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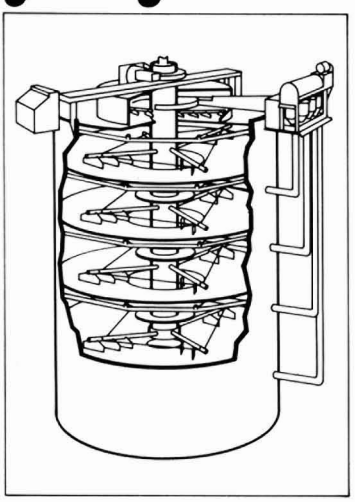

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NOTES AND COMMENTS

World sugar prices

After the upward movement in values at the end of January, caused by the Soviet sugar beet crop disaster, the market settled back and the London Daily Price for raw sugar began the month of February at £171 per tonne, sinking to £168 for most of the first two weeks of the month (apart from a slight rise to £170 on February 5 and 8). Reports that the USSR had bought more raw sugar brought a further strengthening of the market, and the LDP rose to £177 on February 17, thereafter subsiding and reaching only £163 by February 23, the weakness being accentuated as a result of India's request for increased export entitlement under the International Sugar Agreement, which heralds an increase in production perhaps even bigger than forecast. Another factor had been Licht's latest estimate of the EEC sugar balance which indicated export availabilities from the 1981/82 crop which had been raised yet again. At the end of the month there were suggestions that liquidation of the substantial open positions in the March delivery month in the Futures Exchanges in London and, more especially, New York might lead to violent price movements and this was interpreted bullishly to raise the price to £167 on February 26; in the event no undue price fluctuations occurred and the LDP resumed its slide during the early part of March.

The white sugar price was remarkably stable through the whole of February. The LDP(W) started the month at £175 and stayed between this level and £180 for the first two weeks. On February 16 it rose to £183 and stayed at this for three days, after which it started to slide, parallel to the raw sugar price, reaching £175 again on February 24. After a dip to £171 on February 25 and a rebound to £176 the following day, it again weakened during early March but not quite so sharply as the fall in raw sugar values.

International Sugar Agreement[1]

The International Sugar Council normally meets in May and November of each year but decisions regarding the operation of the ISA have to be made on a continuing basis. For this reason responsibility for many decisions has been delegated to the Executive Committee which can meet more frequently. This committee in turn normally establishes working groups to consider problems as they arise.

In February a series of sub-committees met at the headquarters of the International Sugar Organization. Consideration was given to the problems surrounding the establishment of special stocks. Regardless of what may be the truth of the matter, it can be no secret that when special stocks had to be established during the first two years of the Agreement there was some doubt in trade circles as to whether the full tonnages were in fact segregated in every case. This has caused the ISC some concern and a committee has been established to consider how to ensure there will be greater trade acceptance of special stocks figures in future.

A new element is now present with the facility for member countries holding special stocks to borrow money free of interest to assist them with carrying costs. If there were cases in the past where stocks were not held, it is felt that the likelihood will be much reduced in the future. Consideration was also given to the possibility of instituting additional spot check inspections and also some improvement in documentation so that eventual releases from special stocks could be closely monitored. No decision was reached and a further meeting was planned for March 1982.

The group on accessions met and considered points which could be taken up with representatives of the EEC. The general impression was that it was unlikely that the Community would be able to adhere to the current Agreement and it was therefore proposed that the EEC should be asked to what extent and in what way it would be prepared to co-operate with the ISC in attempting to reach common aims.

Consideration was given to the question of establishing basic export tonnages for 1983 and 1984. Various alternatives were proposed but it was clear that none would receive unanimous approval. Currently it seems likely that a method of calculation will be adopted which will ensure that the total in each year will be roughly in line with the 1982 total. This is somewhat disappointing; for most countries export quotas established in relation to current basic export tonnages represent no effective export limitation and it now seems that this important element in the Agreement may continue to be missing until it expires.

Officers of the Executive Committee and of subgroups were appointed and Mr. G. H.Watkins of Australia elected Chairman of the Executive Committee for 1982.

Claims of *force majeure* over shortfalls in exports in 1981 from Zimbabwe and Bolivia were delegated to a panel for further investigation. A working group was set up to consider the request by four countries to be permitted to postpone their obligation to establish special stocks.

Following poor crops for two years in succession and now a potentially very large one, India requested an additional export entitlement for 1982. It is thought probable that it would be appropriate to make an allocation to India under article 69 which deals with relief from obligations. This has been referred to a working group, who will also examine a request by Peru for its basic export tonnage to be maintained at the 1981 level.

At the next meeting of the Council it will be necessary to make a decision regarding the further accumulation of special stocks. Presumably it will be necessary to call upon members to increase their contributions to the stock fund and the Stock Financing Fund Advisory Committee has been asked to prepare calculations on various bases to be put to the next meeting of the Executive Committee on April 16.

World sugar balance, 1981/82

F. O. Licht GmbH recently published their second estimate of the world sugar balance for the period September 1981 – August 1982[2]. Despite the news of the failure of the Soviet beet crop, world sugar production is set at 95,431,000 tonnes, raw value, an increase of more than 7 million tonnes above the 88,157,000 tonnes of 1980/81 (but only just over 4 million tonnes more than the 91,155,000 tonnes of 1977/78). Because of higher availabilities, lower average prices and popul-

[1] C. Czarnikow Ltd., *Sugar Review*, 1982, (1584), 25.
[2] *International Sugar Rpt.*, 1982, **114**, 63-66.

ation growth, world consumption is expected to increase by 2.3 million tonnes, from 88,697,000 to 91,015,000 tonnes. Much of this growth is expected to occur in developing countries where population growth rates are high and where sugar consumption response to price and income change is fairly high. These countries now account for more than 50% of world consumption. The relation of these increases means that world stocks will increase and are expected to reach 32% of consumption.

Prices over the next few months will increasingly be influenced by the size of the next world crop: much of the current optimism stems from the belief that world production next year may fall off in response to lower prices. It is believed that plantings will fall drastically in 1982/83, especially for beet, and some sugar cane could be diverted to non-sugar uses such as ethanol manufacture. Consumption, on the other hand, is expected to continue its upward path; the trend figure for 1982/83 is 93.6 million tonnes but the actual offtake will be influenced by the general trend of the world economy which offers only limited hope for improvement at present.

EEC sugar stocks

Following the earlier announcement[1] that EEC sugar producers had decided to segregate only 992,000 tonnes of white sugar from the 1981/82 crop, instead of the 1.3 million tonnes they had earlier announced, the Commission decided that, instead of making up the difference by withholding additional A- and B-quota sugar from the market, they would store only 693,000 tonnes, slightly less than the 700,000 tonnes they also had said would be segregated to make up a stock of 2,000,000 tonnes[2]. Thus the total segregated stock will be 1,685,000 tonnes or 315,000 less than the original total. The Commission has reserved the right to withhold this 315,000 tonnes of quota sugar should market conditions warrant it.

US Caribbean free trade proposals

At a speech to the Organization of American States in late February, President Reagan announced proposals for a major "Caribbean Basin Aid Program". The political aim of the program is to check the spread of Communism and left-wing subversion in the area and it provides for military support and also improved access to the United States for produce from the area in the form of one-way free trade for a period of 12 years. Certain countries with Marxist governments are excluded from the program, including Cuba and Grenada, but duty-free entry for all commodities with the exception of textiles and clothing will be guaranteed for some 20 countries of the Caribbean and Central America. Naturally, sugar will be one of the most important commodities to be affected.

At the present time, under the Generalized System of Preferences, most of the smaller countries supply sugar to the US free of import levies but it is now proposed that all the 20 should be able to supply free of duty, currently 2.8125 cents/lb. This entitlement is not open-ended, however, and is to apply for amounts up to 10% greater than the historically highest level of supplies.

The *Public Ledger's Commodity Week*[3] comments: "even with this proposed ceiling on sugar imports, the Caribbean initiative is likely to run into some strong opposition from the US farm lobby when it comes before Congress. Sugar producers in the US see the plan as counteracting many of the benefits of the Farm Bill recently signed into law. What is the use of guaranteeing farmers in the US reasonable prices for their sugar, they argue, if there is no protection against cheap imports from such an important producing area as the Caribbean? But although the farm lobby will undoubtedly put up a strong fight, analysts say that, as the Caribbean initiative is primarily a political move, such farm/trade considerations will take a back seat when the matter is debated in Congress.

"The duty-free proposals for sugar represent a victory for sugar producers in the Caribbean — notably the Dominican Republic — who roundly attacked the protectionist implications of the 17 cents/lb support level for sugar incorporated in the Farm Bill.

"But while Caribbean sugar exporters can now look forward to once again getting a bigger portion of the important US sugar market, other non-Caribbean producers who traditionally sell to the US are likely to be hard hit by the move.

"For Australia the plan must conjure up the unpleasant memories of the effect of the UK's accession to the EEC. In 1973 Australia suddenly saw its crucial British market swept away by Britain's entry into Europe and it was forced to seek alternative outlets for its sugar — notably Japan and the US. Now it seems that the US market will also shrink rapidly as Australian sugars are replaced by Caribbean material. And the Australian industry cannot even turn for comfort to Japan, as imports by that country are plummeting in the face of increased use of corn sweeteners. It could well be, analysts feel, that Australia will be forced to cut back its sugar production in the years ahead.

"Annoyance at the Reagan plan will be even greater in the Philippines, however, and there will undoubtedly be pressure from Manila to make this origin a 'special case' before the Caribbean free-trade zone actually comes into effect. For many years the Philippines supplied the US almost exclusively and it was assured very favourable duty advantages. In recent years the country has been forced to diversify its export outlets — notably to the USSR — but a major shift in US purchases away from the Philippines to its own 'backyard' could prove a body blow to that country's sugar industry.

"President Reagan's Caribbean Basin program still has a long way to go before it comes into effect, including a possible stormy ride through Congress when stricter limits on sugar imports might be demanded; but it does pave the way for a major shift in US sugar trading patterns in the 1980's."

World's biggest cane mill[4]. — The new mill being built by A. Goninan & Co. Ltd., of Newcastle, NSW, Austrialia, for installation at Farleigh Cooperative sugar factory in Queensland, is claimed to be the world's biggest, with five rollers each of which weighs 42 tonnes and is 2.75 metres wide. It will form part of a tandem having a capacity of 16,000 t.c.d. The most significant difference between the new unit and existing five-roller mills is the gear drive which requires two steam turbines of 1100 h.p. each, driving a bull wheel through independent pinion shafts. The system will eliminate roll shaft mounted crown wheels and the five rollers will be driven through individual tailbars by machine-cut connecting gears which are integral to the final reduction gear box. In addition, Goninan have been chosen to design and build the 2.75 metres wide shredder which will prepare cane for the mill. The shredder will also be the largest in the world and be driven by a 6600 h.p. steam turbine at 1100 r.p.m. The value of the mill and shredder is some $A 3,000,000.

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[1] See *I.S.J.*, 1982, **84**, 66.
[2] C. Czarnikow Ltd., *Sugar Review*, 1982, (1584), 26.
[3] February 27, 1982.
[4] *Australian Sugar J.*, 1981, **73**, 453.

Modern liquid chromatography

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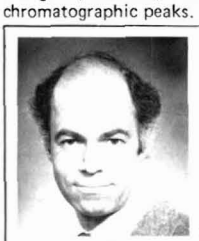
Liquid chromatography is currently one of the most widely used techniques in analytical laboratories. It can be described as a technique whereby chemical species are separated on being transported through a system consisting of a mobile liquid phase intimately in contact with a stationary phase that is either a solid or a second, immiscible liquid. Compounds move through the system only when they are in the mobile phase and separation occurs according to the fraction of time that compounds spend in the mobile phase. Separation occurs only between species that have non-identical distribution coefficients between the stationary and the mobile phase. A similar description could, of course, be used for gas chromatography where a gas is the mobile phase. A very important difference between gas and liquid chromatography is that only compounds having some volatility can be separated by gas chromatography whereas any compounds can, in principle, be separated by liquid chromatography provided that a mobile phase with sufficient solvent strength is used.

The above description of liquid chromatography includes paper chromatography, preparative column chromatography, countercurrent chromatography, size exclusion chromatography, thin layer chromatography (TLC) and high performance liquid chromatography (HPLC). The latter two techniques are the most important for the analysis of sugars and will be discussed in this article. Representative descriptions of these techniques are given in the literature[1-4].

It is impossible to cover adequately either the techniques or theory of modern liquid chromatography in a short review; for this the reader should consult a text such as that written by Kirkland & Snyder[5]. There are, however, a few concepts with which anyone working in the field of chromatography should be familiar. These are described below:

Peak separation is simply the distance between two chromatographic peaks. This corresponds to the distance CD in Figure 1.

Resolution, R, is peak separation divided by average peak widths. For Figure 1, $R = \frac{CD}{1/2(EF+GH)}$. This reduces to $R = \frac{CD}{EF}$ for the common case of two peaks that have nearly the same width. Note that peak width is defined using tangents. The resolution for a baseline separation is not 1, as it would be if the peaks were triangular, but 1.5, owing to the gaussian shape of the chromatographic peaks.



D. Nurok

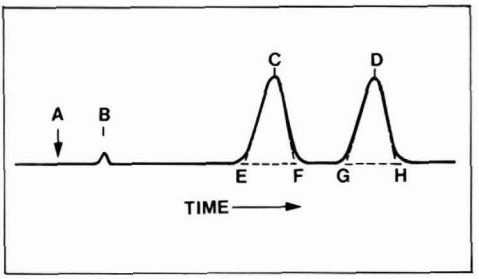


Fig. 1. A typical liquid chromatogram showing point of injection A, unretained solute B (this peak is often not detected), and peaks "of interest" C and D

Chromatographic efficiency is a measure of the band broadening that a compound experiences as it travels through a chromatographic system. A very efficient system will result in minimal band broadening whereas an inefficient system will result in broad bands. Where a pair of compounds have the same peak separation in two systems, the more efficient system will result in better peak resolution as is illustrated in Figure 2. An efficient system is said to have a high number of theoretical plates, N. In addition to N one can define the height equivalent of a theoretical plate (H.E.T.P.),

$$H = \frac{L}{N} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where L is the column length.

This equation can be rearranged:

$$N = \frac{L}{H} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

i.e. the number of theoretical plates is proportional to the column length. The number of theoretical plates is also dependent on many variables which include how well a column is packed or, in the case of a TLC plate, how well the thin layer is prepared; the shape, size and size distribution of the particles of packing material; and the flow rate of the mobile phase through the system. It turns out that H.E.T.P. is of the same order of magnitude as the particle diameter of the column packing, and the search for high efficiency columns has thus led to the use of very small diameter particles. A packing with a particle diameter of 10 μm (i.e. 1×10^{-5} m) would be expected to have a H.E.T.P. of about 10 μm which should result in a column of approximately 100,000 theoretical plates per metre. HPLC columns are commercially available with about 50,000 to 100,000 theoretical plates per metre. Such columns have a high resistanc to flow and consequently modern liquid chromatographs have an inlet pressure that can be increased up to about 6000 p.s.i.

[1] Gauch, Leuenberger & Baumgartner: *J. Chromatogr.*, 1979, **174**, 195.
[2] Lee, Nurok & Zlatkis: *ibid.*, 187.
[3] Fitt, Hassler & Just: *ibid.*, 1980, **187**, 381.
[4] Simatupang: *ibid.*, 1979, **180**, 177.
[5] "Introduction to Modern Liquid Chromatography," 2nd edition, (Wiley, New York), 1979.

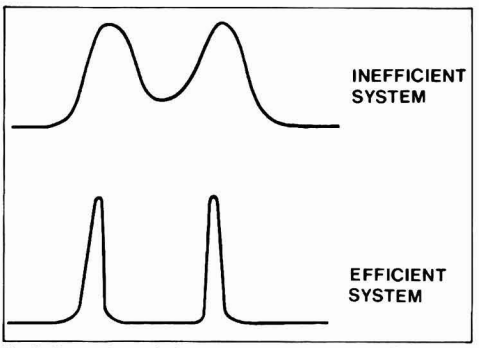


Fig. 2. Comparison of chromatograms obtained on efficient and inefficient systems. Analysis time and relative retention is the same in both cases illustrated

The capacity factor, k', of a compound being chromatographed is the ratio of the amount of that compound in the stationary phase to the amount in the mobile phase. A compound of low capacity factor will spend a large fraction of the time in the mobile phase and will travel rapidly through the chromatographic system. Conversely a compound of high capacity factor will travel slowly through the chromatographic system because it will spend a large fraction of the time in the stationary phase. Pairs of compounds can be separated provided they have non-identical capacity factors.

The separation factor or relative retention, α, is the ratio of capacity factors for a pair of compounds. It is also identical to the ratio of peak retentions given by $\frac{BD}{BC}$ in Fig. 1. The separation factor for a pair of compounds is governed by the way the individual compounds interact with the mobile and stationary phases, i.e. by solute-solvent interactions. It is dependent both on the chemical natures of the compounds being separated and on those of the stationary and mobile phases. It is however, independent of the physical parameters that govern the efficiency of the system such as flow rate and particle size.

The following equation is of great value in understanding how the different parameters influence resolution

$$R = \frac{\sqrt{N}}{4}\left(\frac{\alpha-1}{\alpha}\right)\left(\frac{k'}{k'+1}\right) \quad \ldots\ldots\ldots \quad (3)$$

Equation 3 shows that resolution is dependent on the square root of N, i.e. on the square root of column length (see Equation 2). Thus, to double resolution, column length must be increased by a factor of four. Increasing column length to improve resolution is not always practical, and HPLC columns longer than 40 cm are rarely used owing to the large pressure drop involved.

Resolution may also be increased by increasing the term $\frac{\alpha - 1}{\alpha}$; this is very small for low values of the separation factor, α, but increases with increasing values of α. As mentioned earlier the separation factor is dependent on solute-solvent interactions, i.e. on the chemical nature of the system. By a careful choice of solvent it is possible to achieve relatively large separation factors even for compounds as similar as D and L amino-acids. Here the user of liquid chromatography is in a fortunate position as there are a large number of suitable solvents that can be used either alone or as mixtures.

A third way of increasing resolution is to increase the term $(\frac{k'}{1+k'})$ in Equation 1. This term is very small for low values of the capacity factor k' and tends towards a value of 1 as k' becomes large. The value of the term is 0.09 for k' = 0.1, is 0.5 for k' = 1 and 0.91 for k' = 10. There is little justification for working at a capacity factor of greater than 10 because the improvement in resolution is marginal, whereas elution time becomes very great. This is because:

$$t_R = t_m(1 + k') \quad \ldots\ldots\ldots\ldots \quad (4)$$

where t_R is elution time (the distance AC or AD in Figure 1); t_m is the retention time of an unretained solute (the distance AB in Figure 1).

Capacity factors are directly dependent on the nature of the stationary and mobile phase in liquid chromatography. These are discussed next.

The stationary phase

The most widely used phases in both HPLC and in TLC are unreacted microparticulate silica, which is used for normal-phase chromatography, and silica coated with octadecyl hydrocarbon chains, which is used for reverse-phase chromatography. Each hydrocarbon chain is joined to the silica by a siloxane bond and is known as a bonded phase. It should be noted in passing that many other bonded phases of both a polar and a non-polar nature are used in HPLC. In addition, ion exchange resins can be used in liquid chromatography and have been used to separate carbohydrates as borate complexes.

Normal-phase chromatography is where the stationary phase is more polar than the mobile phase. In chromatography "polar" refers to liquids such as water or acetone that contain strong dipoles or solid materials such as silica or alumina that have a high concentration of polar groups on the surface. Untreated silica is generally used with a non-aqueous solvent in normal-phase chromatography. In this situation very polar compounds would have higher retentions than non-polar compounds. A case of special interest is the use of silica with aqueous solvents for carbohydrate separations. Here the silica surface becomes water-rich and the carbohydrates are distributed between two water-containing phases (several references are given by Lee *et al.*[2]).

In reverse-phase chromatography the stationary phase is less polar than the mobile phase and very polar compounds have lower retentions than non-polar compounds, i.e. the reverse to what is found for normal-phase chromatography. As noted earlier the reverse-phase packings are non-polar and have a hydrocarbon surface. Aqueous mixtures of methanol or acetonitrile are commonly used mobile phases. Reverse-phase chromatography can also be used for polar materials such as carbohydrates and amino-acids owing to the solubility of these compounds in the aqueous mobile phases. It should be noted that, in contrast to the case of a silica stationary phase, the water does not partition into the hydrocarbon stationary phase.

The solvent

Solvent strength is the property that governs how well a mobile phase elutes compounds. The higher the solvent strength of a mobile phase, the lower will be the capacity factors of compounds and the more rapidly will they be eluted. Solvent strength is a function, not only of the solvent itself, but also of the stationary phase.

Thus, a pure hydrocarbon, such as hexane, would be considered a very weak solvent in normal-phase chromatography but would be a strong solvent in reverse-phase chromatography.

There are two different systems for classifying solvents depending on whether adsorption or partition chromatography is being considered. In adsorption chromatography the solute is adsorbed onto the surface of the stationary phase whereas in partition chromatography the solute is dissolved in the stationary phase. Normal-phase chromatography on silica with a non-aqueous solvent is an example of adsorption chromatography whereas reverse-phase chromatography and liquid-liquid chromatography are examples of partition chromatography.

The symbol ϵ is used to designate solvent strength in adsorption chromatography[6]. ϵ is a measure of the energy of interaction between solvent molecules and the solid stationary phase. The higher the value of ϵ, the more strongly will solvent molecules interact with the absorbent and the more rapidly will solute molecules be eluted. Thus desired retention times can be obtained by choosing ϵ correctly.

Snyder[7] has developed a solvent strength parameter, P', for partition chromatography. The interested reader is advised to consult the literature[e.g.5] as a discussion on the derivation of P' is beyond the scope of this article. As with ϵ in adsorption chromatography, the P' value of a solvent can be chosen to achieve the desired retention time for an analysis. It is a simple matter to calculate what proportions of two pure solvents need be mixed to obtain a mobile phase of the desired solvent strength for a particular analysis[5].

Solvent strength, as discussed above, is a powerful tool for choosing candidate solvents for a given analysis. However, some trial and error is usually necessary in the choice of solvent for separating compounds of similar structure. Consider the situation where the choice of a solvent with a certain P' or ϵ value yields a convenient analysis time but does not resolve all compounds. The correct approach is to try other mobile phases of different chemical type but of the same solvent strength. The user of partition chromatography is in a fortunate position as Snyder has measured P' values for a large number of solvents and has classified these into eight different categories depending on the type of interaction (e.g. hydrogen bonding) these solvents can undergo.

