochure N° 21100 upon request).
- "FC" continuous centrifugals are suitable for almost all massecuite curing operations:

– The FC 1000 series (basket dia. 1000 mm) is fitted either with 34° basket for low-grade massecuites, or with 30° basket for affination and B massecuites, or with 25° basket (runoffs separation) for beet 2nd strike massecuites, cane B strike affination and A strike.
To avoid crystal breakage, the FC 1000 can be equipped with 3 m, 4 m or 5 m dia casings. It is also possible to adapt, on centrifugals with 30° and 25° baskets, a device allowing almost instantaneous sugar melting.
– The FC 1250 series is equipped with a 1250 mm dia., 34° basket. Centrifugals of this series are high-capacity units used for beet 3rd strike and affination and cane C strike and affination. (Brochure N° 21108 upon request).

Centrifugal station of the N'Koteng, Cameroons, cane sugar factory. In the foreground, four "COMPACT 411" centrifugals. In the background, five continuous "FC 1000" centrifugals.

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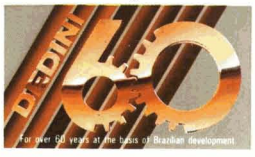

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Nacional

SUGAR CANE MECHANIZATION

Growers and harvester operators can control cane quality. Anon. *Cane Growers' Quarterly Bull.,* 1979, **43,** 12-13. – Practices contributing to high-quality cane are briefly discussed. Drainage minimizes unnecessary delays in harvesting operations. Wide headlands are desirable for a number of reasons all associated with ease of harvester operation and reduction of cane losses. Wide row spacing (up to 1.52 m) also facilitates harvesting and contributes to a reduction in cane damage without any fall in cane yield. Efficient cultivation also permits harvester operation at maximum efficiency, while weed control leads to efficient cane burning, faster harvesting and cleaner cane. Requirements of harvester operators are listed.

The harvester – and how it contributes to cane quality. Anon. *Cane Growers' Quarterly Bull.,* 1979, **43,** 14-16. The main components of the cane harvester are shown in a diagram, and the role played by each is indicated. Advice is given on their maintenance, adjustment and use so as to provide the factory with cane of suitable quality.

Preparation for mechanical harvesting. J. Robinson. *Sugarland,* 1979, **16,** (2), 14-16, 22. – Advice is given on field preparation, drainage and irrigation, row spacing, planting and cultivation to obtain optimum harvester performance.

Steel wire ropes should last longer. P. R. Jonker. *S. African Sugar J.,* 1979, **63,** 405, 407. – A survey of factors contributing to excessive rope usage on various types of cane loader showed that in many cases the tensions on the ropes during loading were far too high, that coiling and uncoiling of ropes was not done corrctly, so that kinks were evident at most sites, that it was common practice not to line-up the trailer or loader with the cane bundle, and that sheaves and drums were sometimes poorly maintained and of inadequate diameter. Advice is given on these points and on suitable type of rope.

Harvesting standover cane in Tully. C. R. Nalder. *Cane Growers' Quarterly Bull.,* 1979, **43,** 50-51. – A number of photographs are reproduced to show how harvesters and break pushers were provided with special circular saws to harvest standover cane, much of which was badly lodged, rat-eaten, damaged by flood and did not burn easily.

Extrapolation of the trash effect on pol losses in bagasse. A. I. Allam. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. – Experiments were conducted in Iraq to relate the trash content of cane harvested manually and by machine, in wet and dry conditions, with the fibre % milled cane and thus bagasse loss. The effect of using the desiccant Gramoxone and burning was also studied. The trash content varied widely with wet or dry conditions for both manually and mechanically harvested cane, each 1% of trash in cane resulting in a loss of 0.21 – 0.24 kg sugar per tonne of cane. Treatment with desiccant and burning gave cane with 2.37% trash against 13.67% in untreated burnt cane, while no drop in juice quality was observed up to 11 days after treatment.

Quality cane and extraneous matter. J. A. Younger. *Paper presented to the 17th Congr. ISSCT,* 1980, 6 pp. – The desirability of fresh clean cane as raw material for the sugar factory is recognized by all, including the manufacturers of sugar cane harvesters. Nevertheless, it must be recognized that, while machine harvesting cannot achieve the standard of trash removal attainable by manual harvesting, the shortage of manual labour and its high cost mean that mechanical harvesting must be employed and efforts of designers and operators must be directed to achieving as good cane quality as possible within the constraints of power consumption and cost in order that the industry may remain economically viable.

Tyres or tracks in cane tillage. L. G. Reeser. *Paper presented to the 17th Congr. ISSCT,* 1980, 11 pp. An analysis is made of those agricultural operations where 2-wheel drive, 4-wheel drive and track-type tractors are best suited, with consideration of tractive efficiency, power efficiency, costs and effects on plant root development. Wheel tractors are well adapted to tillage, transport, landforming, cultivation, weed control and other applications where drawbar loads are light-to-medium and mobility is required. Track-type tractors are most suitable for applications requiring high drawbar pulls, maximum fuel efficiency, minimum surface compaction and long life.

Industrial quality of mechanically and manually harvested sugar cane. S. E. Ferrari, V. L. F. Neto, J. J. C. Lopes and R. Stolf. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. – Comparisons were made between cane obtained using two chopper-type harvesters and manually cut but mechanically loaded cane. The parameters examined included cane pol, fibre %, juice %, reducing sugars % juice, purity, cane yield per hectare and tonnes pol per ha. The values obtained were analysed statistically and showed that manual harvesting gave the highest values for cane pol, purity and yields of cane and pol per ha. Fibre % cane was higher for the MF-201 harvester than for the Santal 116 or manual harvesting in the case of variety CB 41 – 76, but there was no significant difference for CB 56 – 155 cane. Juice % cane was lower and reducing sugars % higher with mechanical harvesting than with manual harvesting in the case of CB 41 – 76 but the differences were not significant for CB 56 – 155.

Investigation of the relationship among quality of cropped sugar cane volumetric weight and loading coefficient of transportation. U. A. Peralta A., A. Abdukadikov, M. Fonseca and M. Dominguez. *Paper presented to the 17th Congr. ISSCT,* 1980, 15 pp. – Cane of variety Ja 60-5, harvested by a KTP-1 chopper harvester and loaded into a trailer was studied using 10 – 20 replicates for the analyses. The total weight of cane was measured and the cane separated into its components: clean cane, trash and dry stalks, tops and suckers. The specific weight of each component was determined and the area harvested to produce the trailer load was measured. The volume of the trailer

was known. In this way it was possible to measure the density of the chopped cane and to analyse the trailer loading coefficient as a function of the cane yield and extraneous matter content. The chopped cane density varied between 300 and 330 $kg.m^{-3}$ while the loading coefficient ranged from 0.28 to 0.31 when the cane yield was between 106.6 and 157 $tonnes.ha^{-1}$ and the extraneous matter varied from 12 to 28%.

Performance testing of chopper cane harvesters for cane quality. T. G. Fuelling. *Paper presented to the 17th Congr. ISSCT,* 1980, 10 pp. – An account is given of a testing program carried out in Australia to assess the work of cane harvesters in respect of billet length, billet damage and extraneous matter. Because of the variability of the condition of the crop along the row, it was necessary to take five 15 – 20 kg samples per observation and to repeat this several times if general conclusions were to be drawn from the examination of the samples. Four machines were tested: the Toft 4000 and 6000, the Massey Ferguson 205 and Claas Libertadora 1400, and some of the studies have been reported[1]. The MF 205 gave the most consistent supply of sound billets, the Claas machine producing a lower level – possible reasons are suggested. The Toft machines use a single rotating chopper while the others have drum choppers giving a self-sharpening scissor-type cut. The Toft machines gave the lowest level of sound billets and the importance of regular knife replacement with these machines is emphasized.

Green cane *vs.* burned cane harvest comparisons 1978-79. N. Rozeff and H. R. Crawford. *Paper presented to the 17th Congr. ISSCT,* 1980, 15 pp. – Atmospheric pollution legislation in Texas limits burning of cane before harvest and trials were made using Claas 1400 harvesters which are able to operate with burned or green cane. Under actual production conditions the machines were used to harvest 812 ha of green cane and 3687 ha of burned cane. The operations are described in detail and the results compared. With green cane there was more millable material left in the field and sugar recovery was 7.41% lower, while production costs were 9.2% higher owing to reduced efficiencies of harvesting, infield and road transport and milling. Harvester life is likely to be shorter and it is concluded that, under present conditions, green cane harvesting is uneconomical.

Cane loss in fields harvested with the push-rake system. M. Morales C. and V. Chavez. *Paper presented to the Congr. ISSCT,* 1980, 12 pp. – At the Casa Grande cooperative in Peru, cane is harvested by the push-rake system and cane remaining in the field is cut by hand and mechanically loaded, This hand cutting is repeated but still some cane remains, and a study was made to determine the extent of this loss. Before the second hand cutting there is an average of 3.8 $tonnes.ha^{-1}$ of millable cane left in the field and afterwards 2.7 $tonnes.ha^{-1}$ (1.95% and 1.47% of the net yield). Some 47% of the cane has been crushed by the machinery and its quality is reduced by comparison with uncrushed cane.

Measuring cutting resistance of sugar cane stalks with pendulums. C. S. Chang. *Paper presented to the 17th Congr. ISSCT,* 10 pp. – A pendulum-type device was used to measure the cutting resistance of cane as a basis for studying the action of mechanical cane harvesters. The resistance was found to vary along the cane stalk, being greater in the middle portion than at the bottom or top. It was greatly affected by cutter geometry and edge sharpness, indicating the potential for reducing power consumption by suitable cutter design.

Semi-mechanized sugar cane harvesting systems for a developing country. A. G. de Beer. *Paper presented to the 17th Congr. ISSCT,* 1980, 10 pp. – South Africa has a ready supply of labour able and willing to cut cane manually but the Mount Edgecome Experiment Station has developed a number of semi-mechanized cutters which could be used and further developed should a shortage of labour occur. The machines are simple and can keep harvesting costs low. In countries where there is widespread unemployment and the growth in GNP too low to rectify this, job opportunities should be increased. Highly mechanized cane farming should be avoided and systems chosen which will provide an optimum combination of labour and equipment to suit the particular circumstances.

The performance of chopper harvesters. A. G. de Beer. *Paper presented to the 17th Congr. ISSCT,* 1980, 12 pp. A review is given of the performance of chopper harvesters in various countries. Test procedures for cane harvesters are considered by describing an experiment conducted during 1978 on an estate in Swaziland to determine the losses incurred when harvesting a cane crop with two different machines by comparison with those incurred when harvesting by hand and transporting the cane on self-loading trailers. Of the estimated 118.9 tonnes of cane per hectare standing in the field, 116.4 $tonnes.ha^{-1}$ were recovered when harvesting manually, 110.9 $tonnes.ha^{-1}$ when using one machine and 100.7 $tonnes.ha^{-1}$ when using the other. Because the cane had been treated with a chemical ripener and an excellent burn was obtained, the amounts of extraneous matter tended to be low in all cases; for hand cutting they were 3.1%, for the first machine 6.1% and for the second 7.0%. Compared with hand harvesting, the use of the two machines resulted in sucrose losses of 4.5% and 12.5%, respectively.

Evaluation of some performance parameters of three combine harvesters of sugar cane *(Saccharum officinarum).* T. C. Ripoli and L. G. Mialhe. *Paper presented to the 17th Congr. ISSCT,* 1980, 28 pp. – A very detailed account is given of trials with three different cane harvesters and their performance assessed in terms of total extraneous matter, tops, leaves and dry leaves, roots, soil, non-selected impurities, chopped cane as a proportion of the cane stalks in the row, effective capacity and frequency of chopped cane length. Measurements were made of soil and cane characteristics and the influence of these on the harvester assessment parameters is noted.