Two methods of solvent optimization in liquid chromatography have recently been published. The first is due to Glajch and co-workers[8] and has been applied to reverse-phase HPLC. These authors use a statistical technique to define a function which relates resolution, between each pair of compounds in a mixture, to solvent composition. A computer technique is then used to find a solvent composition that will separate all pairs of compounds in a mixture. Glajch *et al.*[8] reported use of the method for reverse-phase HPLC using a ternary mixture of aqueous solvents. The method should also be applicable to other systems, both in HPLC and in TLC, and the paper is definitely required reading for all practitioners of liquid chromatography.

The second method of solvent optimization has been developed in the author's laboratory specifically for separation by TLC using binary solvents[9,10]. The separation between two TLC spots, ΔR_f, is:

$$\Delta R_f = \frac{k_2 - k_1}{(1 + k_1)(1 + k_2)} \quad \ldots\ldots\ldots \quad (5)$$

where k_1 and k_2 are capacity factors of the spots being separated. There is often a linear relationship between log capacity factor and the composition, expressed in appropriate units, of a suitable binary solvent. This relationship, used together with Equation 5, allows the calculation of ΔR_f as a function of binary solvent composition. This method is illustrated in Fig. 3 for the separation of two pairs of dyes by normal-phase chromatography using a cyclohexane/acetone binary solvent.

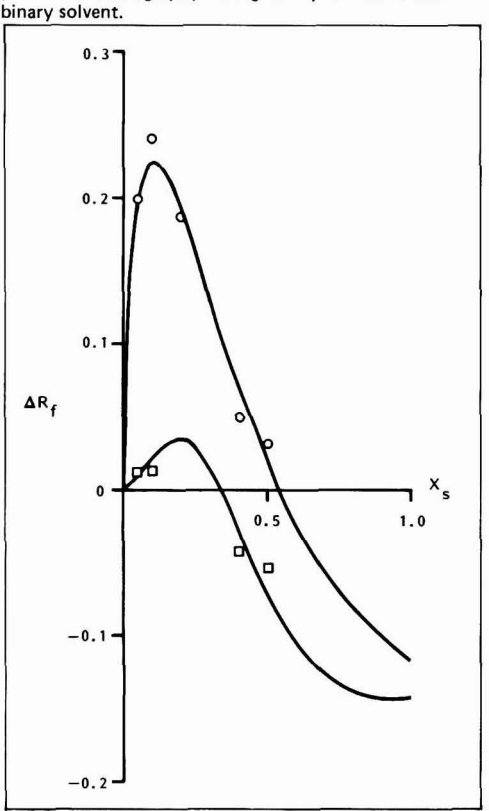


Fig. 3. Separation of azo dyes. A plot of calculated ΔR_f *vs.* X_s, the mole fraction of acetone in an acetone/cyclohexane mixture.

○ experimental ΔR_f for Sudan Black/Fatty Orange

□ experimental ΔR_f for Sudan Black/Acetorange 2R

In HPLC it is often possible to perform the analysis of a simple mixture with a single solvent system. This is called an isocratic run. For complex mixtures, however, it is common to find that, under isocratic conditions, a weak solvent results in good separation for early eluting components but excessively long elution times for late components. A strong solvent elutes late components in a reasonable time, but results in early components being bunched together and poorly separated. This

6 Snyder: "Principles of Adsorption Chromatography," (Marcel Dekker), 1968.
7 *J. Chromatogr. Sci.*, 1978, **16**, 223.
8 Glajch, Kirkland, Squire & Minor: *J. Chromatogr.*, 1980, **199**, 57.
9 Nurok & Richard: *Anal. Chem.*, 1981, **53**, 563.
10 Nurok, Richard, Cunningham, Becker & Bush: *Proc. 16th Symposium Adv. Chromatogr.*, 1981, in press.

problem is overcome by using a solvent gradient such that solvent strength is increased in a regular manner during a run by automatically changing the composition of a two- or three-component solvent mixture. If this is done correctly there will be no bunching of early peaks and late peaks should all elute in a reasonable length of time. Solvent gradients are commonly used in HPLC but are rarely used in TLC.

There are certain other solvent criteria that must be considered, apart from solvent strength and selectivity. The most important of these are that the solvent must not react with the sample or the chromatographic system, that the solvent should be of low viscosity but not too low boiling point and that the solvent must be compatible with the detector used. Detector compatibility is of importance only in column chromatography as solvent is removed before peak detection in TLC. It is also important that the system be operated in a well-ventilated area as many of the solvents commonly used in liquid chromatography are moderately toxic.

Detectors

The three HPLC detectors that are briefly discussed here are those based on UV absorbance, refractive index and fluorescence. These include the most widely used detectors and one of the most sensitive detectors.

The UV absorbance detector is essentially a spectrophotometer with a micro flow-through cell. It is not a universal detector and will detect only those compounds which have an absorbance at the wavelength of radiation used. The detector can detect as little as 10^{-11} g of a compound having a suitable chromophore but sensitivity varies with the molar absorptivity of each compound. Mobile phases used with this detector must not absorb in the ultra-violet and must be free of traces of absorbing impurities such as olefins. This is another reason to use only the highest quality solvents in HPLC.

An interesting development has been the introduction of microprocessor-controlled UV detectors that enable an operator to select wavelengths that optimize sensitivity for individual compounds.

The refractive index detector measures changes in the bulk refractive index of the mobile phase. It is sensitive to any compound having a refractive index different to that of the pure mobile phase. It is particularly suited to the detection of compounds such as carbohydrates which have no significant absorption in the UV. It is not a sensitive detector, maximum sensitivity being about 10^{-6} g of a compound. Furthermore, it is unsuitable for use with gradient elution, owing to a large baseline drift when the refractive index of the mobile phase changes.

The fluorescence detector detects radiation that a fluorescent compound emits when irradiated with excitation radiation of the correct energy. It is an extremely sensitive detector, the detection limit being about 10^{-12} g. Most compounds are not fluorescent but can be converted into suitable derivatives by treatment with a fluorescent reagent such as phenanthrene boronic acid which reacts with diols.

In TLC the only detector available is the spectrophotometer scanner or densitometer as it is sometimes called. In contrast to the conventional spectrophotometer, this instrument generally operates in the reflectance mode rather than the transmission mode and measures the diminution in reflectance due to the presence of a UV- or visible-absorbing compound. It can also be used in the fluorescent mode where the plate is irradiated at a suitable excitation wavelength and the resulting fluorescent radiation measured. In TLC the detection limit for UV absorbance is about 10^{-9} g and for fluorescence about 10^{-11} g. The scanning spectrophotometer is always used after the solvent has been removed from the plate and this allows the optical properties of the solvent to be ignored.

The above descriptions have referred to both HPLC and TLC. Some of the advantages of these two techniques are now briefly discussed.

High performance liquid chromatography

HPLC is the most highly developed form of liquid chromatography with a wide range of instruments and accessories available to the user. The level of sophistication is high with several instruments being microprocessor controlled. An instrument is even available that can be programmed to change systematically the relative composition of a two-component mobile phase on successive runs. This, coupled with automatic sample injection, enables an unattended instrument to generate the information needed to select the best mobile phase composition for a particular separation.

In the past few years HPLC has been the most rapidly growing chromatographic field with a large body of literature being published. This includes several publications describing carbohydrate separations, some of which are included in the bibliography[3,4].

HPLC is more suitable than TLC for the analysis of complex mixtures because of both the high efficiency of a well prepared column and the ease of establishing a solvent gradient in HPLC. TLC, however, is more suitable than HPLC for the routine analysis of simple mixtures such as those of glucose, fructose, sucrose, and trisaccharides found in final molasses.

Thin layer chromatography

TLC has for many years been used by organic chemists as a rapid, useful and inexpensive method for determining the composition of simple mixtures. TLC has undergone a renaissance in the past few years with the introduction of a new generation of high quality scanning spectrophotometers and the availability of commercial high performance TLC (HPTLC) plates. These have approximately the same efficiency per unit length as a well packed HPLC column. The capacity of the plates is smaller than that of conventional TLC plates and the normal sample size used is about 0.2 μg (200 ng). The improved separating power of these plates is due to the fact that the final spot diameter varies between 1 and 4 mm whereas spots on conventional plates can be as high as 1 cm in diameter. It is necessary to use a special application (spotting) device in order to obtain small reproducible spots in HPTLC. Most of the earlier work has been performed with carefully calibrated platinum/iridium micro-pipettes. These give reproducible spots of about 1 mm diameter. Unfortunately, the micropipettes are expensive and tend to become blocked. A more elegant spotting technique has recently been developed by Dr. David Fenimore of Clarke Analytical Systems. The principle of the technique is that material to be spotted is first placed as a solution on a low energy surface. The solvent is evaporated leaving a spot of about 0.1 mm diameter which is then quantitatively transferred to the TLC plate by pressing the flexible low energy surface against the plate. The technique is to be recommended as very small, reproducible spots are obtained and there is no possibility

of blocking the apparatus. Several samples can be spotted simultaneously on a commercial version of the apparatus which is now available.

Spots need migrate a significantly shorter distance for complete separation in HPTLC than in conventional TLC owing to the smaller final spot diameter. The solvent front travels for less than 5 cm in the majority of separations on HPTLC plates. There is also a considerable saving in time owing to the shorter distance migrated. An HPTLC separation often takes as little as 20% of the time required for separation on a conventional plate. Moreover, because of the smaller spot size, more samples can be analysed simultaneously on a single HPTLC plate than on a conventional plate. Camag have introduced a linear developing tank where solvent is fed from a reservoir by capillary action to two sides of a TLC plate held in a horizontal position. Using this tank it is possible to analyse simultaneously as many as 72 samples on a single 20 x 10 cm HPTLC plate.

TLC has several advantages over HPLC apart from the number of samples that can be chromatographed simultaneously. These include:

(1) Solvent is removed before quantitative determination, so that only solvent properties that effect separation need be considered and optical properties of the solvent may be ignored.

(2) No sample clean-up is necessary as plates are discarded after each analysis; this is an important consideration when dealing with samples such as molasses.

(3) The cost of solvent is small as only millilitre quantities are used in development tanks of modern design; this can be an important consideration where a large number of samples are analysed, as solvents for liquid chromatography are relatively expensive, owing to the high purity required.

(4) There are fewer constraints in performing post-separation visualizing reactions in TLC than in HPLC; in general such reactions can be optimized in TLC without interfering with the quality of a separation.

(5) Where necessary, plates can easily be impregnated with substances that will improve separation.

(6) Marginal separations can often be dramatically improved by performing multiple developments[11].

TLC has always been constrained by the relatively short plate length that can be used which, in turn, has always limited the number of compounds that can be separated in a single run to about six or seven. This shortcoming can be overcome by using a suitable multiple development technique. These are:

(i) *Two-dimensional TLC.* A sample is spotted near one corner of a plate and the plate is developed using a solvent that will separate many, but not all of the sample components. The plate is then dried, rotated through 90° and then redeveloped with a second solvent, chosen to separate those spots that were still merged after the first development. Solvents having different properties are used for the two developments. A mixture containing up to about 25 components can be completely separated using this technique. TLC plates are commercially available such that the first development, on an octadecylsilane surface, is in the reverse-phase mode while the second development, on silica gel, is in the normal-phase mode.

(ii) *Programmed multiple developments.* This refers to performing repeated developments, with drying in between, along the same axis. There are actually three forms of multiple developments in this sense, PMD being the most sophisticated[11,12]. A description of PMD is given in Perry's article[11]. The effect of multiple developments is to sharpen TLC spots and hence to improve resolution between spots. The sharpening occurs on redevelopment because the tailing edge of a spot is reached by the solvent before the leading edge. Thus the tailing edge starts to move (and approaches) the leading edge, before the latter is reached by the solvent. It should be noted that after a given number of redevelopments, spot resolution starts to decrease instead of increase. The optimum number of developments depends on the solvent that is used and will be higher for a weak solvent than for a strong solvent. In general, the higher the value of the optimum number, the better will be separation between components. Figure 4 illustrates the improved separation of a series of malto-oligosaccharides obtained by performing multiple developments.

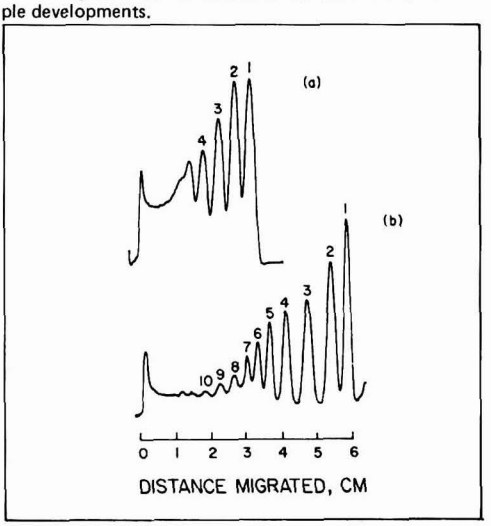


Fig. 4. Chromatograms developed with 2:2:1 (v/v/v) 1-butanol-ethanol-water as solvent: (a) single development of 1hr; and (b) six replicated 1-hr developments. Numbers indicate the degree of polymerization. 1, D-glucose, 2 and higher, malto-oligosaccharides. From Nurok & Zlatkis: *Carbohyd. Res.*, 1980, **81**, 167. *(Reprinted with permission)*

(iii) *Controlled migration thin layer chromatography* (CMTLC). This is a new technique developed by the author[13]. It differs from all other forms of TLC by having a movable point of solvent application. TLC can only be performed efficiently when the solvent front moves no more than 10 to 20 cm from the origin. This of course limits conventional TLC to a 20 cm plate and severely limits the number of spots that can be separated. However, by moving the point of solvent application, a plate of any length can in principle be used and 40 cm plates have already been successfully developed in the author's laboratory. CMTLC is classified as a multiple development technique as it is most efficiently performed when several developments are used for a given separation.

Carbohydrate separation by high performance TLC

HPTLC appears to be an ideal technique for the analysis of molasses, owing to the lack of clean-up

11 Perry, Jupille & Glunz: *Anal. Chem.*, 1975, **47**, 65A.
12 Thoma: *ibid.*, 1963, **35**, 214.
13 Nurok: *ibid.*, 1981, **53**, 714.

requirements and the large number of samples that can be analysed simultaneously. The accuracy of the technique is sufficient for molasses but at the present stage of development may be inadequate for sugar juice. The overall accuracy can, of course, be much improved by simultaneous analysis of a large number of replicate samples.

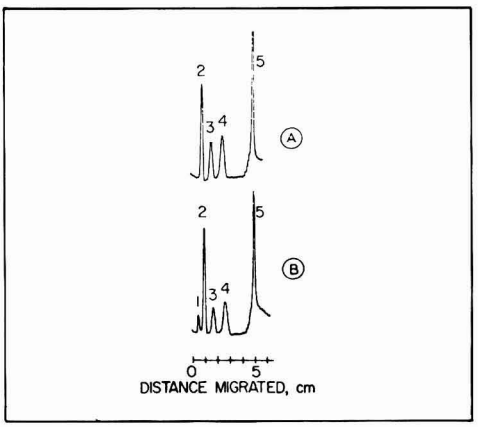


Fig. 5. A, HPTLC chromatogram of sugar mixture (50 ng each): B, HPTLC chromatogram of molasses sample (300 ng); 1 = kestose and higher sugars; 2 = sucrose; 3 = glucose; 4 = fructose; 5 = solvent front. From Lee, Nurok & Zlatkis: *J. Chromatogr.*, 1979, **174**, 187. *(Reprinted with permission)*

The author, together with Dr. Zlatkis and co-workers at the University of Houston, investigated the analysis of final molasses by HPTLC. The solvent used, as well as the TLC plate treatment, were based on a 1972 report by Welch & Martin[14]. Glucose and fructose are difficult to separate on a silica gel plate owing to their similar structures. This problem is easily overcome by impregnating the plate by dipping in a 0.2 M solution of monobasic potassium hydrogen phosphate. Figure 5 shows the separation of carbohydrates in a molasses sample. Figure 6 shows the absorption spectra of glucose, fructose and sucrose as determined after a visualization reaction based on the reaction of a diphenylamine reagent with the separated carbohydrates. A TLC scanner was used to generate the information for Fig. 5. The precision of the method is dependent on the period of time that the plate is heated after treatment with the reagent. The method yields a relative standard deviation of about 1% for sucrose after an optimum heating period of 30 minutes. This precision is better than has been previously reported in the TLC literature.

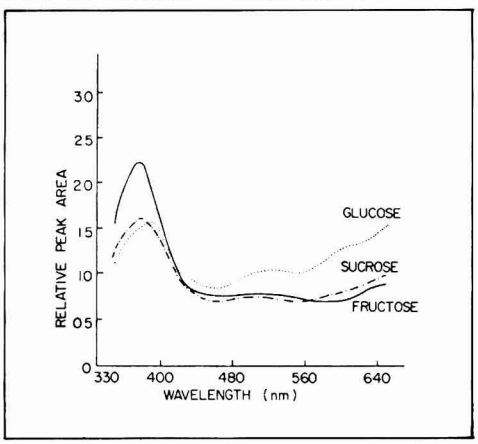


Fig. 6. Absorption spectra of sucrose, glucose and fructose derivatized on a TLC plate (50 ng each). From Lee, Nurok & Zlatkis; *J. Chromatogr.*, 1979, **174**, 187. *(Reprinted with permission)*

Summary

A description is presented of the analytical techniques of thin-layer chromatography, high-performance liquid chromatography, high-performance thin-layer chromatography and multiple-development thin-layer chromatography, together with their application to separation of sugars in a mixture such as molasses.

La chromatographie liquide, moderne

L'auteur décrit les techniques analytiques de la chromatographie sur couche mince, chromatographie liquide à haute performance, chromatographie à haute performance sur couche mince et chromatographie sur couche mince à multiple développement, aussi leur application à séparation des sucres dans un tel mélange comme la mélasse.

Die moderne Flüssigchromatographie

Die Analysentechniken von Dünnschicht-Chromatographie, Hochdruck-Flüssigchromatographie, Hochdruck-Dünnschichtchromatographie und Dünnschicht-Chromatographie mit vielfacher Entwicklung wird beschrieben, auch ihre Anwendung zur Trennung der Zucker in einem Gemisch wie z.B. Melasse.

Cromatografía líquida moderna

Se presenta una descripción de las técnicas analíticas de cromatografía a capa delgada, cromatografía líquida de funcionamiento alto, cromatografía a capa delgada de funcionamiento alto, y cromatografía a capa delgada de desarrollo múltiple, junto con su aplicación a la separación de azucares en una mezcla tal como melaza.

Indian fund for sugar industry modernization[15]. – The Indian government has introduced legislation to create a special fund by means of a levy of between 5 and 10 rupees ($0.55 – $1.10) on every 100 kg of sugar produced in all factories. The government expects collections to total about 350 million rupees ($38.5 million) a year. A committee of officials will administer the fund, advancing loans to factories to obtain modern machinery to replace obsolete equipment, thereby making them more efficient. Most Indian sugar factories were built many years ago with a crushing capacity of less than 1250 t.c.d., now considered uneconomical.

Ethiopian sugar factory expansion[16]. – The Metahara sugar factory in Ethiopia has been expanded to an annual production capacity of 46,000 tonnes at a cost of $46.2 million.

Yugoslavia sugar expansion plans[17]. – By 1985 Yugoslavia plans to reach an annual sugar beet production of 7.9 million tonnes. Production in 1981 is reported to have been 6,140,000 tonnes, 18% higher than the previous crop. The United States Department of Agriculture in a recent field report said that, of the 30,000 tonnes of sugar approved for export, 10,000 tonnes have already been shipped to Syria and negotiations are under way for sale of the additional 20,000 tonnes to the same destination.

14 *J. Chromatogr.*, 1972, **72**, 359.
15 F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 38.
16 *World Sugar J.*, 1982, **4**, (7), 37.
17 F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 57.