Cane stool mathematical model for the evaluation of a topper. J. Lodos and E. Casanova. *Paper presented to the 17th Congr. ISSCT,* 1980, 9 pp. – Experimental measurements of the various parameters describing the vegetative structure of sugar cane plants and the field uniformity of different varieties were used to prepare a model which was used to predict the results of a topper.

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[1] Fuelling *et al.: Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.,* 1977, 209-216.

CANE PESTS AND DISEASES

Leaf scald disease in Jamaica

By M. E. A. SHAW
(Sugar Industry Research Institute, Mandeville, Jamaica)

Leaf scald disease of sugar cane has been identified at Duckenfield Sugar Estate, affecting the commercial varieties B 51129 and B 49119. Following observation during the early part of March, investigations conducted by the Sugar Industry Research Institute have given confirmation to the initial report. An industry-wide search of the susceptible varieties has indicated that the disease may be present only at Duckenfield.

Fortunately, the major commercial varieties in the Jamaican sugar industry are resistant or tolerant. In the case of B 51129, the experience in Guyana, where the disease and that variety have co-existed for well over a decade, is that no detectable loss in yield has been observed. B 51129 occupies 4% of the Jamaican sugar industry. The only commercial variety in Jamaica which would be expected to experience yield loss is B 49119 which presently occupies about 5% of the industry and is already being phased out because of its susceptibility to smut disease. A minor variety, D 3745, occupying around 85 acres at Duckenfield, is also very susceptible.

Leaf scald disease is caused by a bacterium *(Xanthomonas albilineans).* The disease is spread by planting infected cuttings, by cane knives and other field implements, as well as by rats. Control is ultimately by resistant varieties, though interim measures such as killing infected stools, and certain sanitary practices can be quite useful.

Leaf scald disease is already present in nearly all of the region's sugar cane industries. The method of its introduction into Jamaica is unknown; neither is there as yet a reliable estimate of the date.

Growth of *Colletotrichum falcatum* on media containing juice of different sugar cane varieties. R. P. Singh and –. Kamal. *Sugarcane Pathologists' Newsletter,* 1979, (23), 27–28. – Suspensions of three virulent strains of *C. falcatum,* the causal agent of red rot, were added to juice extracted from the stalks of six cane varieties (one resistant, three moderately resistant and two highly susceptible to the disease) in petri dishes which were than incubated at room temperature for 15 days. The radial growth of the fungus was then measured. In another approach, the mycelial mat formed was separated by filtration, oven-dried and the dry weight determined. Results showed that radial growth and fungal dry weight were greatest in the juice from the highly susceptible varieties and lowest in that from the resistant varieties, indicating that the juice from the resistant varieties either contains more of the substances imparting resistance or does not contain the substances necessary for metabolism of the pathogen.

Notes on downy mildew of sugar cane seedlings in Negros Occidental (Philippines). F. T. Gargentiel, R. R. Jalando-on and F. C. Barredo. *Sugarcane Pathologists' Newsletter,* 1979, (23), 29–30. – Since 1976, cane seedlings in the breeding program of Victorias Milling Co. have suffered considerable losses as a result of downy mildew, probably caused by *Sclerospora philippinensis* (although two other species of the causal agent attack cane in the Philippines, viz. *S. sacchari* and *S. spontanea*). Reduction in the disease incidence in 1978–79 was possibly a result of using Ridomil [methyl *dl*-N-(2,6-dimethylphenyl)-N-(2-methoxyacetyl) alaninate] systemic fungicide as protective spray. Although the source of infection has not been fully established, it is considered probably neighbouring diseased corn and cane fields, while other possibilities include filter cake (one of the components of the sowing medium mixture), thought to be contaminated by spores from infected *Saccharum spontaneum,* growing wild at the dumping site.

Nematodes associated with sugar cane in Maharashtra (India). K. S. Darekar and R. N. Pokharkar. *Sugarcane Pathologists' Newsletter,* 1979, (23), 31–33. – Results of a random survey of four districts in Maharashtra, covering cane fields in eleven intensive growing areas, are recorded, showing nine species of plant parasitic and three of free-living nematodes associated with cane. Of the former nematodes, *Helicotylenchus* sp. and *Hoplolaimus indicus* were by far the commonest, while *Indodorylaimus* sp. was the commonest free-living nematode found.

Rust disease in New South Wales. A. G. Hayes. *Sugarcane Pathologists' Newsletter,* 1979, (23), 35–36. Descriptions are given of symptoms, uredospores and teleutospores of *Puccinia melanocephala* found on Q 90 cane at a site at Condong, New South Wales.

Variety range of sugar cane striate mosaic virus in the Tungabhadra Project Area. E. Kondaiah and M. V. Nayudu. *Maharashtra Sugar,* 1980, **5**, (3), 45–46. – The title disease is described as affecting only the top 4–5 leaves of a cane plant in contrast to cane mosaic, which induces symptoms in all leaves. Both diseases were found in two varieties. Of a number of varieties examined, only two were found to be resistant to striate mosaic. Symptoms are mottling and formation of light yellow-green discontinuous stripes 2–3 mm long on the leaf blade and both sides of the midrib. In severe cases, the leaf becomes generally discoloured.

Sugar cane pests: their control measures. R. V. Sinha. *Maharashtra Sugar,* 1980, **5**, (3), 47, 49–51. – Possible means of controlling various cane insect pests are described.

Field screening of sugar cane varieties against scale insects. A. S. Patil, D. G. Hapase and B. P. Gajare. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, Ag.45-Ag.49. – Investigations showed that nine out of ten varieties infested with *Melanaspis glomerata* suffered weight loss by harvest time, the exception being MS 6806; this and MS 6813 were the only two not to suffer loss of sugar content and sugar yield, while MS 6813 showed only slight juice purity reduction. Comparison was made between the infested canes and uninfested ones from each variety.

CANE BREEDING AND VARIETIES

Development of sugar cane varieties and evaluation of crosses in Punjab. P.S. Dhillon. *Maharashtra Sugar,* 1979, **4,** (10), 79. – Some information is given on varieties released for commercial growing in Punjab, and clones that have shown promise in tests at Jullundur during 1978-79 are mentioned.

Sugar cane varietal situation in India. B. K. Tripathi. *Maharashtra Sugar,* 1979, **4,** (10), 81-82, 84-85, 87-88. The most widely grown varieties in each of the Indian cane-growing states are indicated, and lists given of varieties recommended for release. New varieties that have shown promise during 1976-77 are also listed.

Evaluating a new variety (N 11) in seed cane increase plots by means of a sample harvest method. R. S. Bond. *S. African Sugar J.,* 1979, **63,** 481–483. – The yield of N 11 cane was determined at seventeen sites adjacent to plots of N:Co 376 by a method developed by Bechet in which the cane stalk is assumed to be cylindrical. The values obtained were compared with results of selection trials before release of the variety and plotted, for each site, against the estimated potential yield of N:Co 376 cane. The regression coefficient was calculated from the data, and the slope of the regression line used to indicate varietal adaptability at different yield potentials. N 11 appeared to be a stable variety, but it is considered that the comparison should be extended into ratoon crops.

Study of yield and some of its components in 22 cane varieties. G. Galvez and M. Amador. *ATAC,* 1978, **37,** (6), 24–29 (*Spanish*). – A total of 22 varieties were grown in plots in a random block design, over three crops, and measurements made of cane yield, diameter, height, Brix and pol % cane, and yield of pol per hectare. The results were analysed statistically and estimates of variance in the factorial analysis are tabulated and discussed. There were significant differences between genotypes for all the characters, between the results for the three crops. The degree of genetic determination was much greater for Brix and stalk diameter than for height and pol % cane, and these two, especially Brix, offer much more reliable criteria for selection.

Florida's 1979 sugar cane census. G. Kidder and E. R. Rice. *Sugar y Azúcar,* 1979, **74,** (12), 44–45, 48. – The census shows that in 1979 CP 63–588 was the dominant variety for the fifth consecutive year, representing 39.9% of the total cane crop in Florida. CI 41–223, a variety representing 66.4% of all the cane grown in the state in 1970, has since steadily declined in importance to 8.7% in 1979 when it was third in rank. The second most widely grown variety in 1979 was CP 56–59, representing 10.5% of the total cane. Of the 44 varieties grown in Florida in 1979, 32 were grown on less than 1% of the area.

Sugar cane variety trials in Texas 1978–79 season. S. A. Reeves. *Research Cent. Tech. Rpt.* (Texas Agric. Expt. Sta.), 1979, (79-2), 63 pp. – Fifty tables of data are presented, covering sixteen trials at eight locations in the Lower Rio Grande valley. One plant crop and up to four ratoon crops were evaluated. About fifty varieties were tested. Of the new ones, CP 66–315 and CP 68–350, both early to mid-season varieties, gave promising results in terms of cane and sugar yield and were to be released in 1979–80, while L 61–49, N:Co 376 and Mex. 57–473, although giving good yields, exhibited characteristics that limited their consideration for commercial production. CP 44–101, CP 52–68, CP 57–614, L 60–25 and L 62–96 were among established varieties that presented some problems, which are discussed.

Varietal improvement in sugar cane. A review on varietal adaptability. B. K. Tripathi. *Maharashtra Sugar,* 1979, **4,** (12), 9, 11, 13–14. – Cane breeding in India is outlined and the distribution of major varieties (% of total area under cane) is shown for the period 1941–76. A list is given of varieties recommended for commercial cultivation in different states in 1977–78, and recent trends for assessment of varietal adaptability are outlined.

Suggestions for a national system for production of selected seed cane. B. Dantas. *Brasil Açuc.,* 1979, **94,** 192–198, 270–283 (*Portuguese*). – The recent legislation in Brazil governing seed cane standards and the large amount of such cane needed for the expansion of cane area for alcohol manufacture require adoption of a national system to coordinate production and maintenance of quality and hygiene. Breeding of varieties by Planalsucar is the basis of such a system with multiplication in private seed nurseries for distribution to commercial growers, and details are given of recommendations which include the establishment of field stations in each state to test the varieties and ensure that pests and diseases are not spread.

Induction of early maturing and high sugar mutants in sugar cane by gamma ray irradiation. C. C. Lo, P. C. Yang and Y. H. Hsieh. *Rpt. Taiwan Sugar Research Inst.,* 1979, (85), 1–11 (*Chinese*). – Irradiation of the mid-maturing variety F 160 with gamma-rays from ^{60}Co gave two mutants, one of which, 73-4082, was a consistently early maturer of higher sugar content than F 160 and gave 4% greater sugar yield, while its cane yield and disease resistance were about the same. The other mutant, 73–4078, also showed promise.

An observation on side shooting in certain sugar cane varieties in the Tungabhadra Project Area. E. Kondaiah. *Indian Sugar,* 1979, **29,** 447–448. – Sprouted and non-sprouted cane of three varieties was analysed. The extent of side shooting was 23.5% in Co 6806 and some 12% in Co 419 and Co 6415. The juice from the sprouted cane was of higher Brix, pol and purity than that from unsprouted cane in the first and last (early-maturing) varieties named, but was unchanged in Co 419 (a mid-late maturing variety).

An observation on side shooting in certain sugar cane varieties in the Tungabhadra Project Area. E. Kondaiah. *Maharashtra Sugar,* 1980, **5,** (3), 41, 43. – See preceding abstract.

SUGAR BEET AGRONOMY

Economic aspects of quality-improving agricultural practices. R. Merkes. *Die Zuckerrübe,* 1980, **29,** (1), 34–40 *(German).* – The economic effects of various practices are discussed, covering soil treatment, fertilization, varietal selection, drilling, plant protection and harvesting, and advice is given on how to achieve optimum conditions in each category.

Secondary effects of herbicides used in beet on soil microflora. Evaluation of the 1977 results. W. Verstraete, J. Stryckers, J. Cadron, M. van Himme and R. Bulcke. *Publ. Trimest. Inst. Belge Amél. Betterave,* 1979, **47,** 89–98 *(French, Dutch).* – Investigations of soil biomass, respiration, nitrification, ATP concentration and *p*-nitro-phenylphosphatase activity at two sites in 1977 showed that Metamitron, Pyrazon (Chloridazon), Ethofumesate and Phenmedipham all had an adverse effect on the parameters soon after they were applied; in sandy clay the effect was only short-lived, whereas in a sandy loam it persisted up to harvest. The herbicides had the following ranks in order of increasing effect. Phenmedipham < Ethofumesate < Pyrazon < Metamitron.

Timing of pesticide application critical to successful control. Anon. *The Sugarbeet Grower,* 1980, **18,** (1), 7. – Reference is made to the dramatic fall in beet yield resulting from failure to apply Temik nematicide on a number of acres of a farm that supplies beet to the Amalgamated Sugar Co. in the USA. A photograph clearly shows the difference between untreated beets and beets from rows that had been treated. A further problem took the form of large-scale weed growth that the stunted beets had been unable to prevent after early cultivation; the weeds then robbed the beets of available soil nutrients.

Insurance of sugar beet against hail – a necessity? W. C. von Kessel. *Die Zuckerrübe,* 1980, **29,** (2), 8-10, 12 *(German).* – The risk of loss through damage to beet by hailstorms is very much greater with modern growing methods based on planting to stand than previously. Application of herbicides to the soil considerably limits the chances of raising a new crop in June after complete destruction of the beet crop by hail, such as experienced in late May. Hence, under German conditions, the author considers insurance against hail damage necessary, but warns against acceptance of unsuitable terms. The question of whether hail-damaged plants can survive is discussed.

Pig weed control in sugar beet. F. Maykuhs and M. Manning. *Die Zuckerrübe,* 1980, **29,** (2), 14, 16 *(German).* – Trials against *Amaranthus retroflexus* are reported, in which tank mixes of Betanal + Goltix (3 $l.ha^{-1}$ + 4 $kg.ha^{-1}$) and Goltix + paraffin oil (5 $kg.ha^{-1}$ + 5 $l.ha^{-1}$) were successful at up to the 8-leaf stage and also controlled other troublesome weeds such as *Chenopodium album* (fat hen), *Polygonum convolvulus* (bindweed) and *Stellaria media* (chickweed). Care in spraying is needed because of their slight toxicity to beet.

More precise proportioning of nitrogen doses according to the N_{min} content of the soil. A. von Müller and D. Merkel. *Die Zuckerrübe,* 1980, **29,** (2), 22-23 *(German).* – The question of precise dosage of nitrogen on the basis of soil analysis for N_{min} content is discussed and guidelines are given for determining how much to apply.

Control of grasses and weeds. Anon. *Die Zuckerrube,* 1980, **29,** (2), 26-29 *(German).* – Recommendations are given on chemical control of a number of weeds, using both pre- and post-emergence herbicides. Miscibility with other herbicides, trace elements and pesticides is also indicated.

Herbicide trials at Wierthe in 1979. G. Ebers and R. D. Wüstemann. *Die Zuckerrübe,* 1980, **29,** (2), 30, 32-33 *(German).* – Trials with a number of herbicides at Wierthe in West Germany are reported.

Bolter control as a means of containing the weed beet problem: an interim report. P. Longden and K. Scott. *British Sugar Beet Rev.,* 1980, **48,** (1), 14-16. – It is stated that all bolters can produce seed if they flower and the ovules are fertilized with pollen from nearby plants (or, rarely, from the same plant) or from plants at a great distance that contribute to background pollen in the atmosphere, and provided there is sufficient time and suitable weather for the seeds to mature and become viable. The range of numbers of viable seeds a bolter can produce is considerable, from <10 to >2000; a major factor governing the extent of seed production is the date of flowering, late-flowering bolters possibly producing no viable seeds because there is insufficient time for ripening. The proportion of plants which bolt is a complex function of variety, seed crop environment and weather after sowing; the locality chosen for seed production can partly determine the bolting performance of a variety, although two counter-balancing factors play a role in this: (1) the extent to which young plants are induced to become reproductive by low temperatures during winter (vernalization); if there is insufficient cold, only the more bolting-susceptible section of the population will be vernalized and produce seed, so that, in effect, a more bolting-susceptible selection will have been made – "genetic drift" reported in the USA. Hence a suitable seed-growing area must have a winter sufficiently cold to vernalize the entire crop; the more bolting-resistant a variety, the greater is the danger of genetic drift. (2) If the seed crop ripens late in a cool autumn (when temperatures below 10°C are frequent), seed may be partially vernalized "on the straw". To be effective, methods of controlling bolters must prevent at least 95% of bolters producing seed; to date, only hand pulling has achieved this target – mechanization of the work has proved unsuccessful, mainly because the bolters snap off on hard or dry land, so that the bolters might just as well be cut (which is quicker and cheaper, although most cut plants branch out from side buds, and the laterals regrow to flower later, so that a single cut may be ineffective). Other experimental methods being investigated include use of non-selective herbicides and of an electrothermal device[1]. The problems associated with delay of sowing as a means of preventing vernalization are discussed.

[1] *I.S.J.,* 1981, **83,** 146.

CANE SUGAR MANUFACTURE

Development of colour in evaporation. E. Rubio. *Cuba-Azúcar,* 1979, (Oct./Dec.), 27–31 (*Spanish*). – The colour increase from clarified juice to pre-evaporated juice and to syrup was measured for juice processed at Pablo Noriega sugar factory in 1976 (when a normal pre-evaporator was used) and in 1979 (when the pre-evaporator was operated under 25 psi pressure) as well as for juice from Martínez Prieto sugar factory in 1979 (where a normal pre-evaporator was employed). The measurements showed a smaller increase after the pressure pre-evaporator at Pablo Noriega in 1979 than three years earlier, while the colour increase at the other factory was greater than both increases at Pablo Noriega.

Feasibility of collecting data on the continuous crystallizers of a sugar factory. S. Teijero Páez, P Padrón Rivero and R. Aguirre Chacón. *Contr. Cibernét. Automat.,* 1978, **12,** (4), 21–27; through *S.I.A.,* 1980, **42,** Abs. 80–13. – The typical Cuban crystallizer station at Espartaco factory is based on a series of troughs whose elements are fed water at ambient temperature (30–32°C) except in the last, where water at 55–60°C increases massecuite temperature from 40–45 to ≮ 53°C. The most important parameters of the process are discussed, the main perturbations affecting operation are indicated and suitable forms of instrumentation are considered with economic evaluation. Electrical sensors are the simplest to connect to a computer, but are expensive; signals from pneumatic sensors are preferably interfaced with point-to-point conversions, i.e. a pneumatic-electric converter is provided for each channel.

Efficient operation of heating and boiling equipment. S. K. Ghosh. *Maharashtra Sugar,* 1980, **5,** (3), 9, 11, 13–15, 17–20, 22–24. – Advice is given on operation of juice heaters, evaporators and vacuum pans and ancillary equipment.

Muddy juice purity – our observations. S. Kaliyamoorthy, R. Lokan, P. S. Krishnamirdam and P. Thangamuthu. *Maharashtra Sugar,* 1980, **5,** (3), 35–36. – Low purity of muddy juice entering a vacuum filter was attributed to an abnormally high silica content. Because of a high incidence of scale in the last evaporator effect, it was suspected that the silica was being dissolved during clarification, although clear juice colour was low and purity rise satisfactory.

The position of the sugar industry in Peru. W. Tentscher and E. Wittwer. *Zuckerind.,* 1980, **105,** 160–166 (*German*). – A survey is presented of the Peruvian cane sugar industry and of the difficulties facing it. Mention is made of non-centrifugal sugar manufacture, of by-products utilization and of tests conducted on ethanol production from molasses, which showed that only by increasing the area under cane by 42% and manufacturing alcohol direct from the cane would there be sufficient to provide a 20% alcohol mixture as motor fuel.

Use of stainless steel screens in continuous centrifugals. A case study. V. Sridharan, K. S. Rao and K. R. Das. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.1-E.8. – Because of the high cost and relatively short life of electro-formed nickel screens used in low-grade continuous centrifugals, a study was made of the possibility of using stainless steel screens. Results indicated a reduction in crystal breakage by comparison with the nickel screens, but also a lower sugar purity; however, the stainless steel screens had a longer working life. Further investigations are recommended to determine the effects of a number of other factors.

A simple mechanism for desuperheating process steam in a modern sugar plant. S. P. Mishra. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.9-E.13. – In the arrangement described, steam in the exhaust main from the 1st evaporator effect passes through a fine spray of condensate emitted by two atomizer nozzles at a pressure of 20 psig. The temperature of the steam is regulated by adjusting the quantity of spray by means of a manual valve.

Trial and use of aluminium tubes in pans and raw juice heaters. N. B. Masand. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.15-E.20. – The advantages of aluminium tubes over brass tubes in a raw juice heater and over steel tubes in a vacuum pan are discussed on the basis of experience at the author's sugar factory.

A new continuous centrifugal machine. K. S. M. Rao. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.21-E.28. – Details are given of a continuous centrifugal designed and fabricated in the workshops of India Sugars & Refineries Ltd. After successful trials with the machine as C-foreworker, two more centrifugals were built and operated as C-foreworker and -afterworker during the 1978-79 season. Their performances are discussed.

Use of a vertical screw conveyor for conveying massecuites. H. L. Verna, V. K. Rohatgi and A. Singh. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.29-E.33. – For transfer of massecuite from one crystallizer to another in a system converted to continuous from batch operation, a vertical screw conveyor was installed and tested. Results of the trial are reported, and the advantages of the system discussed.

A simple device for checking entrainment in a vapour cell. J. P. Gupta. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.35-E.38. – When the juice level in the vapour cell is too high, a float system operates a steam whistle and alerts the operator. Details are given of the system which has permitted elimination of entrainment since the vapour cell was installed.

Buoyancy not gravity force: the tool for future clarification process for plantation white sugar. B. B. Paul. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.39-E.40. Disadvantages of juice clarification by settling are discussed, and the merits of flotation clarification indicated by reference to use of the process for refinery liquor treatment.

Entrainment in a vacuum filter. A simple way to recover it. R. Lokan, P. S. Krishnamirdam and T. Balasubramani. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.41-E.44. – Entrainment of filtrate from rotary vacuum filters

to condensers can be prevented by installing a conventional entrainment separator from which filtrate can be diverted to a raw juice or sulphitation juice tank. Such a system is briefly described.

The essential use of traps in the sugar industry. R. M. Jawaharlal. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.45-E.47. — Information is given on types of steam trap available, together with advice on their installation.

A composition for reducing the pol and moisture in bagasse — Sushira. N. A. Ramaiah, S. K. Srivastava and L. P. Tewari. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, E.49-E.75. — Extensive trials with the surfactant, Sushira, are reported. Results obtained are in close agreement with those discussed earlier[1].

Phosphatation of unfiltered second carbonatation juice. Development of a new system of cane juice clarification for manufacture of superior quality sugar at reduced manufacturing costs. S. P. Mishra. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.1-M.9. — The process, described earlier[2] and tested on a laboratory, pilot plant and factory scale, was adopted by Kichha Sugar Co. Ltd. and operated on a full scale from February 1979. It has permitted production of high-quality sugar, reduction in process losses, decrease in cost of consumables and elimination of some of the problems associated with the double-carbonatation, double-sulphitation process. Details are given of performance and of teething problems and their solution.