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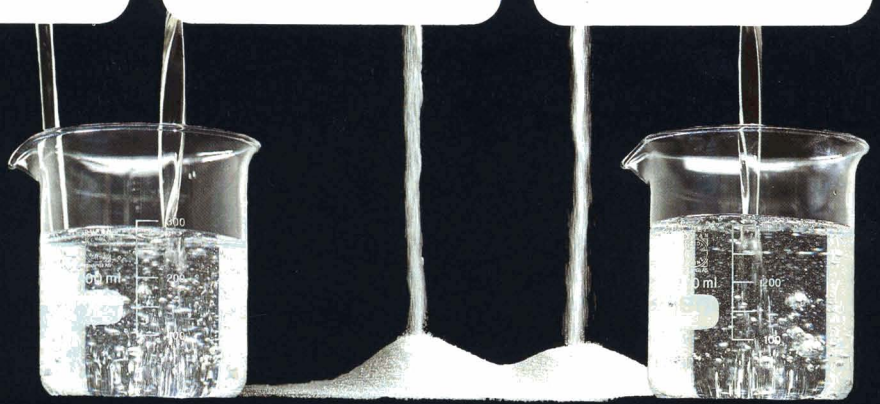

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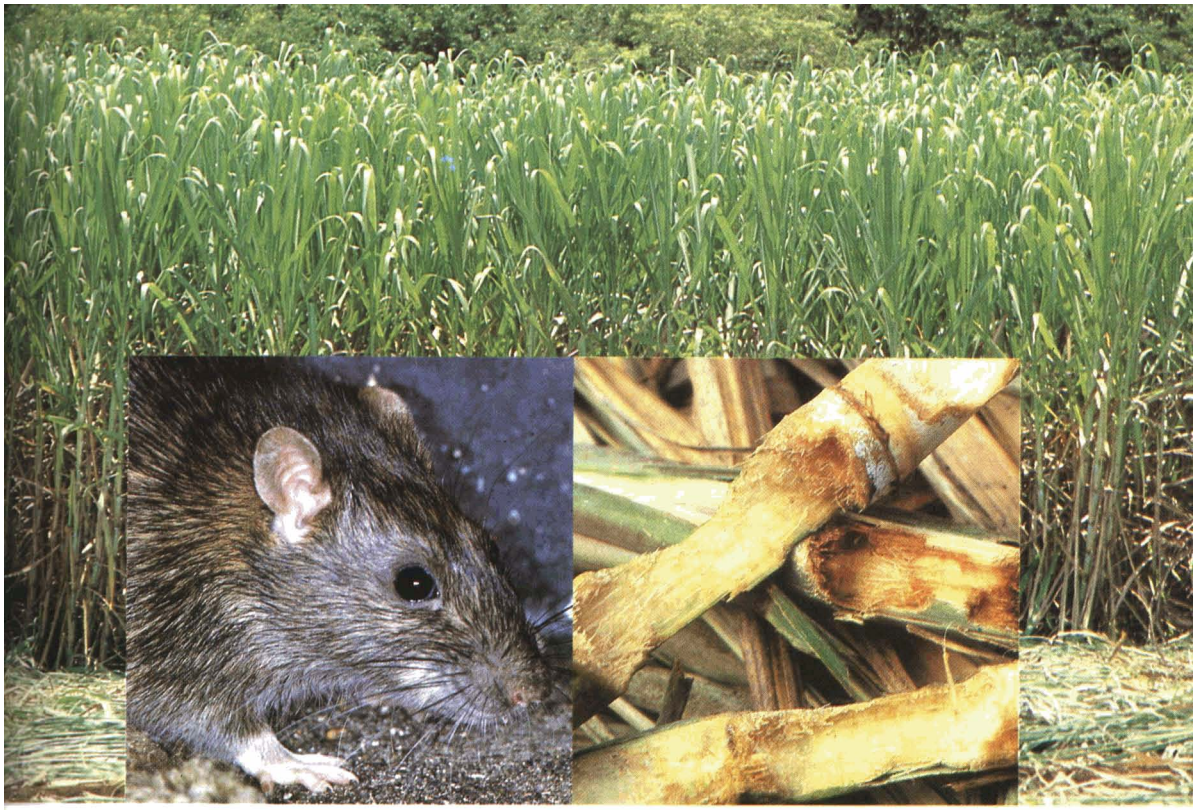

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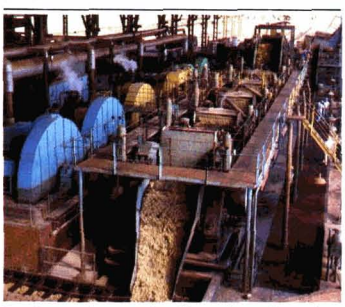

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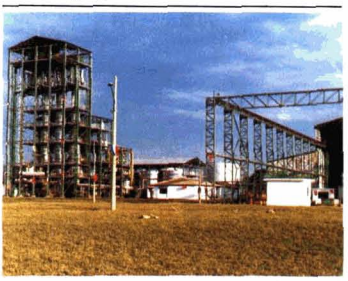

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A modified haze/enzymic method of dextran determination

By J. C. LI SUI FONG* and G. T. MBAGA†

Introduction

Tilbury[1] and Hueck[2] have described two types of sugar cane deterioration, namely autolysis (staling) and biodeterioration (sour storage rot), and have attributed staling to the action of natural enzymes and biodeterioration to the vital activities of micro-organisms that prey on sugar cane. Egan *et al.*[3] also made a distinction between staling and sour storage rot, the former being considered as a slow biochemical degradation of sucrose involving natural processes and weak pathogens and the latter a condition whereby there is a fast decline in the sucrose content of cane accompanied by a rapid accumulation of high molecular weight polysaccharides.

Post-harvest deterioration of sugar cane is therefore generally associated with sucrose losses which are in turn accompanied by the formation of reducing sugars, colorants and microbial metabolites such as lactic acid, acetic acid and dextran. Consequently, deterioration of cane may be monitored by the loss or formation of these compounds or by microbial tests.

In fact, since sour storage rot is nearly always characterized by the formation of dextran which is itself brought about by dextransucrase produced extracellularly by *Leuconostoc mesenteroides, L. dextranicum, L. casei* and *L. confusus*[3], various methods have been developed to quantify dextran[4–9] – methods which are based on the chemical structure (e.g. hydrolysis methods) or the physical properties of dextran (e.g. turbidimetric or viscosity methods). The hydrolysis or enzymic methods are, however, affected by the variations of the dextran structures and the physical methods are not specific because they also measure polysaccharides other than dextran. In addition, many of the more sophisticated methods are time-consuming and require expensive equipment.

In the present studies, it was attempted to develop a simple method of dextran determination, which would improve the specificity of the Nicholson & Horsley haze method[4] and at the same time be less time-consuming than the enzymic method of Richards & Stokie[6]. In this proposed method, alcohol is added to the raw juice and the haze formed is measured. A second sample of juice is treated with dextranase such that all the dextran present is hydrolysed, and the haze formed on the addition of alcohol is again measured. The difference in absorbance then gives a measure of the dextran originally present.

J. C. Li Sui Fong

G. T. Mbaga

MATERIALS AND METHODS

Characterization of dextranase

Tilbury[10], Hidi & Starker[11], and Fulcher & Inkerman[12,13] have examined the properties of the enzymes used for hydrolysing dextran and have obtained results which were not concordant. As a first step, therefore, the factors affecting the activity of the dextranase (from *Penicillium* species) used in our studies were evaluated.

Influence of molecular weight

Dextran T10, T40, T70, T500, and T2000 (Pharmacia, Sweden) were used. Two different concentrations (12.5 mg and 25 mg) of each of the above fractions were incubated with 0.001 mg of dextranase (0.037 EU) at 37°C for 15 minutes in a phosphate buffer of pH 6.0. 0.2 volume of 10% trichloroacetic acid was added and the mixture rapidly cooled in ice to stop the hydrolysis.

AnalaR-grade absolute ethyl alcohol containing 2% methyl alcohol was then added to give a final concentration of 50% alcohol and the haze formed measured at 720 nm.

Figure 1 shows that the amount of dextran hydrolysed decreased with increasing molecular weight, although the amount hydrolysed was practically similar for the dextran fractions of molecular weights 70,000, 500,000 and 2,000,000. These results are in agreement with the findings of Tilbury[10] but disagree with those of Fulcher & Inkerman[13] who stated that the enzyme activity was independent of the type of dextran. Since the latter authors worked with cane dextrans, which, according to Imrie & Tilbury[14], have molecular weights in the range $10^5 - 10^7$, the lack of difference in enzyme activity which they observed could possibly be explained

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† Chemist, Mtibwa Sugar Estates Ltd., Tanzania.

1 PhD Thesis (University of Aston, Birmingham), 1970.
2 *Material und Organismen*, 1965, **1**, 5-34.
3 Egan, Kirby & Noble: *Proc. 16th Congr. Int. Soc. Sugar Cane Tech.*, 1977, 321-325.
4 Nicholson & Horsley: *J. Agric. Food Chem.*, 1959, **7**, 640-643.
5 Keniry, Lee & Mahoney: *I.S.J.*, 1969, **71**, 230-233.
6 Richards & Stokie: *ibid.*, 1974, **76**, 103-107.
7 Hellsing, Enstrom & Richter: *Anal. Biochem.*, 1976, **76**, (1), 149-156.
8 Hidi, Keniry, Mahoney & Paton: *Sugar J.*, 1976, **39**, (2), 25-31.
9 Walkley & Tillman: *J. Chromatography*, 1977, **132**, (1), 172-174.
10 *Proc. 14th Congr. Int. Soc. Sugar Cane Tech.*, 1971, 1444-1458.
11 *Proc. 42nd Conf. Queensland Soc. Sugar Cane Tech.*, 1975, 331-344.
12 *Proc. 41st Conf. Queensland Soc. Sugar Cane Tech.*, 1974, 161-169.
13 *Proc. 43rd Conf. Queensland Soc. Sugar Cane Tech.*, 1976, 295-305.
14 *Sugar Tech. Rev.*, 1972, **1**, 291-361.

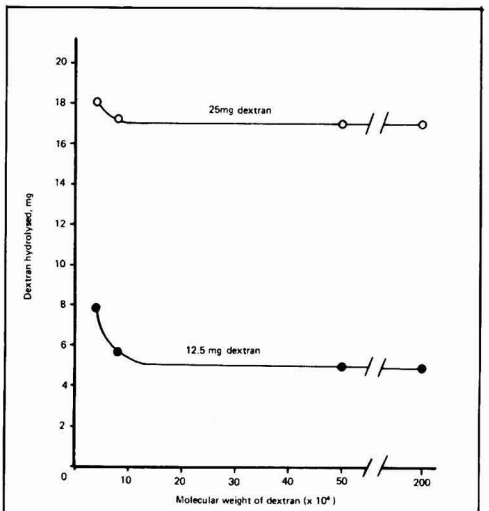

Fig. 1. Influence of molecular weight on dextranase activity

by the fact that the dextrans studied were all of high molecular weights.

Influence of temperature

Samples of 12.5 mg of dextran T500 were incubated at different temperatures with 0.001 mg (0.037 EU) of the enzyme, the hydrolysis being carried out at pH 6.0 for 15 minutes. The enzyme activity increased with temperature and was optimal at 50°C (Figure 2). Increasing temperatures (above 60°C) caused a sharp decline in the amount of dextran hydrolysed. These results are similar to those obtained by Hidi & Starker[11] and Fulcher & Inkerman[13].

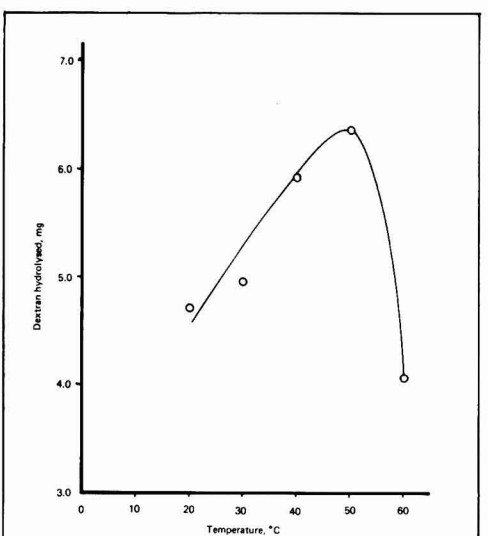

Fig. 2. Influence of temperature on dextranase activity

Influence of pH

The influence of pH on the activity of dextranase was studied using incubation times of 10 and 18 minutes. Samples of 25 mg of dextran T500 were hydrolysed by 0.001 mg of the dextranase at 37°C and at pH 4.5, 5.0, 5.5, 6.0 and 7.0 respectively.

The results appear in Figure 3 which shows that the amount of dextran hydrolysed increased with increasing pH and was at a maximum at a pH of 5.5. These results compare favourably with those of Tilbury[10], Hidi & Starker[11] and Fulcher & Inkerman[13].

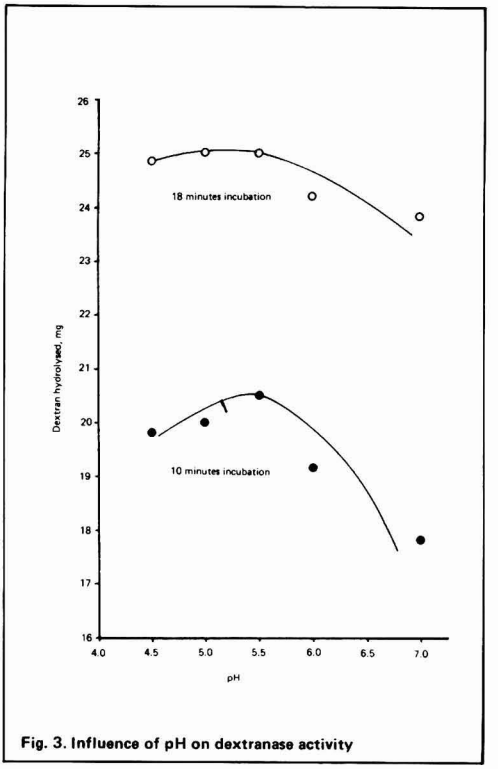

Fig. 3. Influence of pH on dextranase activity

Influence of enzyme to substrate ratio

The enzyme to substrate ratios (w/w) used were 0.01, 0.02, 0.03 and 0.04. The hydrolysis was carried out at 37°C in a phosphate buffer of pH 5.5. The results are given in Table I and show that with an enzyme to substrate ratio above 0.03%, hydrolysis is completed in 35 minutes.

Table I. Percentage hydrolysis of dextran T500 at different dextranase/dextran ratios

	Incubation time (minutes)			
Enzyme % dextran	0	5	20	35
0.01	0%	6.6%	26.2%	44.3%
0.02	0%	17.5%	37.9%	65.0%
0.03	0%	19.7%	78.7%	100.0%
0.04	0%	18.3%	98.9%	100.0%

A ratio of 0.04%, a pH of 5.5, an incubation time of 35 minutes and a temperature of incubation of 50°C

were therefore adopted in the subsequent analyses to ensure complete hydrolysis.

Determination of dextran in cane juice

Take 50 ml of the juice, add filter aid (kieselguhr) and filter using a general purpose filter paper. Collect the filtrate after rejecting the first 10 ml.

Pipette 4.0 ml of the filtrate into two test tubes of the same size. Equilibrate to a temperature of 50°C in a thermostatically controlled water bath.

Pippette 1.0 ml of dextranase solution (0.037 EU/ml in 0.1 M phosphate buffer solution of pH 5.5) into one of the test tubes and start stopwatch.

To the other test tube add 1.0 ml of 0.1 M phosphate buffer pH 5.5.

After exactly 35 minutes of incubation, remove both tubes from the water bath and cool rapidly in ice.

Add 5.0 ml of denatured alcohol dropwise with gentle agitation, taking care to avoid the formation of flocs.

After 20 minutes, measure the absorbance (at 720 nm) of the haze formed against a blank containing 4.0 ml of the filtered juice, 1.0 ml of the buffer solution and 5.0 ml of distilled water.

Find the absorbance due to the dextran by subtracting the absorbance of the hydrolysed juice from that of the unhydrolysed juice, and determine the dextran content from a standard dextran curve.

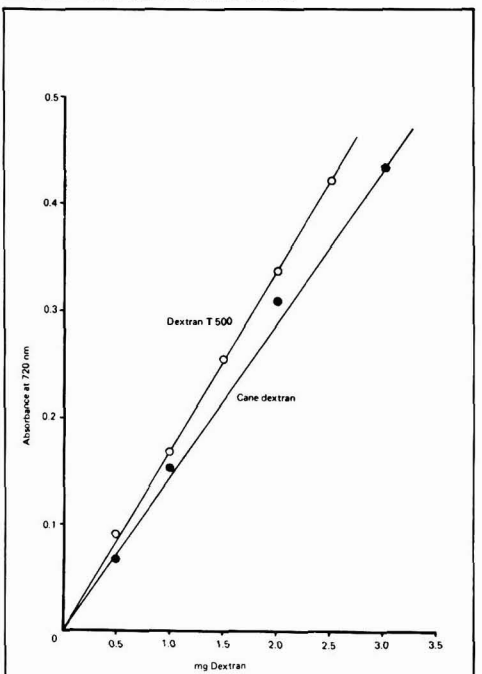

Fig. 4. Standard curves for Dextran T500 and cane dextran

Preparation of standard dextran curve

Prepare a standard dextran T500 solution containing 2 mg/ml of the dextran in distilled water. Pipette 0, 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50 ml of the dextran solution into seven test tubes each containing 2.0 ml of 50% sucrose solution and 1.0 ml of phosphate buffer of

pH 5.5. Add distilled water to each test tube to obtain a final volume of 5.0 ml in each case.

Using another test tube, prepare a blank by mixing 2.0 ml of 50% sucrose solution, 1.0 ml of buffer solution and 7.0 ml of distilled water. Add 5.0 ml of denatured alcohol to the first seven test tubes and after 20 minutes read the absorbance of the haze at 720 nm. Plot a graph of absorbance against mg dextran.

Calculation of dextran content

The dextran content is calculated from the following relationship:

$$\text{ppm dextran on Brix} = \frac{10^5 . m . f}{B . d . V}$$

Where m = mg dextran from standard curve
f = volume of juice before addition of alcohol/original volume of juice used
B = Brix of juice (°Bx)
d = density of juice (from Brix conversion table)
V = volume of juice (ml)

RESULTS AND DISCUSSIONS

Figure 4 shows the standard curves for dextran T500 and cane dextran. Both curves are similar to those obtained by the Nicholson & Horsley method[4] (Figure 5) with the exception that they tend to bend towards the dextran axis when the concentration of dextran exceeds 3.0 mg.

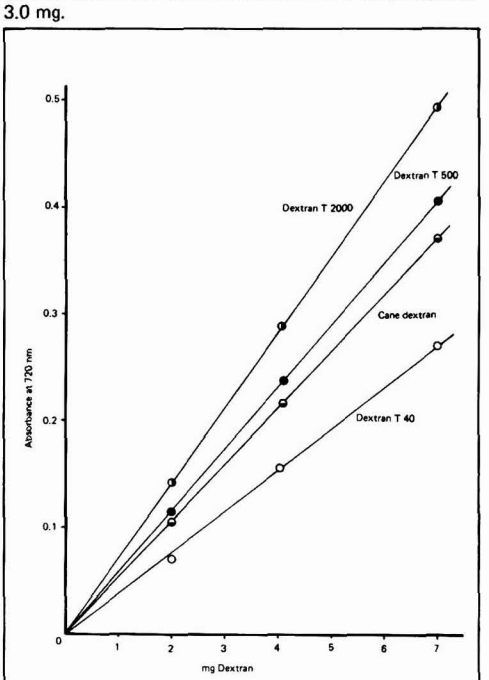

Fig. 5. Standard curves for dextrans of different molecular weights

Table II summarizes the results obtained for the extent of hydrolysis at different pH (range of pH found in fresh and deteriorated juices) and shows that hydrolysis, under the conditions employed, is not affected in the pH range of 4.5 – 6.0. Therefore, the method may be applied to cane juices without the need of adjusting the pH.

Table II. Influence of pH on hydrolysis of dextran T500

pH	4.5	5.0	5.5	6.0
% dextran hydrolysed	99.6	99.6	100	100

Similarly, the hydrolysis of dextran at pH 5.5 was not affected when the molecular weight was varied from 7×10^4 to 2×10^6 (Table III).

Table III. Influence of molecular weight on hydrolysis of dextran

Molecular weight (x 10^3)	70	500	2,000
% dextran hydrolysed	99.6	100	99.6

The sucrose content was also varied from 10 to 20% (wt/vol) so as to cover the range normally found in cane juices. The results obtained (Table IV) show that complete hydrolysis was achieved for all juice samples with a sucrose content in that range.

Table IV. Influence of sucrose content on hydrolysis of dextran T500

Sucrose %	10	15	20
% dextran hydrolysed	99.6	100	100

Thus the sucrose content, pH, and molecular weight of dextran normally encountered in fresh and deteriorated cane juices have no influence on the extent of hydrolysis.

The results obtained for juice samples analysed by this method and by the Nicholson & Horsley method[4] are shown in Table V: the corresponding results differ by a range varying from 4 to 30%, the results of the proposed method being always higher than those found by the Nicholson & Horsley method.

Table V. Comparison of proposed method with that of Nicholson & Horsley

Juice Sample	Proposed method	Nicholson & Horsley method	% Difference
	ppm dextran on Brix		
A	3307	3039	9
B	3783	3631	4
C	7161	5644	26
D	8432	6450	30
E	11126	9005	24
F	13165	10299	28

Table VI gives the recoveries of cane dextran added to a dextran-free cane juice and shows that they varied from 70 to 110% and were generally higher than the recoveries obtained by the Nicholson & Horsley method (90-98%) and the enzymic method of Richards & Stokie[6] (67-96%), possibly because of the similarity between cane dextran and the standard dextran used.

Table VI. Dextran recoveries by proposed method

Dextran added (mg)	1.0	2.0	3.0	4.0
Amount found (mg)	0.7	2.0	3.3	4.2
% recovery	70	100	110	105

The proposed method therefore involves a simple alternative of finding the dextran content in which the difference in absorbance of the haze formed before and after enzymic hydrolysis is measured without the necessity of separating other compounds in the juice such as starch and protein. Other advantages of the method lie in the higher dextran recoveries and improved specificity compared with the haze method. However, the method would not be applicable to low molecular weight dextrans.

Summary

A comprehensive description is given of a simple method of determination in which the dextran content is found from the measurement of the haze formed before and after enzymic treatment and in which the recoveries of cane dextran vary from 70 to 110%.

Une méthode modifiée pour la détermination du dextrane par turbidité enzymatique

Une méthode de détermination aisée est largement décrite, dans laquelle la teneur en dextrane est trouvée par mesure du trouble formé avant et après traitement enzymatique et dans laquelle la quantité retrouvée de dextrane de la canne varie de 70 à 110%.

Eine modifizierte enzymatische Methode mit Trübungsmessung zur Dextranbestimmung

Es wird eine umfassende Beschreibung einer einfachen Bestimmungsmethode gegeben, bei der der Dextrangehalt durch Messung der Trübung vor und nach der enzymatischen Behandlung bestimmt wird, und bei der die Ausbeuten an Rohrdextran zwischen 70 und 110% schwanken.

Un método modificado para determinación de dextrano por caline y enzima

Se presente una descripción comprensivo de un método sencillo para determinación de dextrano en que el contenido es logrado de las medidas de la calina formado antés y después de tratamiento enzimatico, y en que las recuperaciones de dextrano de caña varia entre 70% y 110%.

Cane rust disease in Colombia[1]. – Sugar cane rust has been found in the Cauca Valley, the main cane growing area of Colombia. About 100 hectares have been affected and it is generally assumed that this will affect sugar production in 1982, although no assessment of the possible damage has been given. The 1982 crop was originally estimated at 1,270,000 tonnes, raw value, and 1982 exports were projected at 240,000 tonnes.

[1] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 74.

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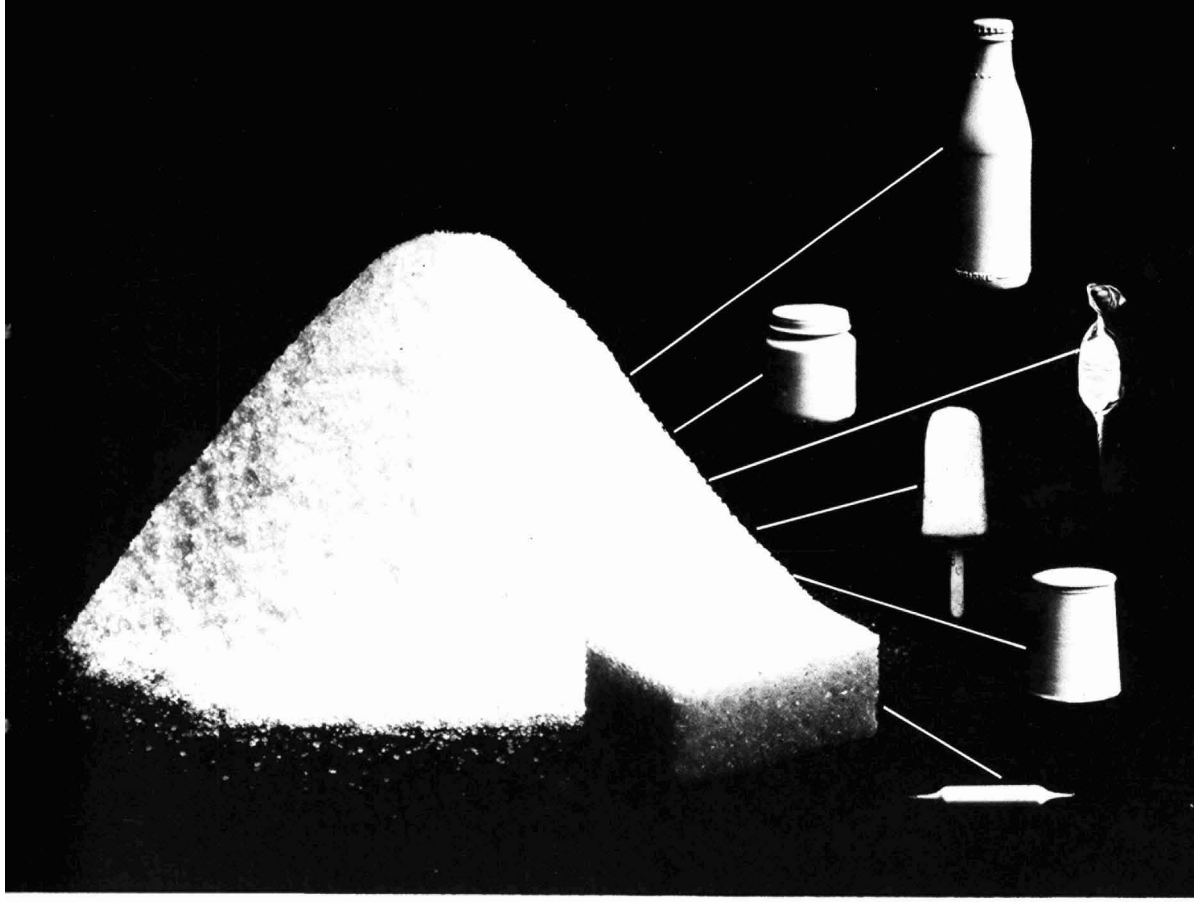

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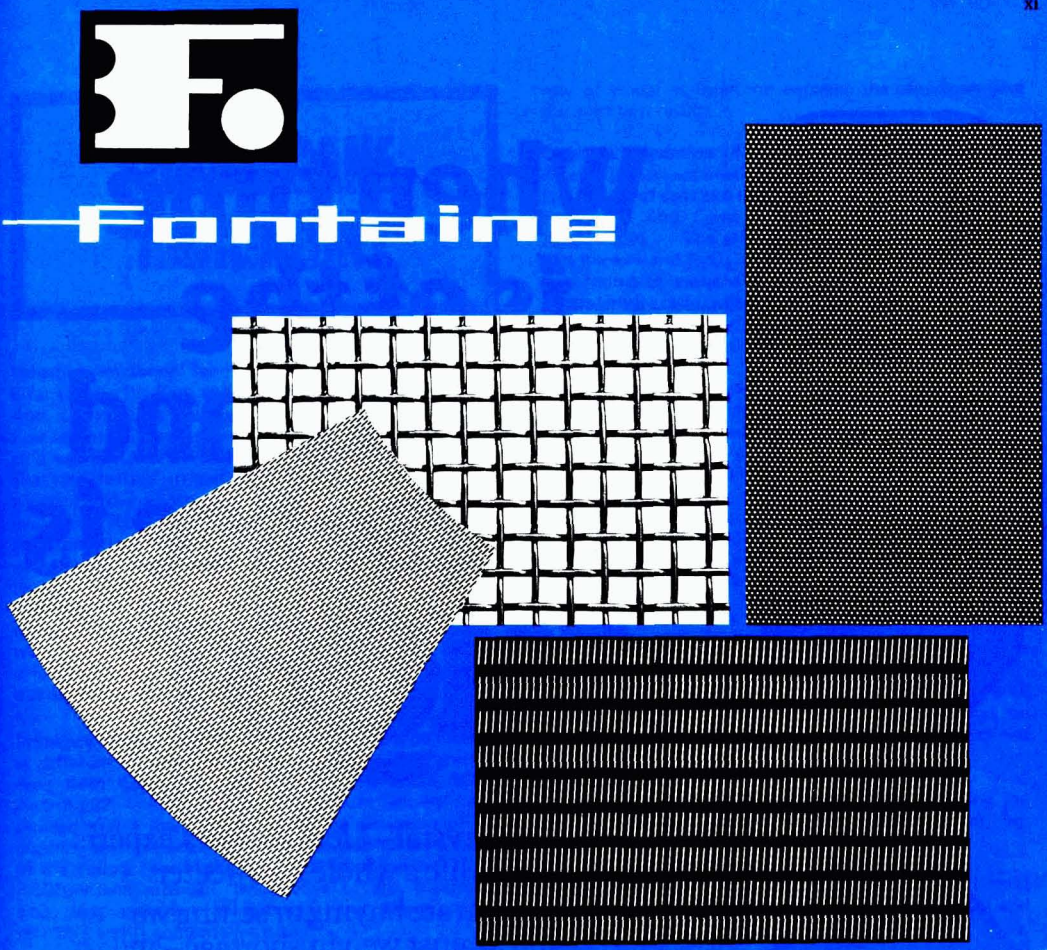

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SUGAR CANE AGRONOMY

Irrigation methods for the sugar cane crop. R. K. Sivanappan, P. Rao and D. Palaniswamy. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.1-Ag.8. Five irrigation methods were tested over a period of up to 5 years, viz. drip irrigation with and without furrows, alternate furrow irrigation, skip furrow irrigation (in which furrow width was varied) and normal furrow irrigation. Results indicated that both types of drip irrigation used least water of all the methods tested while giving the highest cane yields. Skip furrow irrigation used almost as little water as drip irrigation but gave a cane yield which was only slightly higher than with normal furrow irrigation. Hence, some 50% of irrigation water can be saved by using drip instead of furrow irrigation, or 30-40% with skip furrow irrigation, without detriment to cane yield.

Influence of age, tissue moisture and nitrogen on c.c.s. % at different months of harvest of cane. K. R. Perumal. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.9-Ag.22. – Investigation of cane from farmers' fields showed that a lower c.c.s. during the early part of the crushing season (October/November) was mainly a result of the younger age of the cane and higher levels of tissue moisture and nitrogen. Irrespective of age, maximum c.c.s. was recorded in February and March, when moisture and N contents were low.

In a quest to increase sugar productivity in sugar cane. A. V. Bendigeri, S. S. Patil and D. G. Hapase. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.31-Ag.37. Replicated trials were conducted for three consecutive years to determine the effects of spraying with Polaris and Cycocel ripeners on the sugar yield and c.c.s. of variety Co 740. Polaris applied at 4 $kg.ha^{-1}$ in 1000 litres of water during floral initiation (3rd week of September) increased sugar yield and c.c.s. respectively by 9.62% and 15.40% in the 10-month crop (harvested in December) by comparison with the untreated control. Cycocel applied at the same rate as Polaris also increased both parameters by comparison with the control, but to a lesser extent than Polaris.

Studies on the effect of winter intercrops in sugar cane on yield and quality of sugar cane. M. R. Reddy. *Proc. 44th Conv. Sugar Tech. Assoc. India,* 1980, Ag.39-Ag. 48. – Trials on cane intercropping with blackgram, cowpea and wheat showed that none of the intercrops affected cane germination, but that intercropping with two rows of cowpea or two or three rows of wheat between the cane rows suppressed tillering. The highest number of millable stalks was recorded with blackgram as intercrop and was the same as when cane was grown alone. Intercropping with more than one row of cowpea or wheat between the cane rows adversely affected cane juice quality and sugar yield. Highest net additional income was obtained with two rows of blackgram; one row of wheat as intercrop between the cane rows gave the next best results.

Chemical regulation of sucrose in sugar cane. Effect of Polaris (foliar application) on N/P and invert ratio in juice, yield of cane and sugar. K. C. Rao and S. Thangavelu. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980 Ag.87-Ag.91. – The effect of Polaris on the invert ratio and juice N and P_2O_5 contents was studied. The ripener was found to cause a significant decrease in reducing sugars, invert ratio, juice N and N:P ratio and an increase in sugar content 8 and 12 weeks after application. Cane yield was unaffected.

Response of sugar cane to various intercrops under different water management practices. R. S. Joshi, K. R. Patel, J. D. Awadaria and H. C. Mehta. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.109-Ag.118. – Intercropping with garlic, wheat or pea was investigated as well as the effects of water management. Of the intercrops, pea proved the most profitable, while garlic caused a net loss. All three intercrops caused a fall in cane yield. Depth of water and frequency of irrigation did not have any significant effect on cane yield.

A monitoring system of cane quality and its control in the sugar industry. G. S. C. Rao and A. J. Mujumdar. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.119-Ag.129. – A preliminary study showed that the mean of the maximum and minimum Brix (determined by hand refractometer) of individual canes in a consignment received at the factory yard was a fairly good indication of quality, as confirmed by monitoring the primary juice Brix. A sample size of 40 canes per consignment was reasonably representative.

Effect of leaf and juice nitrogen in cane at different growth phases on yield and quality. K. R. Perumal and B. Krishnan. *Proc. 44th Ann. Conv. Sugar Assoc. India,* 1980, Ag.143-Ag.158. – Regression analysis showed that cane and sugar yield and sugar content were positively affected by leaf nitrogen at the 6th month of growth and at harvest, whereas increase in the juice N content was accompanied by a marked fall in cane and sugar yield.

Ratoon cane management. K. K. Prasadarao. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.159-Ag.172. – The advantages and disadvantages of ratoon crops are discussed and recommendations given on practices to give best possible yields.

A study on the effect of pre-mixing compost on the efficiency of phosphate fertilization of sugar cane in saline alkali calcareous soils. P. K. Bose and K. Thakur. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.179-Ag.186. – Replacement of 50 kg. ha^{-1} N with compost pre-mixed with phosphate and reducing the inorganic N application from 170 to 120 $kg.ha^{-1}$ allowed the optimum dose of phosphate (in terms of cane yield and chemical status) to be halved.

Rotary filter cake in combination with different forms of phosphorus, with views to substitution for castor cake and water-soluble phosphate in the fertilization of plant cane. J. T. Coleti, V. C. Bittencourt and G. M. Giacomini. *Brasil Açuc.,* 1980, **96**, 350-361 *(Portuguese).* – Comparative parallel trials using the two combinations of the title showed that the former could be substituted

satisfactorily for the latter.

Importance of chemical analysis of the soil in the fertilization of sugar cane. J. Orlando. *Brasil Açuc.*, 1980, **96**, 362-366 *(Portuguese).* — The amount of a nutrient which should be applied to a soil is the level which gives the maximum yield less the quantity already present in the soil. In order to economize on the high cost of fertilizers the soil nutrient level should therefore be determined, and practices of the IAA-Planalsucar which contribute to this aim are discussed.

The winged subsoiler as an implement for preparation of the soil for sugar cane. J. Fernandes, V. L. F. Neto and R. Stolf. *Brasil Açuc.*, 1980, **96**, 367-374 *(Portuguese).* Tests with a number of soil preparation implements showed that the use of a subsoiler fitted with "wings" in the lower part gave results as good as with a disc harrow, so that it could be substituted for preparation of the soil prior to cane planting.

Efficiency of inoculants for composting of rotary filter cake. A. F. da Eira and A. A. Paccola. *Brasil Açuc.*, 1980, **96**, 386-395 *(Portuguese).* — Filter cake was composted using three inoculants — Cofuna, Nutri-Humus and forest soil — alone and enriched with N and P. The efficiency was evaluated by passing air through the mixtures in closed containers and measuring the amount of CO_2 produced by respiration. It was concluded that Cofuna and the forest soil performed equally well and better than the Nutri-Humus, while the enrichment with N and P produced a benefit only in the initial stages. It was also concluded that effective inoculation may be achieved with a microbiologically active soil or by the naturally decomposed substrate itself.

Field origins of dextran and other substances affecting sucrose crystallization. J. E. Irvine. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 116-120. — Apart from potassium (most of which occurs in the cane tops), the cane non-sugars that have an adverse effect on sugar crystallization are polysaccharides such as starch, gums and sarkaran (an α-glucan thought to be a product of naturally occurring enzymes), while levan and dextran are metabolic products of bacterial growth; levan, a fructose polymer produced by *Bacillus subtilis* and *B.cereus,* is of factory rather than field origin, while dextran, the glucose polymer produced by *Leuconostoc mesenteroides,* is of both field and factory origin. Burning standing cane to facilitate harvesting removes the surface wax, causes cracks in the rind and "cooks" the underlying storage tissue; with a good burn, stalk structure may be so weakened that juice begins to ooze from it and becomes infected by *L.mesenteroides;* the bacterium will also enter frozen cane, purchase of which carries a penalty in the USA. Bad handling of cane during and after harvesting will also cause deterioration and processing problems, as can storage. The problem could be solved by developing a harvester which would combine the capacity of the chopper type with the flexibility of the soldier harvester and the economy of the Vee-cutter.

Control of *Sorghum halepense* (L.) Pers. and other weeds in sugar cane with mechanical soil cultivation and herbicides. J. C. Díaz D. and F. Naranjo M. *Cienc. Agric.*, 1980, (5), 109-124 *(Spanish).* — Increasing the number of ploughings from two to four had a marked effect in the destruction of soil rhizomes of *S.halepense* and in the decrease of weed density, except for dicotyledons. The best herbicide treatment of those examined was Dalapon + 2,4-D amine at 10.8 + 1.15 kg.ha^{-1} a.i. which gave good control of all weed species present up to 80 days from planting. Poorer control was achieved with 4 kg.ha^{-1} a.i. Asulam and 4.5 + 2 kg.ha^{-1} Dalapon + Asulam. Herbicides were not applied to the cane foliage, and no phytotoxic effects on the crop were detected. No such damage was recorded over three months for a cane crop in which 9 and 18 kg.ha^{-1} of Dalapon was applied as pre-planting and pre-emergence treatment.

Sampling and estimation of the principal yield parameters of sugar cane. N. Milanés R. *Cienc. Agric.*, 1980, (5), 155-162 *(Spanish).* — On a basis of previously reported work, conclusions are drawn on the methods that should be applied for the sampling of cane and determination of Brix, juice pol and stalk weight, while a procedure is proposed for collection of stalks from an experimental plot from which to estimate the cane yield, instead of harvesting the entire plot.

Influence of the K:N ratio in the fertilization on some foliar indicators and on sugar cane yields. R. de Armas and N. Musienko. *Cienc. Agric.*, 1980, (6), 35-41 *(Spanish).* — Potassium in different amounts was applied with basal amounts of N and P (to give different K:N ratios) and the effects examined using leaves 3-6 as indicator tissue for green weight, moisture, N, P, total sugars and K:H_2O. The higher proportions of K raised green weight and moisture, and reduced total sugars significantly. Leaf K:H_2O increased with increasing K fertilization, but the N and P levels did not change significantly. The sugar content rose with higher K up to a level of K:N = 1 in plant cane and 1.5 in 1st ratoons. High or medium correlations were found between K:N and yields at the different stages of plant development.

Tolerance of three varieties of sugar cane to some herbicides in red ferralitic soil. J. C. Díaz D. and F. Naranjo M. *Cienc. Agric.*, 1980, (6), 43-61 *(Spanish).* — Trials were carried out with three cane varieties to determine their susceptibility to herbicides. No differences were observed between the three: Dalapon 90, applied as a post-emergence herbicide at 10 kg.ha^{-1} of the commercial product, caused significant losses in plant cane (19 months at harvest) and 1st and 2nd ratoons (11½ months), while post-emergence application of Gesapax 80 at 3, 4 and 5 kg.ha^{-1} caused significant losses in both ratoon crops but not plant cane. No significant losses in any crop resulted from pre- or early post-emergence treatment with 9.5 + 4.5 litres.ha^{-1} of Asulox 40 + Actril-D or 3 + 3 kg.ha^{-1} Diuron 80 + Gesapax 80. Pre-emergence treatment with 6 kg.ha^{-1} Diuron 80 caused a significant loss in 1st ratoons and a tendency to loss in plant cane and 2nd ratoons. The effects on growth and tillering, as well as symptoms, are described. The plots remained weed-free during the tests.

Sub-surface irrigation for the Australian sugar industry. L. S. Chapman. *Australian Canegrower,* 1980-81, **2**, (12), 15-18. — See *I.S.J.*, 1980, **82**, 71-74.

Irrigating cane fields. G. Kingston. *Cane Growers' Quarterly Bull.*, 1981, **44**, 68-91. — As an aid to cane growers in considering whether to irrigate or not, how much water to apply and type of system to use, information based on research conducted by Bureau of Sugar Experiment Stations staff at several centres over many

years has been gathered together to form a survey, which is divided into two parts. The first contains data showing the differences in climate between various regions of Queensland and hence differences in the amount of water applied, examines the four factors that are basic to the implementation of an efficient irrigation system (soil and soil water/plant relationships, stages of crop growth, weather patterns and design capabilities of the irrigation system), practical aspects of irrigation, and the various methods used. The second part discusses quality of irrigation water, the effects of water salinity and alkalinity and associated irrigation management to prevent crop yield reduction, and the reclamation of soils affected by salinity and alkalinity.

Studies on soil aeration and sugar cane growth. I. Effects of soil oxygen concentration on the development of sugar cane roots. Y. S. Sheu and T. C. Yang. *Rpt. Taiwan Sugar Research Inst.*, 1980, (89), 1-12 *(Chinese).* Experiments are reported in which the water culture technique was used to investigate the critical point of oxygen concentration at which root development was affected. A special apparatus was designed to provide seven different oxygen concentrations (0.6, 1.1, 2.2, 3.6, 9.1, 14.2 and 19.2%). Results revealed that the root elongation of cane was closely related to oxygen concentration in the root zone. Root elongation was restricted when the oxygen concentration decreased to 9.1% or below; at a concentration below 1.1%, the depth of root elongation was only three-fifths of that at 14.2% oxygen. By means of pot culture, the effects of duration of an oxygen deficiency on the distribution of cane roots were also examined. By controlling the water table to give five levels of oxygen deficiency, it was found that the proportion of the weight of roots in the 0-20 cm soil profile increased as the deficiency period increased, although the total weight of roots decreased.

Studies on the effects of plant growth regulators on the sprouting, growth and yield of ratoon cane. P. C. Yang, F. W. Ho and C. C. Wei. *Rpt. Taiwan Sugar Research Inst.*, 1980, (89), 13-24 *(Chinese).* — The effects of IBA, Ethrel and gibberellic acid (GA) on the sprouting, growth and yield of ratoon cane treated at three different times were investigated; the experiments involved three cane varieties grown in sandy loam soil at the Taiwan Sugar Research Institute, and were laid out in a two-fold split plot design with four replications, using ratooning times (December, February and April) as whole plots, varieties (F 156, F 160 and F 176) as mid-plots and growth regulators (IBA at 200 ppm and Ethrel at 1000 ppm) as small plots. The chemicals were sprayed over the shaved stubble and later on the young ratoon cane. At a later growing stage, 200 ppm GA was sprayed over the leaf canopy. The results showed that both IBA and Ethrel had marked effects in stimulating the development of shoots and tillers of F 156 and F 160 but not of F 176; the first two varieties showed a mean increase of about 20% in the number of shoots over untreated ratoons. No growth suppression in the treated ratoon crop was observed during the mid-growing stage. Application of GA resulted in a significant increase in joint length and weight, regardless of variety or ratooning time. Furthermore, a greater response in stalk elongation was found in the younger than in the older cane. No substantial difference in cane quality was detected between GA-treated cane and control. Spraying with IBA at early and late ratooning increased the cane yields per ha by 8.84 and 5.64 tonnes, respectively, and the sugar yields by 1.30 and 0.93 tonnes, respectively, while treatment with Ethrel at late ratooning increased the cane and sugar yields by 4.07 and 0.80 tonnes.ha^{-1}, respectively.

Studies on sampling in sugar cane for evaluating the sample size for various characters. R. R. Patil, M. Parshad and K. S. Parashar. *Indian Sugar,* 1980, **30**, 349-352. Studies were carried out to establish optimum sample sizes for estimation of plot yield, cane height and diameter and the number of internodes per stalk. For a plot measuring 7 x 5.4 m with six rows spaced 90 cm apart, two cane rows selected at random were adequate. For cane height and number of internodes, four rows per plot and two stalks per row sufficed, while three rows and three stalks per row were needed for estimation of cane diameter.

Intensive rotation and intercropping of sugar cane. B. S. Mathur. *Indian Sugar,* 1980, **30**, 353-358. -- Experiments over a 3-year period showed that, of four treatments, the best in terms of cane yield was (i) autumn planting of cane without any intercrop, followed by (ii) intercropping of spring-planted cane with onion, (iii) intercropping of autumn-planted cane with wheat and (iv) intercropping of spring-planted cane with maize. [In the case of treatments (ii) and (iv), the cane crop was preceded by a potato crop.] However, by far the most profitable was treatment (ii).

Response of sugar cane to rates and time of nitrogen fertilization in Kolhapur region (variety Co 740). C. D. Salunkhe, V. D. Patil and A. G. Shinde. *Mararashtra Sugar,* 1981, **6**, (4), 21-23, 25-26. — In nitrogen trials, which are reported, two equal doses of N (one at the start of tilllering and the other at final earthing-up) gave a higher cane yield than did other split-dose treatments, all using the same total quantity of N. Appreciable increase in the number of millable canes was achieved by increasing the dosage rate from 168 to 337 kg.ha^{-1}.

Phosphorus and potassium nutrition of cane. K. R. Perumal. *Maharashtra Sugar,* 1981, **6**, (4), 37, 39-41, 43-45. — Experiments showed that higher leaf sheath K in the early cane growth phase increased both yield and sugar content, whereas at harvest it depressed the sugar content. Juice K_2O at harvest was negatively associated with recoverable sugar %. Sheath P in the early growth phase was negatively associated with juice phosphate and recoverable sugar %.

Influence of the K:N ratio in fertilization on the potassium content and soluble invertase activity in the meristem of sugar cane. R. de Armas, E. de la Fuente, S. Naranjo and N. Musienko. *Cienc. Agric.*, 1980, (7), 51-57 *(Spanish).* — Potassium was applied to cane at six K:N ratios from 0 to 2.5, employing two basal levels of N and P. The K contents and activity of acid and neutral soluble invertases in the meristem were studied, but there were found to be no significant differences in invertase activity levels with different K:N ratios or base fertilizer levels. This seems to be connected with the high levels of K which exceeded 5% even where no K fertilizer was applied. The invertase activity varied during the growth cycle, from low levels during the beginning, increasing during the rapid growth stage to decrease in the acid invertase activity and increase in the neutral invertase activity at maturation.