Further observations on the total phenolic content of sugar cane and its quantitative behaviour during clarification. S. C. Sharma, P. C. Johary and G. S. C. Rao. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.11-M.21. Analysis of cane for total phenolic content (TPC) showed that younger tissue such as the epical meristem and buds contained more than older tissue, while basal internodes contained 41% less than top internodes and older leaves 24% less than younger leaves; nodal sections contained 49% more TPC than internodal sections, while the TPC in roots and dry leaves (which reach the factory as trash) was very high. As regards TPC elimination in processing, carbonatation was found to be the best form of juice treatment. The amount of lime added affected TPC removal, a pH of 6.8 in preliming proving better than pH 7.4 or 8.2 and giving approx. 36% TPC removal. Addition of phosphate to mixed juice promoted TPC removal, while pre-sulphitation of mixed juice before liming and sulphitation had little effect. TPC elimination was accompanied by a fall in juice colour.

Continuous juice sulphitation vessel. P. K. Singh. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.23-M.25. — In the system briefly described, juice is pre-sulphitated with gas recovered from the main sulphitation vessel and is then limed in a vessel placed above the sulphitation vessel which it enters via a sparger together with SO_2. The juice flows up to the top of a centrally located vessel occupying about half the height of the main vessel, and then spills over to flow down the space between the wall of the small vessel and that of an outer concentric vessel which is open at the bottom, so that the juice can then flow upwards into the main vessel.

New process to reduce sugar loss in press cake. S. S. Sirohi and J. K. Mehta. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.27-M.38. — See *I.S.J.*, 1980, **82,** 282.

Preliminary trials of continuous vertical crystallizers. K. S. Ramarao, K. Venkataratnam and O. B. Reddy. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.39-M.50. Trials with three vertical crystallizers are reported, in which a final molasses purity some two units lower than from air-cooled batch crystallizers was achieved. Teething troubles, proposed design modifications and advantages of the crystallizers are discussed.

Trial of defeco-melt-phosflotation process without sulphur. A. C. Chatterjee, A. F. Golandaj, S. R. Kalaswad and H. R. Apte. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.51-M.71. — Details are given of trials on defeco-melt-phosflotation (DMP) of raw sugar melt, double-cured *B*- and *C*-sugar melt and syrup. Comparison with sulphitation showed that DMLP was not as good in regard to colour reduction but was better in respect of inversion. The resultant white sugar was of high quality, while other advantages of DMP included reduced chemicals costs.

Some new concepts in designing of a continuous chemical reactor for liming and sulphitation of cane juices. S. P. Mishra. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.73-M.79. — A natural-circulation continuous sulphitation vessel is described which has permitted lower sulphur consumption and increased production of sugar of ISS 30 colour by comparison with previous systems at two sugar factories.

Inversion of juice in a quadruple-effect evaporator and other changes. B. B. Khochare. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India.* 1979, M.81-M.89. — After a brief examination of various physico-chemical changes occurring during evaporation, the author discusses inversion and its relationship to pH, temperature and retention time. Tables are given of inversion as a function of these parameters within given ranges for crushing rates in the range 800-1700 tcd.

Evaluation of sugar recovery loss due to extraneous matter delivered with cane in a factory. A. P. Gupta. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, M.91-M.101. — The abnormally high quantities of extraneous matter delivered with cane to factories in Haryana, Uttar Pradesh and Gujarat are indicated, and the adverse effect of trash on mill extraction, juice quality and sugar recovery is discussed. Optimum cutting of cane to minimize trash is described and an incentive scheme to promote the supply of clean cane is advocated.

Factory Performance Index (General). R. Lokan, P. S. Krishnamiradam and P. Thangamuthu. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, C.9-C.11. — The concept of the Factory Performance Index has been expanded to include capacity utilization, return on investment, crushing rate and efficiency. The resulting FPI (G) can, however, be calculated only after all the sugar produced in a given season has been sold and the financial return established.

A correction suggested to the present R.M.E. formula for taking into account the effect of variation in pol percent cane on mill extraction. C. M. Ugale. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India,* 1979, C.13-C. 19. See *I.S.J.*, 1980, **82,** 282.

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[1] Murugkar *et. al.*: *I.S.J.*, 1980, **82,** 156.
[2] *ibid.*, 1979, **81,** 85; 1981, **83,** 148.

LABORATORY STUDIES

Studies on colouring matter formation in juices and sugar. W. Kofold Nielsen, R. F. Madsen and B. Winstrom-Olsen. *Sucr. Belge*, 1980, **99**, 3–20 *(French)*. See *I.S.J.*, 1980, **82**, 383.

Quantitative determination of mono-, di- and trisaccharides by thin layer chromatography. R. Gauch, U. Leuenberger and E. Baumgartner. *J. Chromatogr.*, 1979, **174**, (1), 195–200; through *Anal. Abs.*, 1980, **38**, Abs. 2F20. – A method is described for the simultaneous determination of up to 11 sugars commonly encountered in food analysis. The chromatogram (on a pre-coated silica gel sheet) is developed three times in the same direction with 17:3 acetonitrile:water, then dipped in a solution containing diphenylamine, anilinium chloride, methanol and H_3PO_4. Determination is by scanning at 420 nm. Results are presented for a mixture of raffinose, melizitose, lactose, maltose, sucrose, galactose, dextrose, levulose, xylose, rhamnose and 2-deoxyribose.

Determination of glucose, fructose and sucrose in molasses by high-performance thin-layer chromatography. K. Y. Lee, D. Nurok and A. Zlatkis. *J. Chromatogr.*, 1979, **174**, (1), 187–193; through *Anal. Abs.*, 1980, **38**, (2), Abs. 2F21. – The molasses sample (200 nl) was applied to a Merck silica gel 60 HPTLC plate that had been treated with 0.2M K_2HPO_4 and then heated at 85°C for 45 min, and the chromatogram was developed for 6 cm with 8:2:1 ethyl acetate:pyridine:water. The plate was then dried, and similarly developed twice more before the compounds were located with an aniline:diphenylamine:H_3PO_4:acetone reagent[1], and the dried plate scanned at 395 nm. The three sugars could be determined with a coefficient of variation of 1.1% for sucrose, 2.2% for levulose and 4.3% for dextrose and with recoveries ranging from approx. 80% for levulose, approx. 87% for dextrose and approx. 91% for sucrose. The precision for both sucrose and levulose was better than that previously reported for conventional TLC.

Application of new methods of assessing the processing properties of beet with the aim of raising its utilization efficiency. M. Z. Khelemskii, S. N. Kalina and L. I. Chernyavskaya. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1978, **25**, 68–81 *(Russian)*. – The work carried out by Wieninger & Kubadinow and others in Austria on estimation of the melassigenic coefficient of beet is discussed, with reference made to the Venema automatic line for beet analysis based on the work. Reference is also made to work carried out by Reinefeld and others in West Germany and by Devillers *et al.* in France. Comparison is made between the results obtained by Silina & Slavgorodskaya[2] and Wieninger & Kubadinow[3], showing that the Austrian results were higher by an average of 0.5% on weight of beet, which for beet stored for a protracted period would be 1.5–2.0%. Hence, it is considered necessary to allow for a higher non-sugar content, and a formula is proposed which takes the form: $S_m = 0.1558K + 0.0623Na + 0.7888$ or $S_m = 0.0901 (K+Na) + 0.0517 (\alpha\text{-}N) + 0.9361$, where the non-sugars are expressed as meq per 100 g beet, and S_m is molasses sugar content % beet. Comparison between calculated and experimental values showed an average difference of ± 0.17% absolute on beet. No sharp differences were found between the chemical compositions of beet in Austria, France, the USSR and West Germany.

A modified method of determining individual groups of colouring matter in weakly coloured products of sugar manufacture. M. Saber Guda, I. F. Bugaenko and A. R. Sapronov. *Sakhar. Prom.*, 1980, (2), 37–38 *(Russian)*. For weakly coloured solutions of high sugar concentration it is suggested that spectrophotometric measurements be made twice, with active carbon treatment in between, at wavelengths corresponding to known colorant groups. The second measurement is then deducted from the first.

An improved iodometric method of determination of SO_2 in clarified cane juice and syrup. M. Prasad and J. K. Srivastava. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India*, 1979, C.25-C.31. – To prevent interference of colouring matter in the detection of the end-point when determining SO_2 iodometrically, titration was carried out at pH 1. Values obtained were much lower than with the unmodified method and differed from results of gravimetric determination by a maximum of 20 ppm in juice and by a maximum of 14 ppm in syrup.

Colorimetric method for the determination of reducing sugars in sugar. M. Prasad and S. K. Upadhyaya. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India*, 1979, C.37-C.47. – Details are given of a spectrophotometric method for determination of reducing sugars which is based on use of Fehling's A and B solutions and measurement of the optical density at 650 nm. Results are compared with values obtained by the ferricyanide method. Both methods are satisfactory at lower levels of reducing sugars (up to 300 ppm), but the new method remains satisfactory up to 500 ppm, whereas the ferricyanide method gives results that deviate considerably from the true values.

Relationship between viscosity and purity of supersaturated impure sucrose solutions. K. Wagnerowski. *Gaz. Cukr.*, 1980, **88**, 4-9 *(Polish)*. – Experiments to determine the relationship between viscosity and purity at various temperatures and Brix levels are reported and the results given in the form of graphs. An empirical equation was derived:

$$\eta_r = \eta_s - (\eta_s - \eta_m) \left(\frac{P_s - P_r}{P_s - P_m} \right)^{\gamma},$$

where η_r, η_s and η_m are, respectively, the viscosities of the impure sucrose solution, of pure sucrose solution and of molasses, P_r, P_s and P_m are the purities of the corresponding solutions, and γ is an exponent expressing non-linearity of the function $\eta_r(P)$ and governed by the non-sugars component but unaffected by concentration or temperature over the ranges 84-90°Bx and 50-85°C. From analyses of molasses samples from healthy beet taken from 14 different factories, γ was found to have a mean value of 0.485 ±0.055; for molasses from substandard beet the value averaged 0.223 ±0.166.

[1] Hansen: *I.S.J.*, 1976, **78**, 157.
[2] *ibid.*, 1974, **76**, 217.
[3] *ibid.*, 1972, **74**, 88.

BY-PRODUCTS

Motor fuel (ethanol) from annual and biennial plants such as sugar beet, manioc and sugar cane. H. Houben. *Zuckerind.*, 1980, **105**, 37–44 (*German*). – The energy balance and economics of producing ethanol from cane, beet, manioc and/or cassava as well as from cane and cassava in a combined process are examined, whereby it is shown that beet is not economically practical as raw material, in constrast to cane on its own or in combination with manioc or cassava.

High value utilization of molasses for fermentative production of L-lysine. J. S. I. Wang. *Taiwan Sugar*, 1979, **26**, 155–160. – A pilot plant for lysine production from cane molasses, using a mutant isolated from glutamic acid-producing bacteria, is described. Feed trials on pigs fed rations containing 0.2% lysine showed that the lysine could replace 2% of the protein without having any adverse effect.

An analogue computer used in a bagasse digesting system. F. M. Chen. *Taiwan Sugar*, 1979, **26**, 166–169. An experiment, involving use of an analogue computer to optimize the ratio between the amount of alkali added and the quantity of bagasse fed to the digester, is briefly described. Results showed that the computer permitted greater stability in the Kappa number and hence in the bleaching and pulping processes while significantly reducing chemicals consumption and labour requirements.

Biochemical indices related to lipid metabolism in grazing cows with different supplements. E. Margolles and R. García *V. Cuban J. Agric. Sci.*, 1979, **13**, 121–126. In investigations to determine the possible effect of three different feed supplements, viz. forage, silage and molasses + 4% urea, on biochemical indices related to lipid metabolism in lactating cows, only molasses + urea caused any significant decrease in the total lipids content; it also gave the lowest supplemented milk yield (which was, however, greater than with the control diet without supplement). There were no significant differences between the various diets as regards milk quality.