CANE PESTS AND DISEASES

Notes on an egg-parasite of sugar cane moth borers. G. T. Lim and Y. C. Pan. *Sugar J.*, 1980, **43**, (6) 22-23. See *I.S.J.*, 1975, **77**, 82.

Principal insect pests of sugar cane in Peru. G. E. Ayquipa A. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1978, **8**, (3/4), 59-84 *(Spanish).* — A survey is presented of pests attacking cane in Peru, and a detailed account is given of the damage caused by *Diatraea saccharalis* and its control.

Preliminary data on the reaction of sugar cane varieties to the pathogen *Xanthomonas albilineans.* N. Rivera, M. Hevesi, M. Cordovés, M. Ezavin and L. Marrero. *Cienc. Técn. Agric., Caña de Azúc.*, 1980, **2**, (1), 79-90 *(Spanish).* — A series of 29 commercial and pre-commercial varieties and some breeding selections were examined to assess their response to the leaf scald pathogen. CB 3822 and Cristalina were classified as highly susceptible, C 334-64 as intermediate, and the remainder as resistant to different extents.

Preliminary study of the reaction of commercial and pre-commercial sugar cane varieties under natural conditions to the pathogen *Puccinia erianthi.* I. Sandoval, L. Cuello and B. Piedra. *Cienc. Técn. Agric., Caña de Azúc.*, 1980, **2**, (1), 91-103 *(Spanish).* — A total of 18 cane varieties were assessed for their resistance to the rust pathogen in terms of distribution and index of infection[1], the latter being a measure of losses. B 4362 was the worst affected variety (index 65.20%), while the others ranged from 11.69 to 41.19% index.

Studies of some biological aspects of the sugar cane rust producing fungus in Cuba. I. Sandoval, L. Cuello and V. Picornell. *Cienc. Técn. Agric., Caña de Azúc.*, 1980, **2**, (1), 105-117 *(Spanish).* — The effects of temperature on germination and viability of uredospores of *Puccinia erianthi* have been studied. Germination occurred at temperatures between 15° and 30°C, with an optimum at 25°C, the interval before germination falling from 2 hours at 15°C to 1 hour at 20-27°C and then rising to 4 hours at 30°C. The % germination rose from about 40% at 15°C to a maximum of 80% at 25°C and fell to about 30% at 30°C. Spores lost their ability to germinate after 20 days at 15-25°C, after 10 days at 27°C and after 5 days at 30°C, but remained viable for 57 days at 10°C.

Population fluctuation of nematodes in an 18-months sugar cane crop. W. R. T. Novaretti and E. J. Nelli. *Brasil Açuc.*, 1980, **96**, 278-284 *(Portuguese).* — Extensive data were assembled during 1976/77 by monthly sampling of soil and cane roots and counting of nematode species. The results showed that ectoparasitic nematodes such as *Helicotylenchus* sp. and *Trichodorus* sp. have a closer relationship with climatic conditions (rainfall and temperature) while endoparasitic nematodes such as *Meloidogyne javanica* and free-living nematodes have a closer relationship with development of the cane root system.

Effect of striate mosaic virus (SCSMV) on sugar cane. E. Kondaiah and M. V. Nayudu. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.49-Ag.52. — Cane infected with striate mosaic virus was yellowish-green, in contrast to the reddish-brown of healthy cane. The disease caused no fall in yield; on the contrary, yield was 28% higher with the diseased cane than with the healthy crop. Juice analysis showed that the healthy cane had a pol 0.32 units higher, a Brix 0.36° higher and a sugar content 0.2 units higher than the diseased cane. However, there was no significant difference in purity and invert sugar content between healthy and diseased cane.

Control of sugar cane Pyrilla using systemic insecticides through irrigation water and soil application. A. S. Patil, D. G. Hapase and P. R. Moholkar. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.53-Ag.60. — Trials on control of the leaf hopper, *Pyrilla perpusilla,* are reported. Results were recorded as reduction of the nymphal population 15, 30, 60 and 90 days after application of the insecticide. Generally, best results were achieved with Methyl demeton at 5 $kg.ha^{-1}$ a.i. applied with irrigation water when the cane crop was 7 months old and with three soil applications (at 10, 11 and 12 months) of Fensulfothion G at 5 $kg.ha^{-1}$ a.i.

Studies on assessment of losses caused by the stalk borer *Chilo auricilius* **Ddgn. in sugar cane.** S. C. Bhardwaj, J. N. Gupta, J. P. Chaudhary and S. P. Singh. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.61-Ag.70. A direct correlation was found between borer incidence and yield losses in varieties CoJ 64 and Co 1148; each 1% increase in intensity of the pest caused a 0.63% fall in cane yield, 0.64% reduction in juice extraction and 0.68% decrease in c.c.s. The actual loss in cane yield in Haryana state during 1978-79 (based on 6.3% stalk borer intensity) was estimated at 285,416 tonnes, and the corresponding sugar yield loss at 34,250 tonnes.

Investigation on the intensity of red rot disease *(Colletotrichum falcatum)* **affecting qualities of cane juice and jaggery (gur) in the calcareous belt of north Bihar.** S. R. Mukherjee, A. Jha, R. D. Shahi and C. R. Prasad. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.99-Ag.107. — Investigations showed that red rot caused deterioration in juice quality (in terms of pol purity, glucose content and noxious nitrogen) as well as gur quality; the greater the disease incidence, the lower was the quality.

Inoculation techniques for sugar cane smut disease. M. B. Bachchhav, D. G. Hapase, T. K. Ghure, V. V. Shingte and S. S. Lambhate. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, Ag.173-Ag.178. — Four methods of inoculation were tested for use in screening varieties for their reaction to *Ustilago scitaminea.* Best results were given by scooping single-eye buds from healthy immature canes, removing their bud scales and then brushing the bud with a thick spore paste. The wound-paste method and preparation of three-eye budded setts (subsequently treated with the spore paste) required skill, while immersion of immature setts in a suspension of spores or brushing with paste was laborious and time-consuming.

[1] Townsend & Heuberger: *Plant Disease Reporter,* 1943, **27**, 340-343.

CANE BREEDING AND VARIETIES

Response of several Florida sugar cane varieties. Tests during the 1979-80 harvest. E. R. Rice, D. G. Holder and R. P. DeStefano. *Sugar J.,* 1980, **43,** (5), 23-25. The responses of varieties to Polaris and Mon 8000 (Glyphosate) ripeners are described and some data tabulated. Clear differences between varietal response and between the effects of the two ripeners, as well as the use of Paraquat herbicide subsequent to Mon 8000 treatment, are indicated.

Genotypic variation in sugar cane quality parameters. M. Singh, G. S. C. Rao, A. J. Mujumdar and B. M. Kuri. *Proc. 30th Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1980, (1), A.5-A.12. – A number of quality components were evaluated in thirty cane varieties grown under identical conditions. Apart from juice settling rate (determined as the time taken for half the maximum quantity of mud to settle), which showed 15.74% heritability, all the parameters failed to show genetic association, suggesting that they are more influenced by environmental factors than is the juice settling rate. Significant negative correlation was found between available juice phosphate and juice settling rate. Further studies are considered necessary.

Current status of field trials with Trombay sugar cane mutants TS-1 and TS-8. H. K. S. Rao. *Proc. 30th Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1980, (1), A.89-A.98. – Preliminary results of trials showed that both TS-1 and TS-8, mutants obtained from Co 419 by irradiation with ^{60}Co, were better than Co 419 and Co 740 in terms of girth, weight and juice quality.

Sugar cane variety tests in Florida 1979-80 harvest season. B. Glaz, J. L. Dean, J. D. Miller and P. Y. P. Tai. *Publ. U.S. Dept. Agric.,* 17 pp. – Trials are reported in which 32 varieties were grown and harvested at eight locations representing five soil types. Cane and sugar yields were compared with those of CP 63-588, the most widely grown variety in Florida. Ratings were also given to each variety for reaction to smut (caused by *Ustilago scitaminea*) and rust (caused by *Puccinia melanocephala*). In the plant cane trials, CP 75-1091 produced on average more cane and sugar per acre than any other variety, although CP 75-1257 outyielded it in sugar when grown on a fine sand. In the 1st ratoon trials, CP 74-2005 was the dominant variety, giving highest sugar yield on all five soils and highest cane tonnage per acre except on one soil, where it was a close second to a variety highly susceptible to rust. CP 72-2086 and CP 73-1547 were the outstanding varieties in the 2nd ratoon trials.

The Louisiana sugar cane variety census for 1979. H. P. Fanguy and L. L. McCormick. *Sugar Bull.,* 1980, **59,** (1), 8, 10-11. – The 1979 census of varieties grown on some 265,000 acres (a decline of 57,000 acres on the 1977 total cane area of Louisiana) showed an 11% (absolute) increase to 61% in the area under the leading variety, CP 65-357; only N:Co 310, the second most popular variety (grown on 11% of the area), and CP 67-412 (grown on 4% of the area) increased their popularity, while there was a fall in the area on which five other leading varieties were grown. CP 65-357 does suffer from low yields in 2nd and subsequent ratoon crops (it is considered that the fact that the cane is cut early in the year because of its early maturation increases the pressure on the ratoon crops), but some of this early cutting pressure could be reduced by increasing the area under CP 70-321 and CP 70-330, two new varieties in the same maturity class as CP 65-357. The third most widely grown variety in Louisiana, CP 61-37, has fallen considerably in popularity because of ratooning failures, and is being gradually replaced, particularly in view of its marginal sugar yield per ton and poor harvestibility.

Comparative study of 16 sugar cane varieties *(Saccharum* spp. hybrids) in two harvest cycles on a red ferralitic soil. R. Ortiz, C. de la Fe and C. Cairo. *Cienc. Técn. Agric., Caña de Azúc.,* 1980, **2,** (1), 51-64 *(Spanish).* – Sixteen cane varieties were grown in two different harvest cycles of plant cane and two ratoons (15½-12½-12 and 17½-11-12 months) and statistical analysis applied to the yields of pol and cane as well as the cane:pol ratios. Of the 15 varieties grown for comparison with B 4362 as standard, My 5723, My 5353 and My 5596 were significantly better and are recommended for extension. Further, the second cycle is recommended for adoption as providing a higher yield of pol per ha.

Influence of varietal crushing scheme on improving sugar recovery, cane yield and area in Punjab. N. Singh, J. S. Sandhu, O. Singh and A. P. S. Mann. *Maharashtra Sugar,* 1981, **6,** (3), 45-50. – Re-distribution of the area under early-, mid- and late-season varieties in Punjab has resulted in almost equal allocation of the area under each class of cane, as represented by CoJ 64 (early maturing), CoJ 46 and CoJ 67 (mid-season) and Co 1148 (late maturing). Crushing is scheduled on the basis of maturity, so that sugar recovery has improved. Since crushing should not extend beyond the first week in April (after which recovery falls because the late-maturing cane is past its prime), there is need for mill expansion or for new mills in those areas where there is ample cane available. Punjab has the longest crushing season of the six cane-growing states of northern India.

Tissue cultivation of sugar cane. Obtaining and later regenerating plants *in vitro*. A. Alfonso and A. Capote. *Cienc. Agric.,* 1980, (6), 29-34 *(Spanish).* – Sections of plants of three cane varieties were sterilized and cultured *in vitro* using a modified Murashige-Skoog medium supplemented with 2,4-D and coconut water. Differentiation among the plants was obtained after transfer of the cultures to the same mineral medium but without the supplements.

Biological activity of the gibberellin-like substance in sugar cane +1 leaf blade. K. M. Huang and Y. S. Chang. *Rpt. Taiwan Sugar Research Inst.,* 1980, (89), 25-32. Gibberellin extracted from +1 leaf blades of F 160 and F 167 cane varieties was subjected to thin-layer chromatography followed by tests for biological activity in a variety of dwarf rice. It was found to have the same R_f values as authentic GA_3 and promoted the growth of the rice.

SUGAR BEET AGRONOMY

Experiences in transport and unloading of sugar beet. W. C. von Kessel. *Die Zuckerrübe,* 1980, **29,** (6), 8-10 *(German).* — Aspects of the title subject under West German conditions are discussed.

The growth, pests and diseases of sugar beet in Belgium in 1979. L. van Steyvoort and N. Roussel. *Publ. Trimest. Inst. Belge Amél. Betterave,* 1980, **48,** 109-132 *(French, Dutch).* --Details are given of the 1979 beet growing season. Despite late sowings, root yields in October and November were far higher than in previous years as a result of excellent weather conditions and healthy beet. Among pests, the pygmy mangold beetle was particularly responsible for damage to beet, especially in fields where the beet crop was the second successive one. A bacterial disease caused by *Pseudomonas syringae* was observed for the first time in Belgium, but remained very localized. Virus yellows incidence was very low because of the insignificant numbers of aphids, and affected less than 1% of the beets.

Loading technique and soil separation. H. W. Hold. *Die Zuckerrübe,* 1981, **30,** (1), 18, 20-21 *(German).* Advantages and disadvantages of the system in which clamped beet are transferred to road trucks by front-end loaders are discussed. Dirt tare has been substantially reduced by use of belt conveyors feeding the trucks, but wet conditions necessitate other approaches, and various pieces of equipment for cleaning and conveying are described.

Traffic regulations and safety in the case of beet transport. E. Dohne. *Die Zuckerrübe,* 1981, **30,** (1), 24-27 *(German).* — Types of beet transport and transport combinations available in West Germany are described and various aspects of their use on the highway and the traffic laws relating to them are discussed.

Six-row tops saver. M. Limb. *British Sugar Beet Rev.,* 1980, **48,** (4), 27-28. — A home-made beet tops harvester to work in conjunction with a Moreau 6-row self-propelled harvester is described.

Venzar post-emergence (herbicide) for best results. W. Hollowell. *British Sugar Beet Rev.,* 1980, **48,** (4), 35-36. — The role and effect of Venzar post-emergence herbicide are discussed on the basis of a meeting held at the Belgian branch of the company responsible for its development. Illustrations are given of beet fields in which trials with the chemical were carried out.

Are your beet safely gathered in? J. Oldfield, M. Shore, J. Dutton and B. Houghton. *British Sugar Beet Rev.,* 1980, **48,** (4), 40-42. — Despite advice from British Sugar Corporation Ltd., some UK farmers fail to complete harvesting each December, so that large tonnages of beet remain in the ground. At the end of 1979, 200,000 tonnes were unharvested; in addition, of 1.8 million tonnes clamped in mid-December, 1.1 million tonnes were unprotected despite earlier frosts. With the aid of colour photographs, the authors indicate the deterioration of beets that are frozen and subsequently thawed, and offer advice on optimum clamping.

The effect of time and method of application of nitrogen on the yield and quality of sugar beet *(Beta vulgaris* **L.).** D. S. Deol, B. S. Bains and R. S. Kanwar. *Indian Sugar Crops J.,* 1980, **7,** 58-60. — In trials involving seven different treatments, no significant differences in beet yield and quality were found between single and split doses of nitrogen (giving the same total quantity per ha) applied by drilling or broadcast.

Seedbed preparation. L. van Steyvoort. *Le Betteravier,* 1981, **15,** (150), 17, 20 *(French).* — Advice is given on seedbed preparation and drilling. Photographs illustrate the various points discussed.

Weed control in the sugar beet crop — 1981. J. M. Belien and J. F. Salembier. *Le Betteravier,* 1981, **15,** (150), 18-19 *(French).* — Guidance is given on chemical and mechanical control of weeds in the beet field.

Sugar beet require a harmonic nutrient supply. W. C. von Kessel. *Die Zuckerrübe,* 1981, **30,** 56-60 *(German).* The author explains how optimum nutrient supply to the beet crop is achieved and examines those factors affecting availability and uptake.

Recent experience in the control of winter barley in sugar beet. W. Garburg. *Die Zuckerrübe,* 1981, **30,** 68 *(German).* — Trials on chemical control of winter barley showed that Fevin at 1.0 and 1.5 $kg.ha^{-1}$ plus 5 litres. ha^{-1} of paraffin oil gave up to approx. 97% and 100% kill, respectively, but results were less satisfactory when the barley emergence was not uniform or its growth had reached a stage where the plant showed some resistance to the herbicide.

Grasses and weed control. Anon. *Die Zuckerrübe,* 1981, **30,** 72-75 *(German).* — Details are given of pre- and post-emergence herbicides and the grasses and other weeds against which they are effective. Miscibilities of herbicides, pesticides and trace elements are given, and treatments are described for certain important weeds.

Pre- and post-emergence herbicide application in sugar beet. B. Stahlecker. *Die Zuckerrübe,* 1981, **30,** 76, 78 *(German).* — Advice is given on herbicide application to achieve best results.

Herbicide trials at Wierthe 1980. G. Ebers and R. Wüstemann. *Die Zuckerrübe,* 1981, **30,** 80, 82 *(German).* Herbicide trials are reported and the results tabulated.

Thoughts on stone removal from arable land. B. Scholz. *Die Zuckerrübe,* 1981, **30,** 89-91 *(German).* — Equipment for stone removal from fields, in order to reduce problems with machinery such as harvesters, is described with the aid of photographs.

Everyone talks about springtails, but who knows them? —. Rieckmann. *Die Zuckerrübe,* 1981, **30,** 96-98 *(German).* — Information is given on springtails *(Onychiurus* spp.), including their life-cycle and conditions favouring their development and activity, means of controlling them and weeds that act as hosts for *O. fimatus.*

BEET PESTS AND DISEASES

Effect of varying period of virus infection on sugar beet productivity. J. Chod, V. Rimsa, M. Jilkova and J. Polák. *Listy Cukr.*, 1980, **96**, 145-147 *(Czech)*. — The adverse effect of virus infections on beet quality was investigated in the case of mosaic, beet yellows virus (BYV), beet western yellows virus (BWYV) and mixtures of these. Highest losses in root yield and sugar content occurred with early infection when the first pair of true leaves appeared, while a mixture of all three named diseases had a worse effect than did BWYV on its own or BYV + mosaic. While delay in the onset of infection resulted in much lower losses, in absolute terms these were still rather high.

Pest management systems for sugar beets in the North American Central Great Plains region. Y. M. Yun and E. F. Sullivan. *J. Amer. Soc. Sugar Beet Tech.*, 1980, **20**, 455-476. — With adverse weather or other conditions, it may become necessary to re-supply beet sown early but lost. Experiments were conducted in the High Plains area of Texas, where the growing season extends from mid-March to mid-November, to determine the effect of sowing new beet seed when the previous seedlings had reached the 2-leaf stage, a total of three sowings being made. In 1976 the sugar yield fell from 4.68 to 3.90 and then 3.20 short tons/acre with the shorter growing seasons, while in 1977 corresponding yields were 4.58, 3.78 and 3.01 tons/acre. This loss can be partly offset by a higher sowing density; however, it is concluded that the original stand must be very poor before it becomes profitable to re-sow.

New fungicide to control powdery mildew in beet. Anon. *British Sugar Beet Rev.*, 1980, **48** (3), 79. — After four years of tests at Broom's Barn Experimental Station, a fungicide, Thiovit, has received approval for use in the UK for control of powdery mildew in sugar beet. It is a formulation of 80% sulphur as a wettable powder of free-flowing spherical granules ranging in size from 2 to 7 microns. In one test in 1979, with particularly severe infestation, Thiovit gave 100% control of the disease and increased yield by 25%.

Study of the effect of beet pesticides on certain pests (pygmy mangold beetles) and on endogenous and epigeous fauna participating in soil fertility and in natural control of pests (mites, springtails, carabids). C. Gregoire-Wibo. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1980, **48**, 133-165 *(French, Dutch)*. — Investigations were conducted on the effects of Lindane and Aldicarb, over a 4-year period, in a beet-cereal rotation at one site and with beet monoculture at another. Of the springtails (indicators of soil condition), the Sminthuridae *(Bourletiella hortensis* and *Sminthurus viridis)* were particularly affected by Aldicarb while its toxic effects persisted at the soil level (about 3 months), after which the soil was rapidly recolonized by immigration. Entomobryidae *(Lepidocyrtus* sp.) were little affected by the insecticides, while Isotomidae *(Isotoma viridis, I.notabilis* and *Isotomurus palustris)* were sensitive to Lindane. Crop rotation was more favourable to springtail populations (especially Isotomidae). Of 11 carabid beetle species (general predators) investigated, five were affected by the insecticides. Mites and pygmy mangold beetles were sensitive to both insecticides, although Lindane was more effective than Aldicarb against the latter pests. The endogenus fauna comprises mainly detritivorous mites and predators and is particularly sensitive to pesticides, so that preparations which allow such fauna to persist are desirable.

Garvox, the new granular insecticide for soil pest control in sugar beet. A. Jones and R. Lemon. *Agrospray* (FBC Ltd.), 1981, (4), 10-12. — The application of Garvox (a 3% granular formulation of the carbamate insecticide, Bendiocarb) in beet fields for the control of wireworms, pygmy beetle, symphylids and millepedes is discussed and results of trials in the UK, Holland and France are reported. The recommended application rate is 10 $kg.ha^{-1}$; the insecticide has increased the vigour of herbicides (probably because of the control of soil infestation) but is inconsistent in its effect on foliar pests. At rates up to 12 $kg.ha^{-1}$ it is not phytotoxic to beet.

Some studies on sugar beet diseases. H. G. Singh. *Indian Sugar*, 1980, **30**, 201-206. — Details are given of beet diseases and disorders observed in fields and in beets supplied to the factory, and field trials on use of various fungicides and nutrients as control means are reported.

After the banning of Heptachlor. W. R. Schäufele. *Die Zuckerrübe*, 1980, **29**, (6), 16 *(German)*. — Heptachlor has been officially banned from use in West Germany since the 1981 beet sowing season because of its toxicity, but the author discusses four insecticides that are available in its place: Bendiocarb, Carbofuran, Lindane and Mercaptodimethur.

After a wet summer, girth scab reappears. Anon. *Die Zuckerrübe*, 1980, **29**, (6), 29 *(German)*. — Girth scab, a fungal disease caused by *Actinomyces* sp., is described, and its harmful effect on root yield, sugar content and beet quality indicated. Conditions favouring its occurrence are briefly discussed.

Occurence of diseases and pests on sugar beet plantations in 1979. L. Urbanowicz. *Gaz. Cukr.*, 1980, **88**, 160-162 *(Polish)*. — A survey is presented of beet pests and diseases found in Polish beet fields in 1979.