The effect of formaldehyde additives and sodium sulphite on the performance of pigs fed final molasses diets. M. Castro, A. Elías and R. J. Alvarez. *Cuban J. Agric. Sci.*, 1979, **13**, 143–148. – While diets containing high levels of molasses have given favourable results when fed to pigs, their high viscosity makes them difficult to use, while dilution with water could cause losses through fermentation. Tests were carried out with diets containing 63.38% molasses diluted 2:1 with water, with 0.25 ml formaldehyde, 1 g sodium sulphite or formaldehyde + sodium sulphite in the same quantities per kg diet added as preservatives. While results indicated no beneficial effect of the preservatives on performance and no economic advantages, the fact that they had no adverse effect could be significant as regards mechanization of pig feeding.

Preliminary trail on the utilization of filter cake mud for chicken fattening. R. S. Ibáñez and C. T. González. *Cuban J. Agric. Sci.*, 1979, **13**, 163–172. – All or some of the raw sugar included (up to 50% as dry matter) in diets fed to 1-day-old chicks was replaced with filter cake of stated composition. Results showed that, up to 56 days, the weight gain, consumption and feed efficiency were greater where no filter cake was included; moreover, filter cake at the two highest levels (37.5% and 50% as dry matter) caused high mortalities, and substantial changes in the pH of different sections of the digestive apparatus were attributed to filter cake. However, in view of the low cost of filter cake and the reasonable results obtained with 1.5% inclusion, this level could be the subject of further investigations, while species other than those tested could have lower requirements and hence be fed low levels of filter cake.

Effect of organic acids on the preservation of bagasse. H. L. Cheng and H. C. Huang. *K'o Hsueh Fa Chan Yueh K'an* (Taiwan), 1976, **4**, (1), 2098–2103; through *S.I.A.*, 1980, **42**, Abs. 80–76. – Samples of bulk bagasse were stored for six months on concrete under polyethylene, the ambient temperature increasing from 15 to 29°C. The bagasse was (a) untreated, loose or baled in darkness or daylight, (b) unbaled, treated with 0.5% propionic, acetic or formic acid, (c) unbaled and treated with 1% of these acids. After six days, microbial activity had heated the samples to (a) 55°C, (b) 44, 52, 54°C, respectively, (c) 18, 20, 22°C, respectively; after 30 days, all samples were within the range 24–27°C, but their microbial counts varied from 3×10^6 per g for treatment with 1% propionic acid to $(2.5\text{–}4.2) \times 10^8$ per g for (a). After 180 days, the counts varied from 1.1×10^9 to 4.5×10^{10} per g, 1% propionic acid being the only treatment for which the decrease consistently exceeded an order of magnitude; when boards were made from the stored samples, this treatment gave boards which were marginally the whitest and strongest.

Molasses as feed for ruminants. A. P. Deshmukh. *Maharashtra Sugar*, 1980, **5**, (3), 37, 39–40. – The use of cane molasses as animal fodder and the form in which it is available are discussed.

Commercial manufacture of citric acid by fermentation. VI. Effect of clarification of saccharine materials on citric acid production by *Aspergillus niger*. P. K. Agrawal, C. S. Bhatt and L. Viswanathan. *Proc. 43rd Ann. Conv. Sugar Tech. Assoc. India*, 1979, G.21-G.37. – In a study of citric acid fermentation of various molasses, gur and cane juice, the last gave maximum yield of total titratable acids (expressed as citric acid). Clarification with various chemicals and by ion exchange was studied. The effects varied with raw material, best results being given by cation and anion exchange of cane juice, viz. a maximum yield of 48.36 $mg.ml^{-1}$ compared with 16.9 $mg.ml^{-1}$ without treatment.

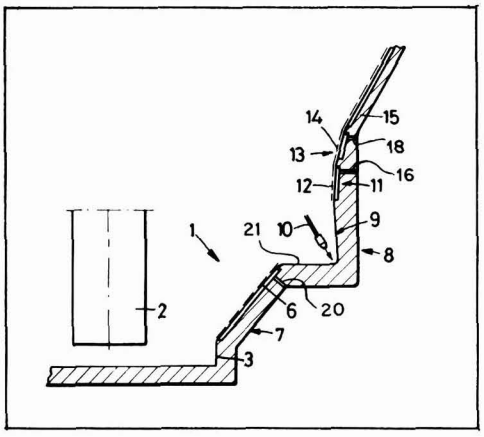
Alcohol: Usina São Martinho makes 1 million litres/day. Anon. *Brasil Açuc.*, 1979, **94**, 393-400 *(Portuguese)*. An illustrated account is given of the Brazilian sugar factory of the above title which crushes 24,000 tonnes of cane per day and produces 1,000,000 litres of alcohol daily from the molasses.

PATENTS

UNITED STATES

Continuous centrifugal. W. Dietzel, of Braunschweig, Germany, *assr.* Braunschweigische Maschinenbauanstalt. **4,131,482.** April 25, 1977; December 26, 1978.

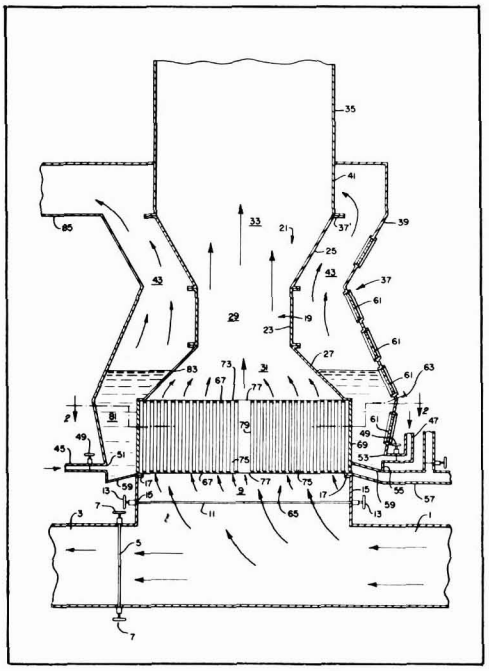
Massecuite is delivered by inlet pipe 2 into the acceleration cup 3 of the continuous centrifugal 1. It passes onto a screen 6 which allows separation of crystals and mother liquor in the pre-separation zone 7 and the crystals, carrying only a thin layer of mother liquor, are delivered into the zone 8 where they are treated with wash liquid through nozzle 10. The interior wall 9 of zone 8 may be vertical or inclined inwards to retain the crystals for adequate mixing with the wash liquid before passing over screens 12 and 14 which form intermediate and separation zones 11, 13, respectively.



Mother liquor diluted by wash liquid passes outside the basket through ducts 16, 18 and the washed crystals pass upwards and outwards on the third separation stage 15 of the centrifugal from which they are discharged at the top.

(Pre-) Evaporator. A. J. Morales, of Coral Gables, FL, USA. **4,131,507.** February 15, 1977; December 26, 1978.

Furnace combustion gases are admitted through duct 1 and, by means of doors 5, 11 operated by hand wheels 7, 13, all or part of the gases may pass through exit duct 3 or through area 9 which leads to a heat exchange calandria and a further exit duct 33 by way of the zones 31 and 29 which form an "hourglass" contriction. The calandria is formed by tube plates 67 and tubes 75 and permits the transfer of heat to cane juice in the chamber surrounding the tubes.



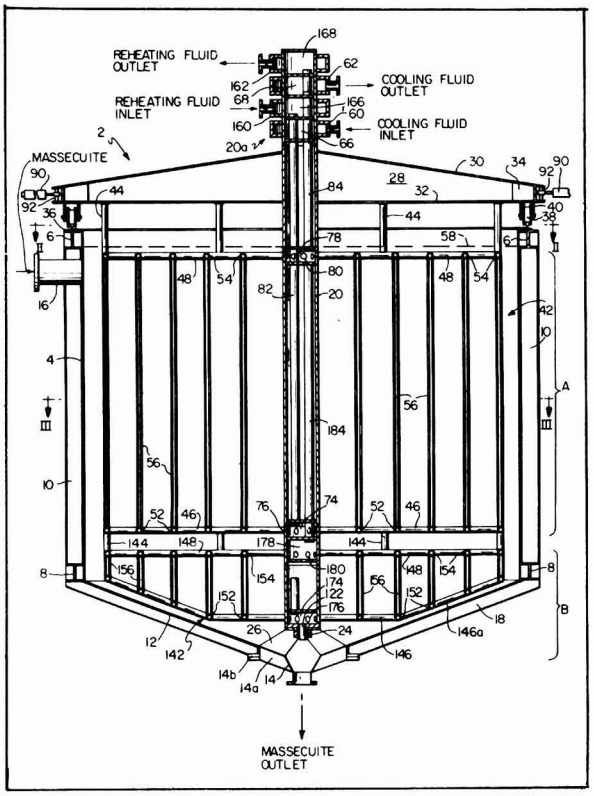
This connects with the chamber of variable annular section formed by wall 39 which generally follows the contours of zones 31, 29 and 33 and which is provided with sight-glasses 61. Juice enters through feed pipes 45 and 47 under the control of valves 49 and is heated by the furnace gases before being carried via duct 85 to the main evaporator. A pipe 57 is provided so that the juice compartment may be drained.

Crystallizer. J. C. V. Ducasse and J. Bouvet, *assrs.* Unice Machine Company, of San Francisco, CA, USA. **4,133,375.** January 28, 1977; January 9, 1979.

The crystallizer 2 comprises an outer cylindrical shell 4 with a conical bottom 12 having a central outlet 14. The shell is reinforced by horizontal channels 6, 8, and vertical channels 10 and the bottom by radial channels 18. A hollow central shaft 20 is supported within the shell with a lower stub axle located in guide bearing 24, itself supported by brackets 26. The shaft is fixed to a dome 28 comprising a conical cover 30 and horizontal plate 32 joined by outer channel 34. The rim of plate 32 is held apart from a circular rail 36 above channel 6 by a number of wheels 38 such that the dome and shaft 20 can rotate. This rotation may be achieved by means of a hydraulic ram system 90, 92 as shown or by any other suitable system.

Two heat exchange systems 42, 142 are supported by the dome; the upper one 42 is supported by vertical brackets 44 and comprises a number of radial horizontal tubes 48, 46 linked by chord tubes 54, 52 and vertical rectangular ducts 56. Similar brackets 144 support the lower system 142 which comprises radial tubes 148, 146 joined by chord tubes 154, 152 and ducts 156. The outer ends 146a of tubes 146 are bent upwards, however, to follow the contour of the bottom 12. At the

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 specification are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).



top of shaft 20 are chambers 168, 68, 160 and 60 formed by horizontal partitions; they communicate by means of internal tubes within shaft 20 with chambers 78, 74, 178 and 174. Reheating fluid (steam or hot water) admitted to chamber 166 passes down through an internal tube to chamber 174, through holes 176 in shaft 20 into tubes 146 and via tubes 152 and ducts 156 to tubes 148, back through holes 180 into chamber 178 and so via internal tube 184 to chamber 168. Similarly, cooling water circulates from chamber 66 through heat exchange system 42 and returns to chamber 68. Thus massecuite entering the shell through inlet 16 is uniformly cooled by the upper system and then reheated by the lower system before discharge.

Separation of sugars from mixtures. S. A. Barker, P. J. Somers and R. R. Woodbury, of Birmingham, England, assrs. Imperial Chemical Industries Ltd. **4,113,696.** May 24, 1977; January 9, 1979. – A mixture of sugars (glucose, fructose) and oxyanions (borate, germanate) in solution, produced during a process for converting an aldose (glucose) to a ketose (fructose) in the presence of the oxyanion, is brought into contact with (A) a (nuclearly carboxylated or sulphonated cross-linked) cation exchange resin having on it divalent cationic counter ions (Ca^{++}) mixed with H^+ ions or (B) a cation exchange resin having monovalent cationic counter ions on it of which a minor proportion are H^+ (the remainder being Na^+) or (C) first a cation exchange resin having all or mostly H^+ counter ions and then an anion exchange resin (a quaternary ammonium resin with a cross-linked matrix) having on it mono- or divalent anionic counter ions [carboxylic acid anions (formate, acetate or succinate ions)]. The sugars are separated into fractions e.g. by elution with water.