Is biological control of the beet nematode *Heterodera schachtii* possible? H. Coene. *Die Zuckerrübe*, 1981 **30**, (1), 28-32 *(German)*. — The system described was first developed over 100 years ago, but failed to find acceptance because of the danger of increase in the nematode population if the host plants, deliberately planted to attract the pest away from the beets, were not completely destroyed once the nematode cysts had formed. However, tests have shown that, with proper herbicidal treatment, it is possible to ensure complete elimination of the host crop. Details are given of the trials.

Beet yellows. L. van Steyvoort. *Le Betteravier*, 1981, **15**, (152), 11 *(French)*. — Advice is given on aphid control with insecticides as a means of reducing beet yellows virus incidence.

CANE SUGAR MANUFACTURE

Study on the influence of liming parameters on the velocity of sedimentation. O. Navia Z. *Centro Azúcar,* 1980, **7,** (1), 103-111 *(Spanish).* — A statistically designed series of experiments was carried out to determine the effects of pH, temperature, P_2O_5 content, retention time, mixing and sugar content of the juice on the settling rate in a clarifier. The last had no significant effect, while pH had the greatest influence. pH, temperature and retention time were inter-acting, and a binary equation was developed by multiple linear regression to express their effects.

Dynamic modelling of the milling train in a sugar factory. J. R. Abreu G. and V. Polonik. *Centro Azúcar,* 1980, **7,** (2), 29-42 *(Spanish).* — In order to establish a dynamic model to calculate the relationships between the different variables of a milling tandem, the relationships between the flow and Brix of the juice in the feed to a single mill, the flow and Brix of imbibition applied, of the juice extracted and in the bagasse from the mill are calculated and analogue computer diagrams obtained from these. The conclusions are extended from a single mill to a series and a model obtained for a typical six-mill tandem for a sugar factory. The results from this model were found to be in accordance with the practical results obtained at a sugar factory.

Study of the crystallization of sugar from the point of view of control. M. Rodríguez B. *Centro Azúcar,* 1980, **7,** (2), 43-55 *(Spanish).* — A description is given of the development of a mathematical model for a batch pan operation in which the inter-relationships between the various factors and parameters (heating surface, specific heats, etc. and massecuite Brix, syrup concentration, etc.) are included.

Economic evaluation of the project of a falling film evaporator. R. Espinosa P. and P. García G. *Centro Azúcar,* 1980, **7,** (2), 75-89 *(Spanish).* — Details are presented of a calculation of the costs of the individual parts of a falling film evaporator.

Economic comparison of Australian and U. C. clarifiers. P. García G. and S. Bolanes R. *Centro Azúcar,* 1980, **7,** (2) 91-104 *(Spanish).* — Details are given of the construction and operation costs of a single-tray Australian-designed clarifier and a multi-cell unit designed at the Central University. The former is cheaper to construct but more expensive to operate than the latter. Inclusion of maintenance costs will be necessary to establish the total costs for comparison.

Heat of combustion of sugar cane bagasse. P. Roque D., A. M. Rubio G. and M. Insua G. *Centro Azúcar,* 1980, **7,** (2), 105-114 *(Spanish).* — Measurements were made of the heat of combustion of bagasse from three cane varieties and these reduced to a basis of dry, sugar-free bagasse. They were different for the different varieties because of their different elemental compositions.

Solubility of CO_2 in cane juice. J. Castellanos E., C. Hernández M. and C. Viscaíno G. *Centro Azúcar,* 1980, **7,** (2), 123-126 *(Spanish).* — As an initial step in the study of cane juice purification by a carbonatation process experiments have been carried out to determine the solubility of CO_2 in cane juice after 5 minutes' passage of an air-CO_2 mixture at different temperatures as influenced by the speed of the stirrer used. The results are presented in graph form and show that the solubility decreases with temperature over the range 30-90°C and that, except at the lowest temperature, solubility increases with stirrer speed up to a maximum and is stable thereafter.

Mill roller grooves — their juice handling capacities. H. N. Gupta. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.1-E.20. — Investigations to determine the juice handling capacities of grooves of different pitches and angles are reported, juice velocity being based on actual factory data and the juice load on feed rollers being estimated under ideal conditions. From calculations of required juice drainage areas, suitable groove pitches and angles have been established, and the value of messchaert grooves indicated.

Off-season maintenance of boiling house equipment. Improved methods and improvised means. K. S. R. Rao, K. Venkataratnam and O. B. Reddy. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.21-E.25. Painting, cleaning and overhauling of boiling house equipment, juice tanks, clarifiers, evaporators, etc. is discussed.

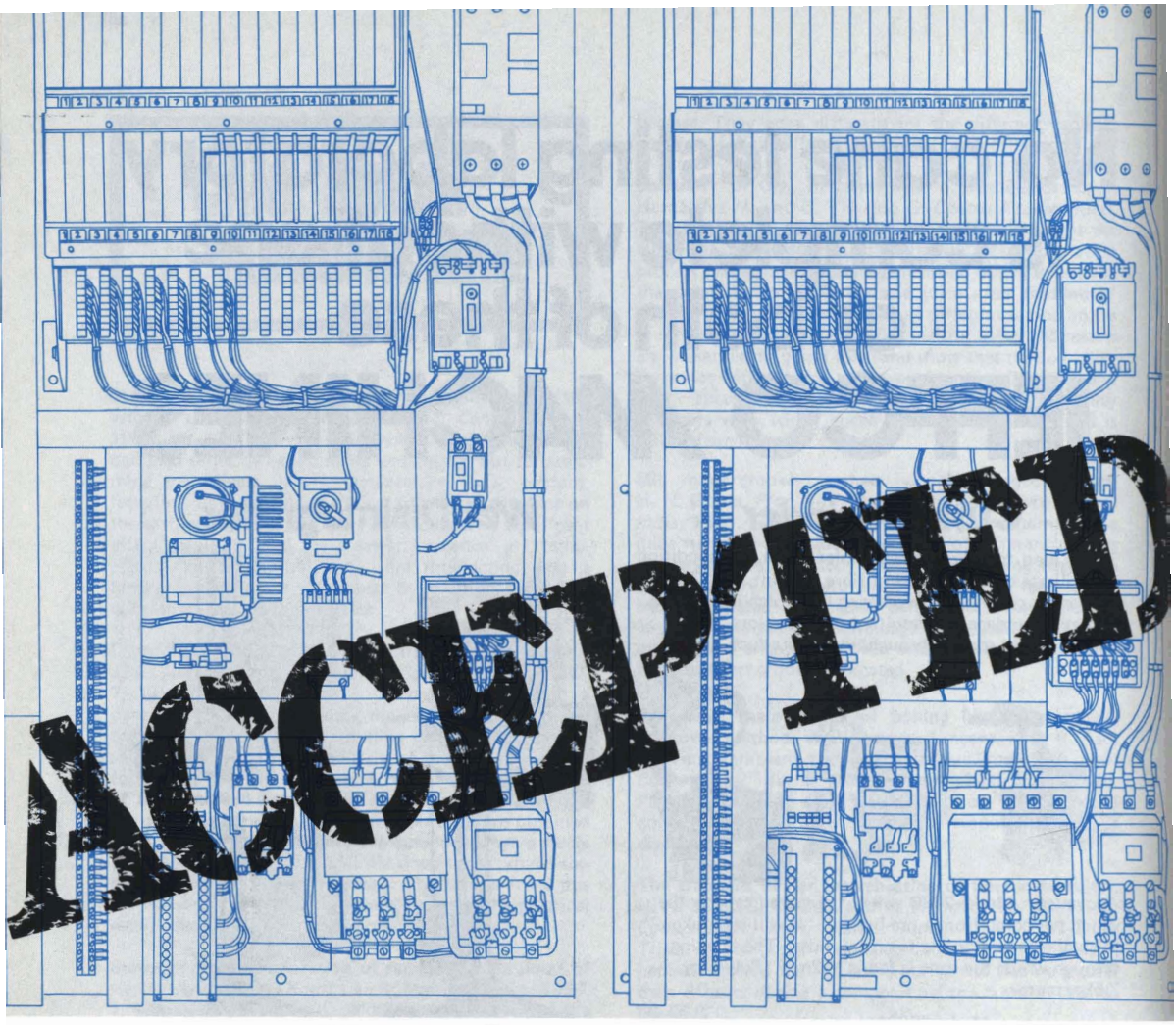
The transient heater for reheating of final massecuites. N. N. Joshi, S. K. Goel and R. Kumar. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.27-E.36. Trials on low-grade massecuite reheating in a transient heater[1] showed that molasses purity rise was no greater than 2 units during a temperature rise from 37-49° to 56-66.6°C.

Improvement in the injection water system. G. Kumar and S. P. Jain. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.37-E.48. — Modifications to the injection water system of the condensers at the authors' factory resulted in a substantial decrease in the power consumption of the system. Details are given.

The importance of thermal insulation in a sugar factory. S. N. Kannan and S. Murthy. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.49 E.62. — The benefits of thermal insulation of steam pipes and process equipment as regards reduction of steam losses are discussed and advice is given on lagging of pipes and flat surfaces. The relative costs of various types of insulating material are indicated.

Distribution of the heating surface in multiple-effect evaporators. B. S. Gurumurthy and C. K. Ramaswamy. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.63-E.76. — In a discussion of the heat transfer coefficient and evaporation rate in a multiple-effect evaporator the authors explain, with the aid of examples, how to obtain the maximum evaporation rate by proper selection of heating surface and temperature gradient for each effect and for the entire evaporator.

[1] See Doss: *I.S.J.,* 1981, **83,** 279.



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ROBERTS CENTRIFUGALS

Rag Sai – a simple cane carrier drive. T. L. Raghavan, C. K. Ramaswamy and K. P. Venkatagiri. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.77-E.85 + diagram. – See *I.S.J.,* 1982, **84,** 80.

Critical study of the cooling tower at Ravalgaon. P. F. Jain and S. V. Joshi. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, E.87-E.97. – Details are given of modifications to the multi-jet, multi-spray condensers and of a cooling tower installed in order to reduce power consumption and water requirements. The results achieved are discussed, and advice is given regarding cooling towers and the need to consider their application in association with condensers.

Experience with the working Buckau-Wolf continuous horizontal centrifugal Model C 1100 on *C*- and *B*-massecuites. S. P. Mishra and S. P. Shukla. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.9-M.18. Experience in the operation of the title centrifugal is reported. By comparison with water-driven centrifugals previously used, the continuous machines gave a 2.5 unit lower molasses purity and significantly improved sugar quality as a result of reduced non-sugars recirculation as well as the higher sugar purity.

Trial of a continuous vacuum pan at Daurala. N. N. Joshi, S. K. Goel and R. Kumar. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.19-M.24. – Preliminary tests on a pilot plant-scale continuous vacuum pan (of Indian design) having three concentric calandrias are described. The pan produced smaller grain of greater C.V. than a batch pan, but the variation was reduced almost to that of the batch pan once a molasses conditioner had been installed. The Brix of the *B*- and *C*-massecuites boiled was below requirement, but it is hoped to cure this by providing more massecuite outlet ports at the calandria periphery.

Preparation of reproducible seed slurry and monitoring of the seed size by the sedimentation method. P. V. Rao and M. R. Reddy. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.25-M.30. – Problems in low-grade boiling were caused by a seed slurry having a crystal size in the range 15-20 μ. Extending the ball mill grinding period from 1 hour to 2½ hours reduced the crystal size range to 3.3-6.6 μ and gave a final sediment of 880 ml as opposed to 480 ml from the same initial volume of sugar solution. The method has proved of value as a test for optimum crystal size in contrast to the time-consuming and laborious microscope method.

Studies on neutralization of the second carbonatated juice with phosphoric acid. J. C. Bhargava and K. P. Sinha. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.31-M.39. – Experiments showed that reduction of 2nd carbonatation juice pH from 8.2-8.5 to 7.0 by addition of phosphoric acid instead of SO_2 was better as regards settling of colloids and colouring matter, with consequent benefits in the form of higher quality sugar and reduced sulphur consumption.

Modification in the design of a 2nd carbonatation tank at Bagpat. S. C. Johri. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.41-M.51. – Details are given of modifications to the 2nd carbonatation vessel at Bagpat in order to improve performance, including better CO_2 and juice mixing. The major changes involved replacement of counter-current by co-current flow, installation of a circumferential outlet for the juice some distance up the tank as opposed to a bottom discharge port, bottom feed of the juice by syphon, and installation of a star distributor in the bottom cone of the vessel for efficient gas dispersion. Wide fluctuation in juice pH was thereby reduced, filter-press performance considerably improved, final molasses purity decreased and the quality of sugar raised.

Important parameters for continuous treatment of final massecuites. B. Chakravarty. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.53-M.64. – After a study had been made of the effects of cooling rate and time on massecuite exhaustion in batch crystallizers, requirements of a continuous system were defined and a scheme devised for low-grade massecuite. Problems encountered in operation of the crystallizers are examined and possible remedies indicated. Factors to be considered in planning a continuous system are listed, and the importance of continuous centrifugals in association with continuous crystallizers demonstrated.

Gas liquid absorption equipment for a carbonatation factory. Development of a continuous reactor design for second carbonatation, thin juice sulphitation and syrup sulphitation. S. P. Mishra. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.65-M.68. – A continuous reactor suitable for carbonatation and sulphitation is described in which juice/syrup flows from a supply tank near the top and passes down through a succession of plates which are alternately perforated, apart from a central solid area, and solid apart from a central perforated area. The plates are arranged in the upper section of the vessel, while the lower section contains a recirculation system made up of gas sparger and vertical feed lines through which the treated juice/syrup flows. Hence, initial gas-liquid mixing takes place in the upper section, after which more intimate and turbulent mixing occurs in the lower section. The vessel has performed satisfactorily in a carbonatation factory.

Pan station performance. P. K. Singh. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.69-M.72. Factors governing massecuite boiling efficiency are listed, and a formula is developed for calculation of pan performance in terms of boiling time and the amount of crystallizable sugar in the massecuite. Calculated "standard" pan performance is then compared with an "actual" pan performance to show that the latter is well below the former.

Elimination of phenolic constituents of cane juice in clarification adsorption, a positive possibility of removal of such compounds. S. C. Sharma and P. C. Johary. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.73-M.92. – Investigations of the adsorption of phenols, as major juice colorants, by various calcium salts are reported. Each group of phenols (mono-, di- and triphenols) was examined individually with regard to its degree of adsorption by calcium carbonate, sulphite and phosphate and the effect on this of time of contact, temperature, pH and quantity of adsorbate. Generally, Ca sulphite and phosphate adsorbed some 30% of the total phenolic content, while Ca carbonate adsorbed about 20%. Adorption increased with increase in the number of hydroxyl groups in the phenols and

mostly occurred at a contact time of up to 2 minutes. Adsorption decreased with rise in temperature. Best results were obtained at pH 11. CO_2, SO_2 or lime added to pure phenol solutions of the same concentration as in raw juice had practically no effect on the phenolic content.

On bringing down the downtime. G. G. Kakade and S. L. Nehere. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.93-M.103. – See *I.S.J.,* 1982, **84**, 80.

On-line continuous Brix meter for evaporator syrup. K. S. R. Rao and M. J. V. P. Rao. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.105-M.108. – Details are given of a continuous on-line Brix measuring system installed between the last evaporator effect and the sulphitation tank at the authors' sugar factory, which operates on the hydrometer principle and is accurate to within ± 1.5%.

Automatic pH control in a sugar factory. N. S. Randhawa. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.109-M.114. – A system is described in which the pH of juice in a sampling box connected to the sulphitation tank is measured by a glass electrode and a signal transmitted to a set-point controller which in turn sends a signal, corresponding to the difference between the actual and target value, to relays controlling a set of solenoids that actuate the lime feed valve. According to requirements, lime is made to flow into the sulphitation tank or is fed back to the lime tank. The system has reduced pH fluctuation to ± 0.15 units at pH 7, compared with ± 0.75 units with manual control. Other benefits of the scheme are a fairly constant juice settling rate (with manual control this had varied with pH) and a slightly higher purity rise, while clear juice lime content is reduced.

Design and operational aspects of lime kilns in carbonatation sugar factories. N. N. Joshi, S. K. Goel and R. Kapoor. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.115-M.125. – Types of lime kiln, particularly the vertical type commonly used in the sugar industry, are discussed, and problems associated with deterioration in limestone and coke quality examined. Factors of importance for efficient kiln operation and the advantages and disadvantages of single- *vs.* double-cone kilns are discussed. The CO_2 pumping capacity requirement and factors affecting CO_2 availability are considered, and a number of recommendations given for improvement in kiln operation.

Phosphocarbonatation-phosflotation technology and manufacture of superior white granulated sugar. S. P. Mishra. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.127-M.139. – Details are given of further modifications to the scheme introduced at Kichha Sugar Co., including a system of syrup and melt clarification. The latest measures have reduced losses still further by comparison with the original double-carbonatation, double-sulphitation system and with the basic phosphocarbonatation scheme. Details for 1979-80 show a considerable fall in the sulphite content of the white sugar, which was almost of Indian refined sugar standard.

An alternative formula suggested for pol fibre reduced mill extraction. V. X. Stephen. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.5-C.7. – An empirical formula is presented for calculation of mill extraction in terms of pol losses in fibre and based on a cane pol and fibre content each of 12.5%.

A new formula proposed for reduced mill extraction. P. S. Narayana. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.9-C.21. – The proposed formula is based on a cane fibre content of 12.5% and a juice purity of 85 and uses the concept of the pol retention factor instead of the juice retention factor. The formula is claimed to be better than those of Deerr and Mittal.

Drying of bagasse. K. N. Sharma and R. K. Kochhar. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, G.127-G.132. – A bagasse pre-drying system, tested as a pilot plant, is described. In the trials it reduced the moisture content from 50 to 42%. However, the outlet temperature of the flue gases used was inadequate, and bagacillo separation unsatisfactory. Moreover, the unit is intended for each boiler individually (having a capacity of 6-7 tonnes of bagasse per hour), so that space requirements could pose a problem.

Activities of the Sugar Industry Research Institute (Factory Technology Division), Jamaica. I. Sangster. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 150-162. – A brief history of sugar production in Jamaica is followed by an account of the establishment of and work carried out at the SIRI Factory Technology Division, with information on the main areas of activity. One exception to the general rule that the research is of a very applied nature, involving assessment of new techniques and equipment and their suitability for the Jamaican sugar industry, is work on the Comfith cane separation process[1]. Mention is also made of a plant for cane by-products development which is being set up adjacent to the sugar technology pilot plant at the Institute, and projects to be investigated are listed.

Decolorization and clarification of cane sugar syrups by means of powdered ion exchange resin technology. R. Kunin and A. Tavares. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 163-170. – Various applications of ion exchange in refining are briefly reviewed, and details given of a process for cane syrup treatment which is a combination of filtration and decolorization based on Ecodex S-1 strongly basic anion exchange resin in Cl^- form; this is used as a filter precoat and is not regenerable. High decolorization efficiencies have been achieved on a laboratory scale in the case of three North American cane syrups.

A new sulphitation process for manufacturing plantation white sugar. C. H. Chen, H. T. Cheng, R. Y. Chang and Y. C. Cheng. *Rpt. Taiwan Sugar Research Inst.,* 1980, (89), 33-43 *(Chinese).* – In Taiwan, white sugar is mostly made by the carbonatation process; however, this has the disadvantages of high skilled labour requirements, problems associated with disposal of a highly alkaline filter cake, difficulties in filtration, low sugar recovery, etc. A new process has been developed in which the juice is treated by sulphitation, and the raw syrup by phosphatation followed by sulphitation. The white sugar from this process is as good as that from the conventional carbonatation process, although the fine syrup is darker. By comparison with carbonatation the new process is easy to operate and has the advantages of lower operational costs, cheaper investment, lower labour requirements, greater profitability and absence of filter cake disposal problems.

[1] Hanson *et al.: I.S.J.,* 1981, **83**, 327-330.

BEET SUGAR MANUFACTURE

Molasses desugaring process at Kitami factory. S. Kanno, S. Meguro and R. Kanda. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1980, **29**, 79-87 *(Japanese)*. From its start-up in 1957 until 1967, the Kitami beet sugar factory of Hokkaido Sugar Co. Ltd. used the Steffen batch process for sugar recovery from some of its molasses, the rest of the molasses being discarded. In 1968 the melibiase process was introduced and preceded the Steffen process; no molasses was discarded. The raffinose content in the treated molasses fell remarkably, and all secondary molasses could be recycled to the saccharate process, resulting in an increase in white sugar recovery. In 1970 recycling of cold filtrate was adopted, and in 1973 the RT continuous saccharate process was introduced. This gave better saccharate formation and filtrability; the volume of Steffen waste was halved, while white sugar recovery was substantially greater than with the former process. $CaCl_2$ addition was tested on a factory scale; although the volume of waste fell, there was no improvement in saccharate purity.

Investigation of forces interacting between the sugar beet and drum of a beet slicer. S. M. Grebenyuk and A. M. Shcherbakov. *Sakhar. Prom.*, 1981, (2), 22-25 *(Russian)*. — The forces involved in the slicing of beet are examined mathematically, particularly those factors affecting friction. An equation has been derived from theoretical considerations as well as experimental data for calculation of the force holding the beet to the drum wall; after suitable modification, the equation is valid for calculating design parameters.

Effect of the solid phase in decanted 1st carbonatation juice on the quality of purified juice and syrup. A. P. Lapin. *Sakhar. Prom.*, 1981, (2), 26-27 *(Russian)*. Studies had shown that the over-flow from 1st carbonatation juice settling could still contain 1.7-2.0g.l^{-1} solid particles, so that experiments were carried out to establish the effect of liming such juice before 2nd carbonatation. Addition of lime equivalent to 25% of the total used in juice purification, followed by 5 minutes' retention at 95-96°C, had no adverse effect on 2nd carbonatation juice or thick juice, provided the solids content in juice from healthy beet did not exceed 3 g.l^{-1}; however, such treatment caused a fall in quality of juice from sub-standard beet, so that greater attention would have to be paid to filtration of 1st carbonatation juice in order to minimize the solids content.

Operational features of conical continuous centrifugals. B. N. Tereshin. *Sakhar. Prom.*, 1981, (2), 27-29 *(Russian)*. The theory of operation of conical centrifugals is explained mathematically, and the advantages of these continuous machines over batch centrifugals stated. The importance of screen perforation size is discussed, as well as factors of importance relative to performance and throughput. It is considered that a continuous machine with suspended shaft has advantages over the centrifugal with floor-mounted axis. An experimental model has been designed on the basis of the various factors considered, and tests were to be carried out on treatment of *B*- and *C*-massecuites and on affination. Crystal damage and inadequacy of washing are given as reasons why conical centrifugals are not used in the USSR.

Drying of granulated sugar. V. I. Kruglovenko. *Sakhar. Prom.*, 1981, (2), 29-34 *(Russian)*. — Factors governing the thickness of the film on crystals to be dried are discussed, the effect of re-crystallization and of drying on the film composition and sugar purity is indicated, and equations presented for calculation of the mass crystal growth rate in the film during drying. The rate is analogous to that during sugar crystallization in solution. At a higher film purity the rate of crystallization drying is greater than with a film of lower purity. Two-zone drying was carried out to check the theory; in the first zone, when the sugar moisture was high and the film surrounding the crystals was of high purity, it was safe (as regards thermal decomposition of the sugar) to use a high drying temperature (130-145°C for 20-40 sec); in the second zone, however, the lower film purity (resulting from intensive crystallization in the first zone) and reduced moisture content dictated a temperature of 70-100°C for 80-100 sec. Mechanical mixing was used in the first zone (the presence of the film surrounding the crystals prevented their damage), and fluidized bed drying in the second. The results indicated a final moisture content after the combined drying which was half that achieved by drying, from the same initial moisture content, in a one-zone system; the colour content was the same with both systems.

An automatic candle filter for filtration of beet sugar factory products. E. A. Koval'chuk, A. P. Ponomarenko, A. N. Nesterov and V. I. Khokhotva. *Sakhar. Prom.*, 1981, (2), 36-39 *(Russian)*. — A Soviet candle filter, intended for 1st and 2nd carbonatation juice treatment, is described and its automatic operation explained.

Use of wet ash separators with venturi-type swirler coagulator for sugar factory power houses. V. S. Mokhort and V. N. Chikirisov. *Sakhar. Prom.*, 1981, (2), 45-46 *(Russian)*. — Operational and design parameters are presented of a wet ash separation system designed to handle the ash (up to 23% by weight of the fuel) from 10.3 tonnes of fuel per hour.

User programs for process computer application in sugar factories. D. Piotrowski and K. Urbaniec. *Zuckerind.*, 1981, **106**, 135-138 *(German)*. — Computer programs devised by Chemadex for the Compucorp 425 mini-computer are briefly described, including ones for automatic compiling of a 3-massecuite boiling system, for evaluation of evaporator performance, for sugar and molasses balances, factory and powerhouse process data reporting, coordination of materials flow at the juice end and optimization of low-grade crystallization.

Methods of beet handling: their effects on beet breakage and sugar losses. D. F. A. Horsley. *Zuckerind.*, 1981, **106**, 138-147. — See *I.S.J.*, 1981, **83**, 343.

The IRIS electric massecuite reheater. J. C. Giorgi and R. Gontier. *Sucr. Franç.*, 1981, **122**, 105-110 *(French)*. Types of reheater used for low-grade massecuite are surveyed, and difficulties encountered by the authors in

tests on massecuite reheating are mentioned. A reheater incorporating horizontal metal grids carrying electric current is described[1]. In tests, the temperature of the massecuite was raised from 54-55°C to 64-65°C, while mother liquor purity remained virtually unchanged. The unit is suitable for an hourly throughput of 6-7 tonnes of massecuite.

Results of trials with a continuous sulphur burner. Z. Kalata. *Gaz. Cukr.*, 1980, **88**, 207-209 *(Polish)*. Results are given of trials with the continuous sulphur burner mentioned previously[2]. Maximum heat liberation, at which SO_2 output was greatest, was 44 x 10^7 $J.m^{-3}.hr^{-1}$ (110,000 $kcal.m^{-3}.hr^{-1}$).

Automatic dosing of flocculants in clarifiers. S. Chmielewski and A. Rozycki. *Gaz. Cukr.*, 1980, **88**, 212 *(Polish)*. — A scheme for automatic flocculant metering which embodies a rotary flowmeter in the flocculant line and control based on the juice flow to the clarifier is outlined.

Measurement of the temperature profile in a stream of low-grade massecuite. V. Jozefy and V. Hromek. *Listy Cukr.*, 1981, **97**, 49-51 *(Czech)*. — Application of thermographic photography to low-grade massecuite cooling is described and the results obtained are discussed. Sufficient variation in the temperature at the surface of the massecuite was found in a horizontal crystallizer to prevent optimization of the cooling process. The possibility of an improvement with vertical crystallizers is to be investigated.

Heat losses in pipelines and their dependence on insulation quality and temperatures. P. Hoffman. *Listy Cukr.*, 1981, **97**, 55-61 *(Czech)*. — Heat losses in piping have been calculated, allowing for the effects of free convection and radiation, in the case of uninsulated piping and piping carrying 25-100 mm of lagging, at a temperature difference in the range 50-170°C between the medium (steam or feedwater) and the ambient temperatures and pipe diameters in the range 50-500 mm. The heat loss over a 90-day campaign with inadequate insulation is compared with that with good insulation, and, by calculating the monetary value of the lost energy equivalent, the optimum insulation thickness is established.

Investigation on specimen storage of beet at Trnava sugar factory in Trebatice. J. Zahradnicek *et al. Listy Cukr.*, 1981, **97**, 65-70 *(Czech)*. — Trials were conducted on storage of beet in a newly constructed dry yard of 35,000 tonnes capacity. The beets were stored from October to December for 80 days in the case of the control (A), for 58 days where forced ventilation was used (B) and for 55 days where both forced ventilation was used and the beets sprayed with Orthofaltan fungicide supplied by Standard Oil Development Co. (C). The sucrose, α-amino-N, ash, invert sugar, Na, K, Ca and free amino-acids were determined before and after storage. Results showed that beets in group (C) suffered 87% lower losses and in group (B) 84.6% lower losses than did those in group (A). Apart from a higher total free amino-acid content in beets from group (C), the treated beets contained very much less non-sugar and were considerably healthier than the control.

The point at which to introduce recycled 1st carbonatation mud in progressive preliming. K. P. Zakharov, V. Z. Semenenko, N. I. Zharinov, R. G. Zhizhina, P. P. Zagorodnii and V. V. Folomeeva. *Sakhar. Prom.*, 1981, (3), 29-33 *(Russian)*. — Studies to determine the optimum point at which to add 1st carbonatation mud to juice undergoing preliming, i.e. to achieve maximum settling of colloids and best juice filtration, showed that the greatest effect was achieved where the juice conductivity was minimum, corresponding to maximum colloid stability and hence rapid and maximum settling. For low-quality beets, the minimum conductivity occurred at pH_{20} 7.7 and for high-quality beets at pH_{20} 10.0.

Sugar diffusivity from beet under the effect of aluminium sulphate on beet cossettes. Yu. B. Navrotskii and A. A. Lipets. *Sakhar. Prom.*, 1981, (3), 33-35 *(Russian)*. At a constant temperature, treatment of diffusion water with aluminium sulphate gave an increased diffusivity as the pH was reduced from 6.0 to 4.5 or as it was increased to 6.5, while treatment with SO_2 gave a diffusivity which varied only slightly over the pH range 4.5-6.5. Diffusivity also rose linearly with temperature rise from 50° to 70°C, water treatment with aluminium sulphate again giving better results than SO_2 treatment; however, where the beets were sub-standard, the temperature had to be lower than that at which diffusivity was maximum. To compensate for this, it is suggested that the pH of the diffusion water be adjusted to approx. 5.0 by treatment with aluminium sulphate, thereby permitting maximum sugar extraction.

Compensatory device for viscosity control. V. V. Kozhukhar' and S. M. Bashlykov. *Sakhar. Prom.*, 1981, (3), 39-41 *(Russian)*. — A description is given of a transistorized system for control of e.g. pan boiling and massecuite crystallization based on response to changes in viscosity. The scheme uses a rheostat to change the voltage on the asynchronous micro-motor as compensation for the effect of viscosity on the motor shaft, the speed of which is thus maintained constant. The corresponding signal is used for control purposes. Tests at two sugar factories have given positive results.

Optimization of design and operational parameters of sectioned heaters. V. G. Belik. *Sakhar. Prom.*, 1981, (3), 44-47 *(Russian)*. — A method for calculating design and operational parameters of sectioned juice heaters is described and recommended values given for juice handling capacity, heating surface and number of sections.

Steam economy in a sugar factory in India processing sugar beet in the later part of the season after the sugar cane season. A case study. I. J. C. Bhargava and V. K. Jain. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India*, 1980, E.99-E.126. — For the case in question, it is calculated that the steam consumption can be reduced from 80-100% to 48-50% on beet by replacing boilers operating at 160 psig with boilers working at 583 psig and a turbo-alternator operating at 568 psig, with exhaust steam at 26.3 psig used in a a quintuple-effect evaporator, vapour being bled from each effect. All the pans would use bled vapour from the 3rd effect. The steam saving would cover the capital costs within a maximum of 5 years.

[1] See also Giorgi & Richard: *I.S.J.*, 1979, **81**, 89; 1980, **82**, 112.
[2] *ibid.*, 1982, **84**, 58.

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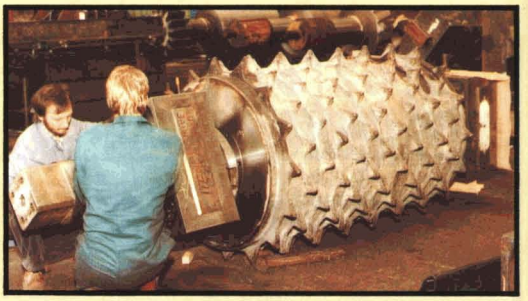

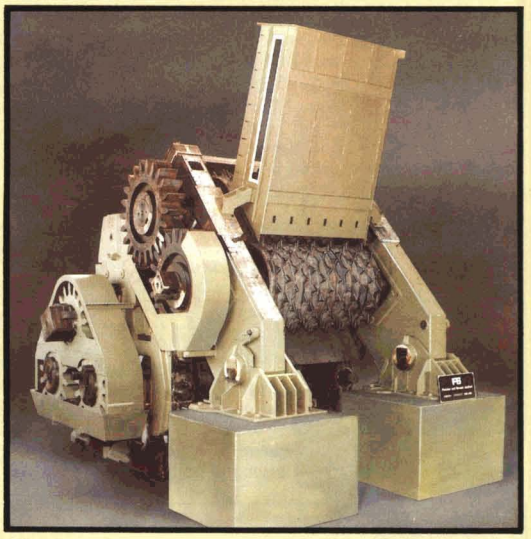

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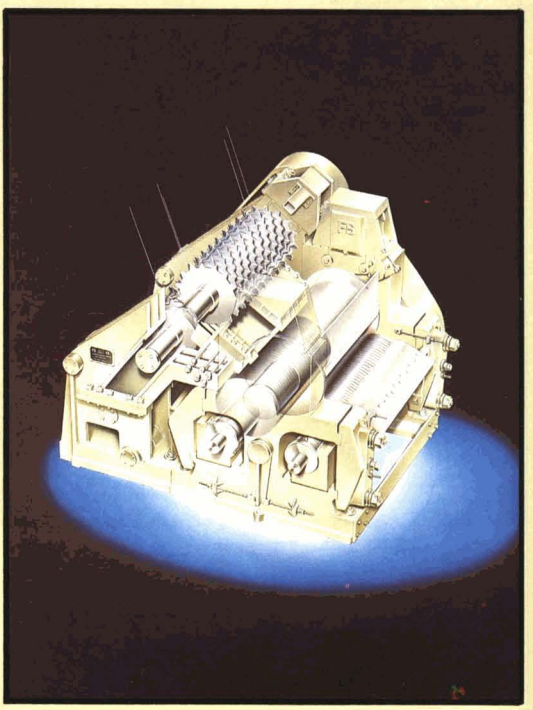

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SUGAR REFINING

Waste water treatment station for removal of carbohydrate and nitrogenous pollution in a beet sugar refinery. F. Heitz. *Sucr. Belge,* 1981, **100,** 15-25, 61-68 *(French).* See *I.S.J.,* 1981, **83,** 57.

Production of refined sugar at Larisa sugar factory. The effect of colour and ash. P. Christodoulou. *Hellenic Sugar Ind. Quarterly Bull.,* 1981, (44), 340-354 *(Greek).* Reference is made to the manufacture of Category 1 (refined) sugar at Larisa during 20 days of the 1980 campaign. The quality was 4.10 points under the EEC system (which, for this type of sugar, ranges from 0 to 8 points), despite the processing of lower quality beets of high ash content (giving a thick juice ash content of 3.8%, 18.3°St colour and 90.9 purity). Analysis of intermediate products in the boiling house to establish the main contributors to sugar colour over a 5-day period showed that 47.8% of the colour was due to affination sugar recirculation, 45.6% to thick juice and syrup retention in holding tanks and to *A*-massecuite boiling, 40.4% to syrup retention and *C*-massecuite boiling, and 20.2% to *B*-massecuite boiling.

Decolorization of cane sugar remelt syrup at Marseille refinery. R. Celle and D. Hervé. *Ind. Alim. Agric.,* 1980, **97,** 701-718 *(French).* — Full details are given of the Applexion decolorization resin scheme introduced at Marseille refinery in 1979 to replace bone char treatment of remelt liquor. The system incorporates three pairs of resin columns in which the liquor flows at a rate of 30-35 $m^3.hr^{-1}$; since the requirement is for a total treatment rate of 65-70 $m^3.hr^{-1}$, the scheme allows for two lines operating on decolorization while the third is being regenerated. Decolorization efficiency at a liquor Brix of about 65° and a pH of 8.3 is 85-87% at an average colour of untreated liquor of 952 ICUMSA units.

Purging efficiency of final massecuites — effect of reheating massecuite. S. Nomura, T. Takezaki, T. Niihara and A. Kodaka. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1980, **29,** 101-110 *(Japanese).* — At the authors' refinery, low-grade massecuite is mingled with diluted final molasses before curing in the centrifugals. Tests were carried out on reheating of the massecuite after dilution. By heating from 45° to 53°C, the purging capacity was increased by some 70% at the same colour of sugar, while final molasses purity remained unchanged. At the same purging capacity, sugar purity rose from 74 to 85, while the colour fell from 700 to 400°St; final molasses purity rose by only 0.3 units. After cooling, the massecuite in the crystallizer was reheated with water at 65°C, discharged and diluted before spinning. The quantity of diluted final molasses fell from 2-3 m^3 to 0.5-1.5 m^3 and final molasses purity fell by comparison with the conventional process. Purity rise from mother liquor in massecuite after cooling to final molasses fell from 6-10 to 4-6 units.

Effluent treatment at a sugar refinery by a complete-mixing type of activated sludge process. T. Higuchi and T. Fujisaki. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1980, **29,** 121-134 *(Japanese).* — The effluent treatment system at the Yokohama refinery of Ensuiko Sugar Refining Co. Ltd. adopted after a number of investigations is the Oxyrapid complete-mixing type of activated sludge process developed by Société Dégremont and modified in cooperation with Organo Co. Ltd. The system was suitable for the restricted site available and occupied only one-third of the area normally required for the standard process. At a daily effluent feed rate of 1500 m^3 and a COD of 800 ppm, treatment was satisfactory in terms of COD removal (94%), but sludge settling was poor, with a high SV_{30}. For successful operation, effluent volume and load should be minimum and constant.

Experience at Panevezhis sugar factory in raw sugar processing. K. Yu. Likas, S. L. Truchenene and L. S. Bruzhas. *Sakhar. Prom.,* 1981, (1), 20-23 *(Russian).* At the title sugar factory in Lithuania, cane raw sugar has been refined since 1955 (apart from one year), and details are given of the process used, including sweetening off of the filter cake after filtration of the carbonated liquor. The mud from the disc filters is sprayed into a mixer and then transferred to a series of disc filters. When sufficient mud has accumulated on the filtration surfaces, the feed is stopped and the cake washed with barometric condenser water at 85-90°C. The filtrate is further filtered together with the filtered liquor and melted *B*-sugar; the mud from this is mixed with that from the initial liquor filtration and undergoes the treatment as described above. Mud losses do not exceed 0.03% by weight of raw sugar.

Sugar milling with roller mills (optimization of parameters). J. Gebler and J. Duchacek. *Listy Cukr.,* 1981, **97,** 52-55 *(Czech).* — Factors governing the efficiency of icing sugar production by milling of granulated sugar were investigated with an experimental mill. The parameters included roller diameter and surface properties, width of inter-roller gap, forward creep created by differences in roller speeds, crystal size and throughput. The results showed that the gap between rollers was of paramount importance and was optimum at 0.2 mm (in the case of 250 mm roller diameter) for an output of 1.1-1.4 tonnes.hr^{-1} per m roller length. Best results were obtained where the initial material was made up of very coarse crystals.

Operation of lime kilns during raw sugar processing. L. D. Shevtsov, R. Ya. Gurevich and V. V. Panov. *Sakhar. Prom.,* 1981, (2), 44 *(Russian).* — During raw sugar processing at beet sugar factories, the amount of lime and carbonatation gas required is considerably less than during the beet campaign. There is therefore need to reduce lime kiln output while maintaining lime and CO_2 properties. Advice is given on operation of a lime kiln and ancillary equipment under these conditions.

Application of linear modelling to the refined sugar production process. P. García G. and V. González R. *Centro Azúcar,* 1980, **7,** (2), 65-74 *(Spanish).* — A description is given of the method by which a mathematical model of a Cuban sugar refinery process may be established.

Dextrans in raw sugar. R. Priester. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 123-124. – Mention is made of melt liquor flow problems and crystal elongation in low purity massecuite boiling at the author's refinery; these were attributed to dextran present in the raw sugar at abnormally high levels.

Problems arising from the presence of dextran in sugar products. G. W. Vane. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 125-127. – The author concludes that, of the processes used by Tate & Lyle, only carbonatation has any effect on dextran removal from liquor, and even this is limited and dependent on the size and shape of the carbonate particles. Only where fine filtration is involved is there any significant removal of the impurity. While a significant increase in the dextran levels in a range of sugar products has occurred in recent years, there has been no associated increase in customer complaints, suggesting that dextran at the levels commonly encountered does not cause any great problem. Measurements have shown that granulated sugar contains 0-100 ppm, while non-crystalline material may have between double this quantity and several thousand ppm. Raw sugar dextran varies between 100 and 1000 ppm or even more. Alcohol haze problems attributed to the presence of dextran are discussed, and mention is made of adverse reaction of hospital patients to dextran-containing invert sugar solutions. Traces of dextran retard setting of candy pieces, possibly causing distortion and hence problems, particularly at the packaging stage. Sugar used for tabletting had a high alcohol haze, and the tablets produced were very prone to capping, i.e. they tended to fracture across their longitudinal axes. The adverse effect of dextran on sucrose transformation is mentioned. The question of method of dextran determination is also briefly discussed.

The use of a two-bed (acrylic and styrenic) strong base ion exchange system for the decolorization of cane sugar liquors. W. Freis and R. W. Walker. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 171-181. A summary is presented of 10 years' laboratory work on decolorization of refinery liquors using ion exchange resins. Results have shown a clear advantage of two-bed over one-bed systems in respect of decolorization efficiency; while ash has a significant effect on resin performance, this effect is less marked with a two-bed system. Replacement of bone char with a two-bed system involving a strong base macroreticular resin (Amberlite IRA-958) followed by a strong base macroreticular styrene resin (Amberlite IRA-900) has proved economically more favourable and easier to use; for darker liquors, flow rates must be lower and shorter runs (more resin) used.

A comparison of the structure and properties of bone char and ion exchange resins for cane sugar refining. R. Kunin. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 182-190. – The structure of bone char is explained and its use for ash removal discussed. The desirability of replacing bone char with adsorbent systems that do not require the same energy-consuming regeneration procedures, but will possibly be more efficient as purification means, is indicated, and requirements of a suitable ion exchange system for liquor demineralization and decolorization listed. Details are given of a mixed bed system involving use of Amberlite IRA-93 anion exchanger and Amberlite IRC-50 cation exchanger in a 3:1 or 4:1 ratio (depending on liquor quality); this system, operated at approx. 60°C and a flow rate of 0.25 $gal.ft^{-3}.min^{-1}$, reduced the total cation content from 436 to 16 ppm and the colour by 97% by comparison with a reduction to 307 ppm and by 82%, respectively, with bone char treatment at a flow rate of 0.1 $gal.ft^{-3}.\ min^{-1}$ or less. Use of a mixed bed system for decolorization is briefly discussed, and economic considerations of ion exchange are examined.

Experiences in decolorization alternatives: C and H experiences. R. S. Patterson. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 199-203. – After outlining the operations of the bone char station at California & Hawaiian Sugar Co., the author discusses the pros and cons of decolorizing resin use and describes plans to use resin for clarified raw liquor treatment, followed by bone char. A résumé is then given of other refinery processes that remove colour, including the Talodura process, affination, phosphatation or carbonatation, the Talofloc process and boiling.

Imperial's experiences with granular carbon. T. N. Pearson. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 204-206. – Experiences with a new carbon installation at Imperial Sugar Co. are reported. Although initial results of liquor treatment by two passes through the adsorbers gave an expected low sugar colour, a drop in flow rate was caused by filter aid in the liquor; this problem was solved by treating it with bone char before instead of after carbon treatment. A reduction in liquor pH after carbon treatment was caused by loss of magnesite (as a result of attrition during conveying) through a DSM screen used for the carbon slurry before it is fed to the adsorbers. This difficulty was overcome by installing a finer mesh screen and adding make-up magnesite to each adsorber to bring the level to 4-5%. The carbon plant has permitted a 36% reduction in the bone char burn rate and hence in the BOD of char waste water as well as elimination of one shift of two men for char filter dumping. During the first eight months of 1980 average liquor colour reduction was 84% (from 596 to 95 units) with carbon treatment; however, sugar colour is sometimes abnormally high despite a low colour content in carbon-treated liquor.

CSR experience with ion exchange resin decolorization. H. R. Delaney. *Proc. 1980 Tech. Session Cane Sugar Refining Research,* 207-211. – At Adelaide refinery, a set of three pairs of columns, containing ion exchange resin having quaternary ammonium groups, is used for decolorization. Fouling of the resin was investigated and found to be caused by polymerized colorants, while a fall in resin performance was also caused by inorganic ions which competed with colorants for the active sites. Polymerization of colorants occurred within the resin bead; however, the polymeric structure could be disrupted by exposing the bead to hydrolytic conditions to break sensitive bonds, and this was achieved by using 10% NaCl at pH 12 for regeneration. Intermittent acid washes also proved effective in countering the fall in performance caused by irreversibly adsorbed colorants (luteolin- and apigenin-based pigments and phenolic acids). Resin was found to be less effective than bone char in the removal of phenolic acids and amino-N compounds, so that more colour was formed during boiling of resin-treated liquors, resulting in 2nd and 3rd strike sugars of abnormal colour.