Centrifugal basket screen. A. Mercier, of La Madeleine, France, *assr.* Fives-Cail Babcock. **4,133,770.** November 3, 1977; January 9, 1979. – See UK Patent 1,548,523[1].

Purifying waste water. H. Skogman and L. Huss, *assrs.* Svenska Sockerfabriks AB., of Malmö, Sweden. **4,134,830.** August 18, 1977; January 16, 1979. – Water rich in carbohydrates or proteins is (a) subjected to an anaerobic fermentation where it is treated with methane-producing organisms whereby substantial amounts of methane gas are generated and a first sludge-bearing water is produced. The gas is collected and led off while the sludge-bearing water is separated to give a sludge concentrate and a first aqueous effluent. The sludge concentrate is partly discharged and part returned to the anaerobic fermentation while the effluent is subjected to an aerobic fermentation to give a second sludge-bearing water. This is separated into a second sludge concentrate and a purified water. Part of the second sludge concentrate is returned to the aerobic fermentation and the remainder to the anaerobic fermentation. Where the original waste water is rich in proteins ammonium ions are formed in the anaerobic fermentation and these are removed from the effluent by treatment with alkali (to pH 9–11) and the ammonia released is driven off by blowing air through. Alternatively the effluent may be passed through a (Na^+-charged) cation exchanger.

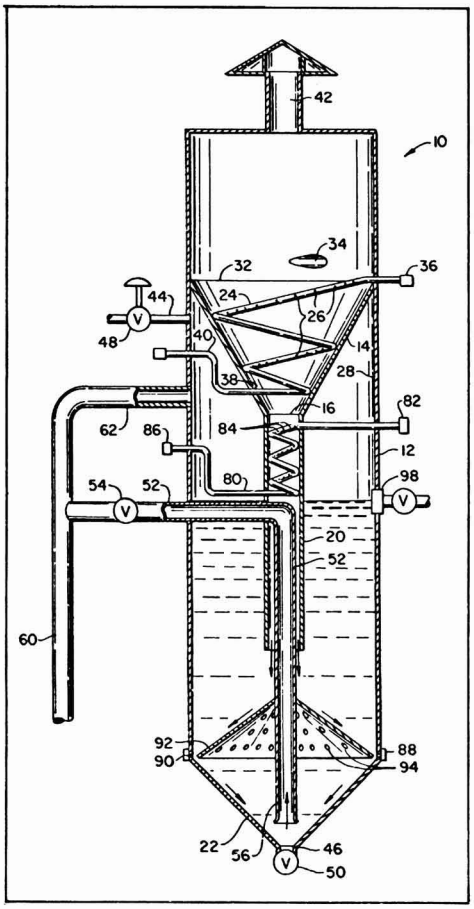
Drying beet pulp. M. Bosnjak, of Denver, CO, USA, *assr.* Buttes Gas & Oil Co. **4,135,309.** July 11, 1977; January 23, 1979. – Pressed beet pulp is (preheated and) dried (with agitation) in heat exchange relation with a heating medium (steam) [in an indirectly heated dryer (a steam-jacketed dryer)] to vaporize a substantial proportion of the water present while keeping the vapours produced and the heating medium separate. Dust entrained in the vapour is separated (centrifugally) and heat stripped from the dust-free vapour.

Treatment of cane juice. J. A. Casey and I. E. Rojas. **4,135,946.** February 3, 1978; January 23, 1979.

The tower 10 is basically similar to that described in US Patent 3,963,513[1] with juice admitted tangentially through port 34 and flowing along the inner surface of cone 14 while additive material such as a lime or flocculant solution is supplied through holes 26 in the flexible pipe 24. The treated juice passes into the axial pipe 20 and is treated with a coagulant through the perforations 84 in a spiral pipe 80.

The juice is directed over dispersion cone 92 towards the tower wall and then passes along the bottom cone surfaces 22 to the bottom of tube 56 up which it rises, passing into pipe 52, through valve 54 and into 60, flow being assisted by the siphon effect. The movement

[1] *I.S.J.*, 1981, **83**, 189.
[2] *ibid.*, 1979, **81**, 284.

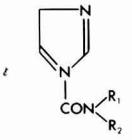


is, however, gentle enough that particles of coagulated impurities are not broken up. The valve 54 is adjusted to maintain juice level at such a point that floating debris such as bagacillo may be removed through outlet 98.

Process for preparing glucose isomerase using *Streptomyces glaucescens* mutants. P. Weber, of Greifensee, Switzerland, *assr.* Givaudan Corporation. **4,137,126.** November 14, 1977; January 30, 1979. – The enzyme is produced by cultivating (at 25 – 40°C and pH 5.5 – 7.5) a mutant of *S. glaucescens* NRRL B-2900 (NRRL 8071, 8072, 8073 or 8074), having no or practically no intracellular tyrosinase activity, in a nutrient medium containing sources of assimilable C and N. Xylose or a polysaccharide degradable to xylose is used as an induction agent. The enzyme is then isolated.

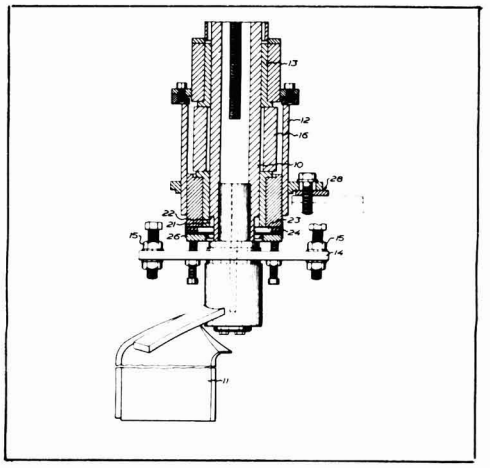
Glucose isomerization under expanded bed conditions. W. H. McMullen and W. Carasik, *assrs.* Novo Laboratories Inc., of Wilton, CT, USA. **4,138,290.** April 22, 1976; February 6, 1979. – A 30 – 55% w/w glucose syrup is passed at isomerizing temperature and pH up through at least one bed of a cell mass in particulate form of glucose isomerase preparation having (an activity >100 IGIC units per gram and) (containing 5 – 20% of finely divided Al_2O_3 and) a uniform size of 150 – 2500 μm, at a superficial linear velocity for the syrup of 0.5 – 1.5 $m.hr^{-1}$, the velocity and particle size being inversely related to create a bed expansion of 5 – 100% and plug flow of the syrup through the bed whereby conversion to at least 40% fructose is achieved. The isomerization is continued until the unit activity of the enzyme has declined to 25% of its initial level, the flow rate decreasing as enzyme activity decreases. The life of the bed may be extended by intermittent or continous addition of fresh enzyme.

Regulating plant growth. L. G. Copping and J. F. Garrod, of Nottingham, England, *assrs.* The Boots Co. Ltd. **4,139,365.** March 31, 1977; February 13, 1979. – Growth of sugar cane is regulated and the yield increased by applying to it (2 – 8 weeks before harvest) a suitable amount (2 – 8 $kg.ha^{-1}$) of a compound of the formula



where R_1 is a C_1 – C_{10} alkyl, a C_3 – C_5 alkenyl or an optionally substituted phenyl or benzyl group having 1 – 4 substituents which may be halo, C_1 – C_2 alkoxy, C_1 – C_4 alkyl, trihalomethyl or cyano, and R_2 is a C_1 – C_{10} alkyl, C_3 – C_5 alkenyl or an optionally substituted phenyl, benzyl, 2-phenylethyl, phenoxymethyl or 2-phenoxyethyl, where the phenyl nucleus has 1 – 4 substituents which may be halo, C_1 – C_2 alkoxy, C_1 – C_4 alkyl, trihalomethyl or cyano [R_1 is C_1 – C_5 alkyl and R_2 is a benzyl or phenoxyethyl with 1 – 3 substituents which are all halo or methyl or a combination of these (1-N-2-phenoxyethyl-N-propyl carbamoyl imidazole or 1-N-2,4-dichlorobenzyl-N-*iso*-propylcarbamoyl imidazole)].

Locking device for a centrifugal plough. I. H. Saxne, of Hässleholm, Sweden, *assr.* Ingenjorsfirman Nils Weibull AB. **4,140,269.** August 2, 1977; February 20, 1979.



The shaft 10 which carries the plough11 is supported by bearing 12 provided with the lining 13. The shaft is able to move relative to the bearing by means of hydraulic cylinders governing radial and axial movement. The radial cylinder acts on an arm which passes through an opening in bearing 12 and engages with ring 16. This carries wedges which fit into longitudinal grooves in the shaft 10 so that the latter can move up and down under the action of the second cylinder. The grooves are provided at the lower end with an inclined ramp so that they form a continuous surface from the outer diameter of the shaft to the smaller inner diameter of the bottom of the groove.

The bottom of the shaft has two recesses 21 cut away, the inner surface forming a chord of the circular section of the shaft. At the bottom of the bearing 12 are two diametrically opposed holes covered by plates 26 and housing pins 23 which are held against the inner chord surfaces of recesses 21 by springs 24 in the form of rubber blocks. If hydraulic power should fail while the plough is in its raised position, the shaft descent would be limited to the distance whereby the pins 23 would be engaged by the upper surfaces 22 of the recesses 21. When the shaft is rotated, however, the ends of the pins follow the chord surface so that the springs are compressed and the pins retract in the holes until their ends are at the surface of the shaft. At this position the shaft can move axially and, since the grooves in the shaft are located directly above, the pins are released down the ramp surfaces into the grooves in the shaft. In this way the shaft is prevented from rotating when moving axially and prevented from moving axially when rotating, each of which could cause damage to the centrifugal were it to occur during operation.

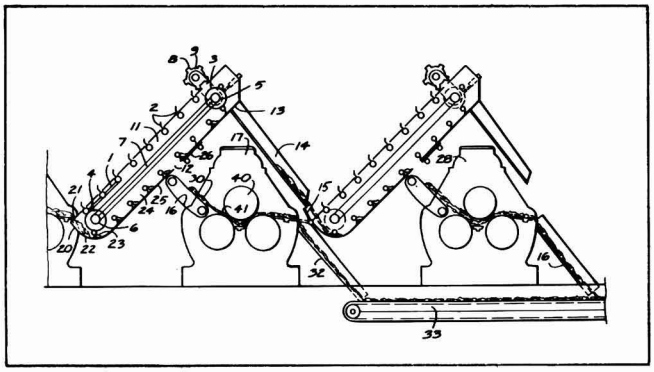
Treatment of crude sugar juices by ion exchange. K. Popper, of Willits, CA, USA. **4,140,541.** March 25, 1977; February 20, 1979. – Raw beet juice containing K^+ ions and large particulate matter is filtered and passed through a mixed bed of cation and anion exchange resins charged with Ca^{++} and OH^- ions, whereby the K^+ ions are removed and Ca precipitates are formed in the juice. The ion exchange resins are held within the ion exchange zone without plugging by maintaining a fluidized bed of constraining beads having a density less than that of water above and directly in communication with the ion exchange resins, the size of the beads being such as to permit passage of the Ca precipitates while rejecting passage of the resins. The latter are regenerated with $CaSO_3$, $Mg(OH)_2$ or $CaCO_3$.

Immobilizing glucose isomerase. S. Enokizono and S. Ushiro, *assrs.* CPC International Inc., of Englewood Cliffs, NJ USA. **4,144,127.** March 23, 1977; March 13, 1979. – A glucose isomerase is immobilized by bringing an aqueous solution of the enzyme into contact with colloidal silica [the silica gelatinized (and treated with a bifunctional agent)] and the product solidified by freezing to between $-10°$ and $-30°C$, thawing, and separating the solid silica on which the isomerase is absorbed. The solid is in the form of granules or flakes having a particle size of 20- to 100-mesh.

Method for seeding supersaturated sugar solution to effect crystallization. R. F. Madsen, E. Knovl, G. R. Moller and W. K. Nielsen, of Nakskov, Denmark, *assrs.* A/S De Danske Sukkerfabrikker. **4,145,230.** May 20, 1977; March 20, 1979. – To a supersaturated sugar solution is added a suspension of finely milled sugar in a liquid (a polyethylene glycol, a polypropylene glycol) which is wholly or partly soluble in water, which does not significantly dissolve sugar crystals, and which has a boiling point higher than the temperature of the sugar solution to be crystallized. The suspension (produced in a ball mill with steel balls) has a viscosity sufficiently low to permit its spread through the sugar solution and sufficiently high to provide stability when subjected to slow flowing movement.

Cane mill feeding. A. R. Mayo, of Clewiston, FL, USA. **4,147,557.** February 3, 1978; April 3, 1979.

The intermediate carriers between the mills of a tandem comprise stationary housings 11 containing driven rake conveyors 2. Bagasse enters each housing through opening 21 and is carried upwards along the bottom inclined surface 25 towards openings 12 and 13, which extend across the housing and are of a width corresponding to that of the mill rollers. A plate 26 is provided which can be adjusted to close all or part of gap 12 whereby all the bagasse or none is fed to mill 17 or the amounts passing through gaps 12 and 13 are equal. Alternatively, the plate may be recipro-

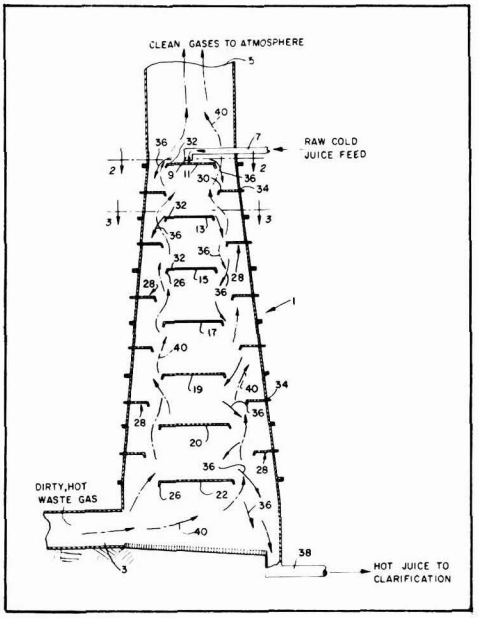


cated in relation to the rakes passing over the gap 12 whereby the bagasse carried by one rake is permitted to fall through while the bagasse carried by the next rake is carried up to gap 13. The bagasse falling through gap 12 passes onto the feeder conveyor 16 where a mat is formed which enters the feed inlet 41 of the mill 17.

Bagasse discharged through gap 13 falls into chute 14 and so into the carrier which delivers it to the feed of the mill 28. From this it is discharged on chute 16 to conveyor 33. Bagasse which has passed through mill 17 is either discharged onto chute 32 and so to conveyor 33 or, depending on the position of flap 15, may be directed into the inlet of the intermediate carrier feeding mill 28. Thus, feed to mill 17 may be varied between all or none of the bagasse entering the housing 11, as may be the feed to mill 28. Similar arrangements along the tandem allow considerable flexibility in feeding of individual mills to achieve optimum operation.

Pollution control and juice heating. A. J. Morales, of Coral Gables, FL, USA. **4,149,901.** October 6, 1977; April 17, 1979.

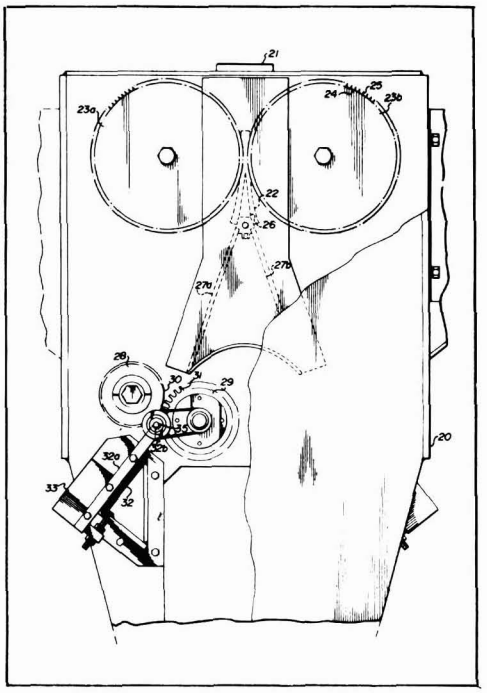
The smoke stack 1 is fed at its bottom end with dirty, hot waste gases from the boilers of a sugar factory while cold raw juice is distributed from a feed line 7 through an outlet 9 onto a series of baffles 11, 13, 15, 17, 19, 20 and 22. The baffles are alternately of circular and rectangular shape to provide better cascading and mixing.



Mounted on the inner surface of the tower wall is a series of annular baffles 28, each with a downward directing lip which also aids mixing. The juice flows from pipe 7 and cascades from one baffle to the next below and eventually flows from the smoke stack through exit pipe 38. The hot gases pass upwards through the stack, mixing with the cascading juice and are eventually discharged through the top 5 to atmosphere. During this passage, the gases are cleaned and cooled, while the raw juice is heated and charged with CO_2 from the gases.

Cane processing equipment. B. Vukelic, of Windsor, Ont., Canada. **4,151,004.** October 17, 1977; April 24, 1979.

In the cane separation process whereby stalks are split by a knife 26 onto which they are drawn by rollers 23a, 23b from hopper 21, the half-stalks are flattened between rollers 28 and 29 and the pith separated from the rind by the teeth 31 of the roller 29. A deflector plate is used to aid separation of the pith but the latter tends to accumulate as the edge loses its sharpness. This causes blockages which require the machine to be stopped so that it can be cleared. In order to avoid this the deflector plate 32 is provided with a rotating deflector roller 35 which has a series of teeth or grooves along its length slanted so as to deflect the rind and pith in the correct paths and to cut, break up or remove



fibrous material which might otherwise be caught on the leading edge of the plate.

Iron-containing cell mass glucose isomerase preparation. T. K. Nielsen, W. Carasik, L. E. Zittan and K. Gibson, *assrs.* Novo Industri A/S., of Bagsvaerd, Denmark. **4,152,211.** August 23, 1977; May 1, 1979. A cell-mass particulate form of glucose isomerase is activated by admixing with the enzyme a solid, non-toxic, water-soluble iron salt (ferric ammonium citrate, ferric sulphate, ferric chloride, ferric citrate, ferric pyrophosphate, ferric nitrate, ferrous sulphate, ferrous lactate, ferrous citrate or ferrous acetate) in sufficient amount to give 0.05 – 2.0% w/w of Fe. In addition, 0.5 – 3.0% w/w of MgO may be added on dry weight of glucose isomerase, and also 2 – 15% of glucose monohydrate.

Cane harvesters. D. J. Quick, of Bundaberg, Australia, *assr.* Massey-Ferguson Services N.V. (A) **4,152,883.** April 7, 1977; May 8, 1979. (B) **4,154,047.** July 29, 1977; May 15, 1979. (C) **4,155,602.** March 24, 1977; May 22, 1979.

Sucrose derivatives. K. S. Mufti and R. A. Khan, *assrs.* Tate & Lyle Ltd., of London, England. **4,156,776.** May 25, 1977; May 29, 1979. – 4, 6-O-*iso*-propylidene sucrose is prepared by treating sucrose with 2,2-dimethoxypropane in N,N-dimethylformamide, in the presence of *p*-toluene sulphonic acid at room temperture. The product is isolated in the form of its hexa-acetate or hexa-benzoate by treatment with acetic acid or benzoyl chloride, respectively, in pyridine, and can be recovered by de-esterification.

BREVITIES

Corrigendum. — In the article "Evaluation of raw sugar quality and refining operations", which appears in our January 1981 issue, the equation on line 54 of p. 9 is incorrect and should read: $Y = 1.54P + 0.12V + 0.54M - 1.40A - 55.12$.

CITS Scientific Committee Meeting. — Between its general assemblies, held at 4-yearly intervals, members of the Scientific Committee hold informal meetings to discuss progress in various aspects of beet sugar manufacture. Such a meeting has been held in Norwich, England, during June 1 — 3, with 22 members taking part, as well as 24 of their colleagues. The group toured the British Sugar Corporation Research Laboratories at Colney, near Norwich.

Juba sugar project. — "Sonkorta Juba" is the title of a new film about the Juba sugar project in Somalia which received its première on May 11 in the presence of H.E. the Ambassador of Somalia and the Chairman of Booker McConnell Ltd., Mr. Michael Caine. The project, valued at $188 million, is Somalia's largest development scheme and the film follows its progress from its beginnings in 1975 to the first production of sugar by the factory in July 1980 and its formal inauguration on September 3. Booker Agriculture International undertook the initial feasibility and planning studies and has subsequently been responsible for implementation and on-going management. Finance was provided by the Abu Dhabi Emirate, the Saudi Fund for Development and the OPEC Special Fund. The project involved the development of 8000 hectares of irrigated cane, erection of a 3360 t.c.d. white sugar factory and the necessary infrastructure for an area previously only sparsely populated. The factory was designed, supplied and commissioned by Fletcher and Stewart Ltd.

New Indian sugar factories[1]. — A Rs. 80,000,000 sugar factory, with a crushing capacity of 1200 t.c.d., is to be set up at Thoubal, about 40 km from Imphal. About 6000 acres of land in the Manipur central district will be brought under cane to provide a supply to feed the factory. Two new mills, one at Gurdaspur and the other at Zira, have been set up by the Punjab Khand Udyog Ltd. Each cost Rs. 70,000,000 and will crush 900 — 1000 tonnes of cane per day, supplied from areas of 15 —18,000 acres.

Fiji disease in Australia[2]. — Fiji disease has been found in N:Co 139 cane on two farms in the Mackay district of Queensland, according to the Bureau of Sugar Experiment Stations. The disease is not expected to affect overall Australian sugar production, although the variety affected is one grown on about 70% of the cane area of the Mackay district.

Mauritius bulk sugar terminal[3]. — Mauritius now boasts the world's third largest mechanical sugar loading terminal, with a storage capacity of 35,000 tonnes. This has significantly speeded up loading operations by enabling a 14,000-tonne cargo to be taken on in just one day, representing a dramatic improvement on the 1100 tonnes per day previously achieved. In the past sugar has been loaded onto freighters via lighters but now a travelling shiploader drops the cargo directly into ships' holds. The $40 million complex, which was opened last November, is a joint public and private venture in which the government has a 58% share.

Italian sugar factory closures[4]. — The Eridania Group has announced that it is to close its white sugar factories at Ceggia (3000 tonnes daily slice) and Polesella (4500 tonnes) before the next campaign.

Record Florida sugar crop[5]. — Florida's sugar industry produced a record crop of 1,121,490 short tons of raw sugar during the 1980/81 season, exceeding the previous record of 1975/76 by more than 60,000 tons.

Taiwan sugar exports, 1980[6]

	1980	1979	1978
	tonnes, raw value		
Hong Kong	678	10,225	1,909
Indonesia	13,153	0	10,870
Japan	156,864	121,849	165,635
Korea, South	202,363	205,654	136,534
Malaysia	12,455	0	0
Saudia Arabia	23,914	17,936	10,870
USA	0	25,733	51,476
Other countries	423	605	678
	409,850	382,002	377,972

Hawaii sugar production fall[7]. — Sugar production from the 1980 crop in Hawaii was the lowest for more than ten years at 1,023,232 short tons, raw value, as against 1,059,737 tons in 1979.

US alcohol/HFCS project abandoned[8]. — The Great Western Sugar Co. has said it has abandoned plans to construct a fuel alcohol and/or HFCS facility at Reserve, Louisiana. A combination of adverse economic and political factors has persuaded those in control of the raw sugar factory against the project, at least for the time being. Critical construction cost figures, originally provided by engineering consultants, apparently turned out too low, which undermined the basic economic viability of the facility, and the Reagan administration's announced delay in some synthetic fuels loans while they undergo closer scrutiny contributed to the decision.

South African cane movement ban as a pest control measure[9]. The Council of the South African Sugar Association agreed unanimously in January to ban movement of cane from areas presently infested with the Eldana borer to areas that are free of the pest. The move has been welcomed by growers in the Natal Midlands who had feared introduction of Eldana from the coastal areas where it has been the cause of considerable loss. A line has been drawn across which cane must not pass; it runs north to south and closely follows the 16°C July mean daily temperature isotherm. In the meantime, entomologists are travelling in other countries seeking natural predators which might be bred and introduced into South Africa in order to establish biological control.

Ethiopian sugar expansion[10]. — The Ethiopian Sugar Corporation plans a major expansion of the industry, including four new schemes — at Finchaa, at Angete-Balhamo and Maro-Galla (both in the Awash Valley) and at Gojeb. In addition, the operations at Wonji, Shoa and Metahara are to be expanded. The extra output is necessary in the short term to keep production ahead of consumption. The latter is currently advancing at over 6% p.a. and has virtually eliminated exports which averaged 10-20,000 tonnes in the 1970's, mostly to Djibouti. The present capacity is 144,000 tonnes of sugar per year and expansion of the existing facilities will add a further 53,000 tonnes and ensure self-sufficiency. If the 75,000 tonnes per year Finchaa project comes on stream as planned Ethiopia will have modest quantities of sugar to export through to the late 1980's. Ultimate capacity of the project will be 129,000 tonnes a year and its capital cost is expected to be of the order of $200,000,000.

British energy expertise group. — Within the UK there is experience in production and harvesting of energy crops, usually in the tropics, while other parts of UK industry have experience in plant design, manufacture, construction and operation for fermentation, distillation and effluent treatment. A sub-group of the British Anaerobic and Biomass Association Ltd. has therefore been formed to promote the contribution of British firms to power alcohol industries. Information may be obtained from B.A.B.A. at The White House, Little Bedwyn, Marlborough, Wiltshire SN8 3JP, England.

1 *Indian Sugar*. 1980, **30**, 347, 401.
2 F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 188.
3 *Public Ledger's Commodity Week*, March 14, 1981.
4 *Zuckerind.*. 1981, **106**, 277.
5 *Lamborn*, 1981, **59**, 31.
6 F. O. Licht, *International Sugar Rpt.*, 1981, **113**, S 131.
7 *Lamborn*, 1981, **59**, 35.
8 F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 202.
9 *S African Sugar J.*, 1981, **65**, 3, 10.
10 F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 341.

Philippines sugar exports, 1980[1]

	1980	1979	1978
	tonnes, raw value		
Algeria	20,784	0	0
China	44,443	119,251	204,923
EEC	5,282	0	0
Indonesia	144,122	0	10,869
Iraq	102,228	85,109	107,684
Japan	377,101	350,482	52,617
Korea, South	244,479	159,906	85,984
Malaysia	21,716	11,265	44,811
Morocco	24,678	0	0
Singapore	0	8,132	8,173
Thailand	26,669	0	0
USA	429,519	403,828	626,865
USSR	352,020	19,484	0
	1,793,041	1,157,457	1,141,926

Colombia bagasse paper plant[2]. — A study is being made by the Consejo de Política Económica y Social of the construction of a factory with a production capacity of 92,500 tonnes per year of white paper from bagasse. The necessary investment, estimated at 12,000 million pesos (US$231 million), will be provided jointly by the Colombian Government, the private sector and Spanish enterprises. The factory will not only allow the country to reduce its trade deficit but will also allow for the export of around 50,000 tonnes by 1990.

Rumania sugar expansion plans. — According to radio reports monitored by the British Broadcasting Corporation, developments in Rumanian sugar engineering will by 1985 permit the processing of a 10 million tonnes beet crop in only 100 days, to produce 1,300,000 tonnes of sugar[3]. The Independenta factory at Sibiu has started delivery of equipment for the first domestically produced sugar factory in Calafat, and another three factories are to go into operation near Ianca in the Braila district, in Zimnicea in Teleorman district, and in Ard in Arad district, all of about 4000 tonnes daily slice[4]. The new factories will raise the total daily slice to more than 65,000 tonnes whereby the campaign will be reduced by 25-30 days to 117 days.

Bangladesh sugar expansion plans[5]. — Twenty new sugar factories are planned in the private sector with a capacity of 40,000 tonnes annually.

Cane alcohol plant in South Africa[6]. — A labour-intensive development project with an ethanol plant as the main industry to be establish Transkei at a reported cost of about 300 million rand (US$235 million). It will provide work for more than 11,000 people. In the first stage of the project, sugar cane will be planted on 37,000 hectares of land between Port S. John's and Port Edward. When in full production the ethanol plant will manufacture 653,000 litres of ethanol a day. Announcing the project, the Prime Minister of the Transkei said that initially more than 1000 houses will be built for workers and millions of rand will also be spent on roads, sewerage and water networks.

Philippines fuel alcohol program[7]. — The investment requirements of the five-year fuel alcohol program in the Philippines will be reduced from an original estimate of 1800 million pesos to 800 million pesos, because of a drop in gasoline consumption of as much as 20%, which was the amount to be replaced by alcohol by 1985. The Philippine National Alcohol Commission is encouraging the establishment of alcohol distilleries annexed to existing sugar factories instead of setting up new and autonomous distilleries which would require new plantations. The Commission, which will supervise the acquisition of distillery facilities from foreign suppliers through international bidding, had already invited more than 30 foreign companies to submit bids not later than April 6 for the supply of 3-10 sugar-based distilleries

Uruguay sugar production, 1980/81[8]. — Beet cultivation for the 1980/81 campaign was severely hampered by adverse weather conditions including heavy rain. The area sown to beets was only 10,300 hectares against the normal 21,500 ha and only three of the four factories sliced the crop from which sugar production reached an estimated 39,000 tonnes, raw value, compared with 64,653 tonnes produced in 1979/80. Cane sugar production also suffered and at 42,700 tonnes, raw value, was 5300 tonnes less than the amount produced in 1979/80. As a consequence, Uruguay was obliged to import 10,000 tonnes of sugar from Argentina in November 1980 and it is estimated that a further 15,000 tonnes will be required to satisfy domestic consumption.

Taiwan sugar situation[9]. — The Taiwan Sugar Corporation expects sugar production in 1980/81 to total 758,000 tonnes, sharply lower than last season's output of 874,000 tonnes. Major reasons for the drop are reduced cane and sugar yields caused by a four-month drought from June to September 1980 and a reduced area because of a relatively better price for rice at the time of cane planting in the autumn of 1979. Strong domestic demand and favourable export prices could tempt the Corporation to reduce stocks to below normal levels. Hence actual exports in 1980/81 will be largely determined by its willingness to draw on stocks.

US sugar imports, 1980[10]

	1980	1979	1978
	short tons, raw value		
Argentina	197,172	234,820	271,019
Australia	349,229	107,384	165,493
Belgium	0	0	25,146
Belize	71,561	57,967	87,261
Bolivia	72,508	89,189	62,441
Brazil	841,091	1,262,358	600,684
Chile	7,152	0	0
Colombia	214,357	26,103	113,410
Congo	7,544	0	0
Costa Rica	68,262	80,405	78,317
Dominican Republic	615,362	816,967	733,530
Ecuador	72,924	82,227	37,294
Fiji	49,717	130,161	50,722
France	0	0	42,851
Germany, West	0	0	16,539
Guatemala	218,113	170,869	155,879
Haiti	10,044	11,287	5,757
Honduras	89,133	65,303	17,781
Ivory Coast	35,318	0	0
Madagascar	20,472	9,610	14,295
Malawi	60,168	35,727	37,028
Mauritius	55,216	115,529	112,212
Mexico	0	60,117	52,822
Mozambique	88,107	98,139	12,913
Nicaragua	62,592	122,307	108,204
Panama	156,351	157,287	123,003
Paraguay	11,041	0	0
Peru	52,241	188,630	225,241
Philippines	408,997	413,189	833,339
Rumania	0	0	13,209
Salvador	41,039	160,957	130,365
South Africa	164,025	88,779	60,100
Swaziland	141,935	102,072	82,456
Taiwan	0	28,200	56,569
Thailand	66,203	9,436	64,761
Uruguay	0	0	8,220
West Indies	214,366	210,907	184,390
Zimbabwe	13,620	0	0
Total	4,475,860	4,935,926	4,583,251

EEC raw sugar price and refining margin. — Little beet raw sugar is produced in the European Economic Community and, when the prices were agreed for the new sugar regime to start on July 1, there was some subsequent controversy arising from translation problems, etc., as to what had been agreed in respect of raw sugar prices, which mainly apply to imports from the ACP countries. At a meeting of the Council of Agriculture Ministers on May 12, it was agreed that the increase in the intervention price for raw sugar should be 7.5%, 1% less than the price increase for white sugar. This would improve the margin for the Community's refiners, the largest of which is Tate & Lyle Ltd. Cane sugar producers from the ACP countries have rejected the proposal as inadequate, however. The guaranteed price would be raised under the proposals to about $427 per tonne, well above current free market levels, but the producers point out that the cost of freight and insurance for shipping sugar to Europe has risen by 60% over the past year and are demanding a 15% increase in the intervention price.

Cane smut in the Dominican Republic[11]. — An outbreak of smut disease has been identified on two experimental cane varieties being tested on the estate of Central Romana in the eastern part of the Dominican Republic. It was believed that smut may have been present in the Dominican Republic and Haiti for at least the past two years and could be widespread throughout the island. The eastern region of the Dominican Republic, where the disease was identified, accounts for about 60-70% of the total cane area.

[1] C. Czarnikow Ltd., *Sugar Review*, 1981, (1536), 45.
[2] *Westway Newsletter*, 1981, (89), 12.
[3] *Reuter Sugar Newsletter*, March 27, 1981.
[4] F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 274.
[5] *Standard Chartered Review*, April 1981, 23.
[6] *World Sugar J.*, 1981, **3**, (10), 37.
[7] *Standard Chartered Review*, April 1981, 31.
[8] *World Sugar J.*, 1981, **3**, (10), 38.
[9] F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 209.
[10] *Lamborn*, 1981, **59**, 42.
[11] F. O. Licht, *International Sugar Rpt.*, 1981, **113**, 338.

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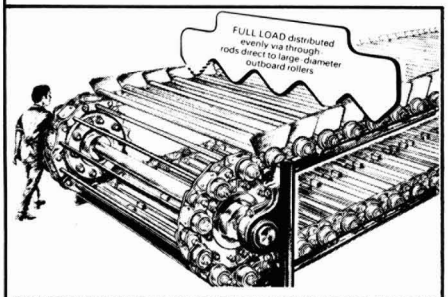

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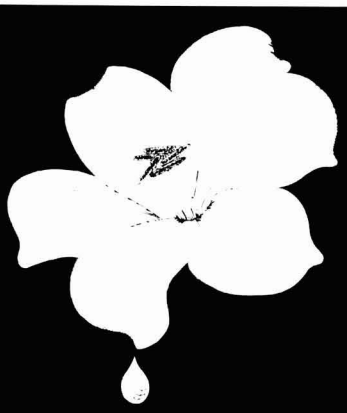

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