LABORATORY STUDIES

Acidic polysaccharides in a cane final molasses. S. Fujii, J. Ohyama and M. Komoto. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1980, **29**, 28-35 *(Japanese)*. Polysaccharides were isolated from a cane final molasses sample by dilution, centrifuging and ultrafiltration to remove all colouring matter, and freeze-drying. This fraction was further fractionated to five components by chromatography on a DEAE-cellulose column using a phosphate buffer and eluting with NaCl solutions. The two largest fractions were isolated and purified by repeated preparative DEAE-cellulose chromatography. Both were found to be acidic and moved toward the anode in paper electrophoresis. After acid hydrolysis, the hydrolysates were separated into neutral and acid fractions by treatment with anion exchange resin. The neutral fractions were analysed by paper chromatography, and then, after reduction with sodium borohydride and acetylation, by gas-liquid chromatography and gas chromatography-mass spectrometry. The acidic fractions were analysed by GLC (after trimethylsilylation) and paper chromatography. Their molecular weights, as determined by iodometry, were 14,360-16,720 and 17,770-19,820. Tentative constitutions of the two polysaccharides, each of which appears to be a type of gum originating from the cane plant, are suggested.

Enzymatic determination of glucose in refined sugar. H. Fujimoto and S. Sakuraba. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1980, **29**, 45-53 *(Japanese)*. The procedure developed involved adjusting the sample concentration to 15% (w/v), dissolving 70 mg of glucose oxidase and suitable colouring agent in distilled water and diluting to 50 ml, pipetting 2 ml of the sample solution and the enzyme solution into a test tube, allowing the contents to react for 10 min at 20-30°C and stopping the reaction by adding one drop of 4N HCl, and then measuring the absorbance against a blank and determining the glucose concentration from a calibration curve. The method gave results in close agreement with those obtained by the Knight & Allen method[1], although the enzymatic method showed a lower standard deviation. The Ofner method gave higher values than the other two methods. The enzymatic method can determine as little as 3 ppm glucose in refined sugar. Close correlation was found between glucose content, conductivity ash, colour and Hunter whiteness of refined sugar.

Continuous determination of sucrose by colorimetry. M. Fukimoto, S. Nishimoto, K. Muraoka, A. Kodaka and S. Suzuki. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1980, **29**, 54-59 *(Japanese)*. – In tests to develop a continuous detector for sugar in boiler feed water and waste water, a major disadvantage of the method based on ammonium molybdate was decomposition of the molybdate, after a long period of heating, to form precipitates which clogged the reaction tube. Using sodium molybdate instead and a Pyrex glass tube as reaction tube with the inner wall purged with air at regular intervals, it was possible to carry out continuous operation successfully for two weeks. Impurities such as silica, phosphorus and reducing matter (except reducing sugars) interfered in the determination. Refinery waste water contains about 10 ppm silica, in the presence of which only about 60% of the expected value of sugar was found. However, five-fold dilution with condensate in the apparatus reduces the error. About 50 ppm H_2SO_3 present in condensate had no effect on the colorimetric determination. Optimum conditions were a sample:6% molybdate:8% H_2SO_4 ratio of 5:1:1, a reaction temperature of 95°C and a reaction time of 7-8 min. For waste water, the lower limit of detection was 10 ppm sugar.

A simple method for determining crystal regularity. I. Kensho, T. Yamaguchi and S. Nakamura. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1980, **29**, 60-71 *(Japanese)*. – In the method described, a 100 g sample is screened through a nest of five sieves (710, 590, 500, 420 and 297 μm), the fraction through 297 μm discarded, and the remaining five fractions examined separately. Between 100 and 150 crystals from selected size fractions are classified under a magnifier, the percentage calculated, and the points system of Hibbert *et al.*[2] used for scoring. Results for 29 granulated sugars are tabulated. Since there was no significant difference between the "moderate" rates for the samples, the crystal regularity could only be assessed from the "good" classification. Moreover, only two fractions (through the 590 and 500 μm screens) could be used for assessment in the factory where the M.A. was controlled as a quality parameter.

Determination of trace elements in molasses by emission spectroscopy. Z. P. Miroshnikova and G. A. Chikin. *Sakhar. Prom.*, 1981, (2), 47-49 *(Russian)*. – A method for qualitative and quantitative determination of beet molasses trace elements is described. The trace elements are concentrated by precipitating with 8-oxyquinolinic acetate and a small quantity of tannic acid, and the precipitate filtered, dried, ashed and calcined at 500°C. The concentrates are vaporized and then subjected to spectrophotometry. Results are given for Mn, Mo, Cu, Co, Ni and Pb in molasses from three sugar factories and a citric acid plant.

Determination of the "hard fibre:pith ratio" in sugar cane varieties. A. A. Rodella, C. Parazzi and A. C. P. Cardoso. *Brasil Açuc.*, 1980, **96**, 155-160 *(Portuguese)*. The fibre:pith ratio in cane is a factor influencing its milling quality, and a mechanical method has been developed to separate the two constituents so that the ratio can be determined both in varieties currently under cultivation in Brazil and in selections from the I.A.A.–Planalsucar breeding program.

Composition of vinasse from autonomous distilleries. A. A. Rodella, C. Parazzi and A. C. P. Cardoso. *Brasil Açuc.*, 1980, **96**, 209-212 *(Portuguese)*. – Analyses have been made and are tabulated of the composition, Brix and pH of vinasse from nine autonomous distilleries, i.e. those which use cane juice as their raw material instead of molasses. The composition varies slightly with the period of sampling and more so with the area, where the soil is different. The potassium and ash variations are similar to those noted for vinasse from molasses

[1] *I.S.J.*, 1960, **62**, 344-346.
[2] *ibid.*, 1975, **77**, 35-37.

distilleries, but the Mg content is higher in juice-based vinasse than that of Ca, in contrast to their relationship in vinasse from molasses distilleries.

Measurement and calculation of physico-chemical properties of sugar solutions. P. Kadlec, R. Bretschneider and A. Dandar. *Sucr. Belge,* 1981, **100,** 45-59 *(French).* From data in the literature and experiments conducted by the authors, mathematical equations have been obtained for calculation of a number of physico-chemical properties (molar concentration of non-sugars, solubility, boiling point elevation, density, viscosity, specific heat and enthalpy, thermal conductivity, diffusion coefficient and milk-of-lime density) and set out in the form of an algorithm and then as sub-programs using Fortran language. These form a data bank applicable to sugar solutions and massecuite.

Studies on the kinetics of crystallization of sucrose. Effect of Mn and Co salts. N. A. Ramaiah and K. M. Tewari. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, M.1-M.8. — In a study of means of increasing the crystallization rate in vacuum pans, the effects of Mn and Co chloride and sulphate were determined at a supersaturation of 1.10 and 34, 45 and 55°C. The results showed that, under the laboratory conditions described, the rate constant of the pure sucrose was reduced by the presence of 5.0M of a salt, was increased by addition of 10.0M salt, but then fell again as the salt concentration was raised to 15.0M. In all cases, the constant increased with temperature.

X-ray diffraction studies of sucrose and sucrose irradiated with γ-radiation. M. Prasad. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.1-C.4. — Irradiation of sugar crystals with ^{60}Co was found to cause damage to the crystal lattice as indicated by a reduction in the inter-planar spacing *d* by comparison with untreated crystals.

Dextran in sugar house products — a method for neutralization of its effect during polarimetric analysis. S. Bose and L. Singh. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.23-C.34. — Of a number of clarifying agents tested for their efficiency in precipitating dextran in sugar solutions and cane juices prior to their polarimetric analysis, the most effective proved to be Herles' lead nitrate reagent. This gave a clear filtrate of almost the same pol value as a blank; the amount of reagent to add was governed by the solution Brix and dextran content.

Colorimetric method for the determination of ammonia in condensate. A. K. Srivastrava. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.51-C.55. — A brief description is given of a method for determination of ammonia in condensate which is based on use of Nessler's reagent (containing potassium iodide and mercuric chloride) and measurement of the optical density of the condensate at 420 nm.

A method for estimation of sulphur dioxide in white sugar by chloramine-T. S. K. D. Agarwal and S. K. Upadhyaya. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.57-C.87. — The method developed by Carruthers *et al.*[1] and officially adopted by ICUMSA for SO_2 determination in white sugar is valid for the range 5-40 ppm, while a method suitable for the range 0-70 ppm is required. Details are given of a method based on chloramine-T[2], and comparison with other methods for tests on white and refined sugar samples is discussed. Close agreement was found between the values given by the proposed method and the conventional iodine method, while the ICUMSA method gave greater divergency. The Bodeker method based on sodium nitroprusside proved suitable for micro-detection.

A simple method for determination of colour of white sugar in solid form. R. D. Athavale. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.89-C.92. Preliminary results of investigations into the possible use of a spectrophotometer, originally developed by the author's company for measurement of paper brightness, etc., to measure white sugar reflectance are discussed.

Abnormal Brix and intermolecular orientation in a sucrose-water system. M. Prasad. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.93-C.102. — The physical basis of the Brix of a pure sucrose solution is discussed in terms of a newly introduced parameter, the molecular ratio (moles of water:moles of sucrose), volume contraction and specific gravity. Comparison between calculated Brix and experimental data show close agreement in the limiting value for massecuite. Abnormal Brix values reported for low-grade massecuites are attributed to volume contraction. A proposed model of symmetrical intermolecular orientation of the sucrose molecules in a 65°Bx sucrose solution is strongly supported by evidence from X-ray diffraction studies.

Application of the conductance method for estimation of ash in sugar cane products. P. Thangamuthu. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.103-C.108. — The validity of conductivity measurement of juice, syrup and final molasses as a means of ash determination is confirmed, and the significance of the glucose:ash ratio as an indication of melassigenic properties demonstrated.

A new optical method for estimation of colloids. A. P. Gupta, S. P. Shukla and K. M. Tewari. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, C.109-C.117. The method described is based on addition of Night Blue dye to the juice; the dye causes coagulation of the colloids which is complete at the isoelectric point and hence corresponds to minimum optical density, which is measured colorimetrically at 660 nm. The amount of Night Blue to add is found from arsenic sulphide reference standards treated with known quantities of the dye.

Adsorption of colouring matter by particles of calcium and magnesium hydroxides. I. F. Bugaenko and M. Saber Guda. *Izv. Vuzov, Pishch. Tekh.,* 1980, (6), 58-60 *(Russian).* — When milk-of-lime or 5% solutions of $MgCl_2$ and $Ca(OH)_2$ were added to model solutions of caramelization products, melanoidins and thermal degradation products from reducing matter, adsorption of the colouring matter (as determined by measuring the optical density at 540 nm) was in the order of preference as given above. The mechanism of this preferential adsorption is explained. The advantage of the poor solubility of $Mg(OH)_2$ as regards colorant adsorption is discussed; it is of particular importance for removal of caramelization products, which are adsorbed only to a minor extent on $CaCO_3$ particles.

[1] *I.S.J.,* 1965, **67,** 364-368.
[2] "Newer redox titrants". Ed. Belcher & Gordon (Pergamon, London), 1965, p.37.

BY-PRODUCTS

Methane fermentation of bagasse and some factors to improve the fermentation. S. Oi, H. Yamanaka and T. Yamamoto. *J. Ferment. Tech.* (Japan), 1980, **58,** (4, 367-372; through *S.I.A.,* 1981, **43,** Abs. 81-252. – Tests on the meosphilic methane fermentation of bagasse are reported. The efficiency of fermentation was greatly improved by pre-treating the bagasse with dioxane or dioxolane followed by incubation with cellulolytic and hemicellulolytic enzymes. Bagasse treated in this way and fermented after addition of 0.03% glutamic acid evolved, from each g of bagasse, nearly 200 ml gas containing 68% methane. Bagasse pre-treated with NH_4OH, Cadoxen or Zinkoxen evolved somewhat smaller quantities of gas, generally with a lower methane content. A possible mechanism for the stimulating effect of glutamic acid is indicated.

Influence of infection on biosynthesis of citric acid. I. Januszewicz and K. Mossakowska. *Prace Inst. Lab. Badaw. Przem. Spozyw.,* 1978, **29,** 27-44; through *S.I.A.,* 1981, **43,** Abs. 81-256. – Ranges of counts of various types of microflora in 34 molasses samples from beet factories are quoted, and effects of stated numbers of certain organisms on growth of *Aspergillus niger* and on citric acid yield are quantified. *Candida tropicalis* or *Bacillus subtilis* had negligible effect, but bacteria reducing NO_3^- to NO_2^-, NO or N_2O were very harmful; such bacteria were present in 32 of the samples. The first stage of *A.niger* growth was the most susceptible to infection – once mycelia formed on the surface, citric acid synthesis was ensured. Dangerous infections are more likely to arise from local sites in the equipment than from the incoming molasses, since this will have been sterilized.

Possibilities of application of mathematical programming to the optimization of process models of the production of biomass. P. García G. and P. Hernández S. *Centro Azúcar,* 1980, **7,** (2), 1-14 *(Spanish).* – A summary is presented of articles on mathematical programming and on its application to yeast production.

Determination of the optimum mixture in the production of B-325 cardboard. E. González S., F. Ramos M. and R. Castro P. *Centro Azúcar,* 1980, **7,** (2), 115-121 *(Spanish).* – An experiment in which six factors were varied in the production of cardboard from bagasse and secondary pulps, in order to determine their interactions and optimize the operation, is reported. Recommendations are made as a consequence of the study.

Characterization of the chemical composition of different types of vinasse from the region of Campos, RJ. J. Bolsanello and J. R. Vieira. *Brasil Açuc.,* 1980, **96,** 293-307 *(Portuguese).* – Analyses were carried out of vinasse samples taken on three occasions during the 1978 and 1979 crop years from six distilleries in the Campos area. The compositions varied with distillery, with the time of sampling and with the must used, but organic matter was the largest component and potassium was the predominant mineral constituent.

Energy agriculture of crops potentially useful. S. C. Srivastava and A. K. Srivastava. *Maharashtra Sugar,* 1981, **6,** (3), 31, 33-38, 40-41. – The authors examine the energy inputs and outputs of cane, beet, cassava and sorghum, and compare their biomass, alcohol and sugar productivities.

Obtaining calcium gluconate and fructose from sucrose. B. W. Krol. *Zesz. Nauk. Politech. Lodz,* 1980, (361), 187-193; through *S.I.A.,* 1981, **43,** Abs. 81-453. – A process is outlined whereby calcium gluconate and fructose are obtained from sucrose reasonably cheaply with satisfactory yield. Sucrose is hydrolysed with HBr, and the syrup is subjected to electrochemical oxidation via BrO^- by a known method, using an initial concentration such that much of the Ca gluconate later crystallizes out without evaporation, during 100 hr at ambient temperature. The precipitate is centrifuged, washed and dried, giving a 1st crop equivalent to 46% on initial glucose. Bromide and colorants are removed from the liquor obtained, by selective ion exchange, allowing recycling of much of the Br^-. Evaporation and crystallization (as before) yields a further 27% on initial glucose. The mother liquor contains only 12% Ca gluconate on fructose (unaffected by the process), and tastes like fructose. It can either be used as such, or be deionized and evaporated for crystallization from aqueous ethanol (yield 46% on dry solids).

Sucrose inversion by immobilized *Saccharomyces cerevisiae* yeast cells. Y. Y. Linko, L. Weckstrom and P. Linko. *Proc. 2nd Int. Congr. Eng. Food,* 1979, 81-91; through *S.I.A.,* 1981, **43,** Abs. 81-454. – Entrapment of invertase-active *S. cerevisiae* cells within gel beads of Ca alginate or cellulose diacetate is outlined. Inversion tests on 10-50% sucrose solutions and 33°Bx cane molasses are reported with graphs. The activity of both products was high and very stable; with appropriate flow rates, total inversion was achieved at 40°C. The half-life of the alginate product is estimated to be 5.7 years.

Commercial manufacture of citric acid by fermentation. VII. Effects of some fats and oils on citric acid fermentation by *Aspergillus niger.* C. S. Bhatt, P. K. Agrawal and L. Viswanathan. *Proc. 44th Ann. Conv. Sugar Tech. Assoc. India,* 1980, G.1-G.7. **VIII. Effects of some alcohols and crude extracts on production of citric acid by *Aspergillus niger. Idem ibid.,* G.75-G.85.**

VII. The effects of ten fats and oils on citric acid yield by surface fermentation were determined. Only butter fat and mustard oil, added to the medium at 1% v/v and 1% w/v, respectively, increased yield by comparison with the control, and also increased mycelial growth.

VIII. Addition of 1% methyl alcohol to the medium increased citric acid yield by comparison with the control, whereas 2% and 3% addition reduced it. Addition of 1, 2 and 3% ethyl alcohol increased yield, the increase being greater with the amount added. Isopropyl alcohol inhibited citric acid production. Addition of 0.05% yeast extract, 0.2% malt extract, 0.05%, 0.1% or 0.2% peptone or casein hydrolysate, or 0.2% beef extract (v/v) increased citric acid yield by comparison with the control, greatest increase being given by 0.2% malt extract or 0.1% casein hydrolysate. Only malt extract failed to increase mycelial growth.

TRADE NOTICES

Process refractometer. Moisture Systems Ltd., 17 Low Farm Place, Moulton Park, Northampton NN3 1HY, England.

The SSR-72 process refractometer embodies a rotary helical scanner which continuously sweeps a beam of light through a series of angles at the interface between a large sapphire prism and the process solution. Indication is based on the time measurement between a light and a dark pulse. If the concentration of the solution changes, there will be a proportional change in the critical angle. The unit makes 60 measurements a second and detects a change within 16 msec. The sensing head, available with an extended probe, may be mounted up to 500 ft from the control console.

Lobe pumps. ITT Jabsco Ltd., Bingley Rd., Hoddesdon, Herts. EN11 0BU, England.

ITT Jabsco Ltd. have announced a new range of pumps, the Pureflo lobe series, which are fitted with interchangeable computer-designed rotors. Available in eight basic sizes, from 25 to 100 mm, with differential pressures up to 10 bar, the pumps have a capacity ranging from 100 to 1000 litres.min^{-1} and can handle liquids of varying viscosities at temperatures up to 110°C.

Weigh cell mechanisms. Optibal Holdings Ltd., Radnor Park, Congleton, Cheshire, England.

The new range of Flexure weigh cell mechanisms have strain gauges bonded onto them to provide a sensitivity to weights as low as 0.05 g. Available in capacities up to 100 kg, the units are virtually maintenance-free and are suitable for incorporation in weigh filling machines and checkweighers.

Liquid level control. Bestobell Mobrey Ltd., 190-196 Bath Rd., Slough, Berks. SL1 4DN, England.

A new range of ultrasonic transducers for liquid level control is announced by Bestobell Mobrey Ltd.; designated the Hi-Sens, the unit comprises a welded stainless steel cylinder housing two ultrasonic crystals attached to the cylinder walls at diametrically opposite positions. In air, the two crystals "communicate" ultrasonically via the walls of the cylinder to activate the control unit, but when a liquid surrounds the cylinder this "communication" is lost and the control unit is deactivated. The state of the control unit provides a signal for the alarm caused by failure of the transducer.

Flow measurement. Kent Process Control Ltd., Flow Products Division, Old End Lane, Stonehouse, Glos. GL10 3TA, England.

A new flux sensing electro-magnetic flow measurement system announced by Kent has an accuracy of 0.5% of flow rate and is suitable for use with all conductive fluids, including viscous liquids and slurries. Liquid flowing through the electro-magnetic detector head cuts the magnetic field and causes induction of an emf which is detected by two small electrodes. This is proportional to the flux density multiplied by the flow velocity; the flux density is measured by the detector head, using an integral search coil, which produces a voltage signal proportional to it. The associated converter offers a comprehensive range of analogue and frequency output signals.

Level transmitters. KDG Instruments Ltd., Fleming Way, Crawley, West Sussex RH10 2QE, England.

The 8700 Series of level transmitters incorporates the well-proven capsule and LVDT technique used internationally for tank level measurement. The transmitter emits a 4-20 mA signal as standard. The transmitters are intended to meet the requirements for contents gauging systems with minimum size tank penetration compatible with long-term stability, corrosion resistance, etc. The sensor may be mounted inside or outside the tank.

Portable sack stitching machine. Union Special (U.K.) Ltd., 22 Mandervell Rd., Industrial Estate, Oadby, Leicester LE2 5LQ, England.

A completely new portable sack stitching machine, the Power Packer style 2000A, is designed for efficient, fast, easy closing of all types of sacks. It weighs only 3.8 kg, incorporates simple threading, built-in thread chain cutter, automatic shut-off carbon brushes, and stitches up to 350 bags per hour.

PUBLICATIONS RECEIVED

A European group in the starch industry. Roquette Frères S.A., 62136 Lestrem, France.

A 20-page brochure describes the activities of Roquette Frères S.A. in the field of starch and starch-derived products. The company has signed a technical cooperation agreement with Fives-Cail Babcock for construction and marketing of high fructose corn syrup plants.

Fives-Cail Babcock. Fives-Cail Babcock, 7 rue Montalivet, 75383 Paris Cedex 08, France.

Two brochures from Fives-Cail Babcock describe the activities of this major industrial group, which is well known in the sugar industry for designing and constructing sugar factory equipment and supplying complete beet and cane sugar factories.

Stainless steel filters. Seitz-Werke GmbH, Postfach 1049, D-6550 Bad Kreuznach, Germany; Seitz Engineering (GB) Ltd., Orion House, High St., Addlestone, Weybridge, Surrey KT15 1TU, England.

A new 12-page leaflet provides construction, operating and technical data on the Seitz Orion 40 sheet and precoat filter for use in a number of applications including polish filtration in the sugar industry. The Orion 40 has vertically arranged filter elements with interleaved filter media; use of the four-eyelet principle permits complete venting and draining of the filter pack and even flow across the media surfaces. The plates and frames are available in different materials and designs. The unit is available with up to 14.30 m^2 filter area when used as a sheet filter, or up to 7.84 m^2 as a precoat filter.

Sack filters. Fördertechnik Hamburg-Harry Lässig, Mühlendamm, D-2000 Hamburg-Schenefeld, Germany.

An eight-page brochure from FTH gives details of the company's sack filling, conveying, packaging and storage plants for both bulk and bagged product handling. The equipment described includes palleting and depalleting plant.

Screw conveyors. UESCO Ltd., Hudson Rd., Viking Industrial Estate, Bedford, England.

A recent brochure from UESCO Ltd. gives details of the various types of screw conveyor the company manufactures. The conveyors are suitable for a large number of applications, including handling of raw and refined sugar and beet pulp.

West Germany campaign results, 1981/82[1]

	1981/82	1980/81	1979/80
	hectares		
Beet area	463,999	414,301	405,208
	tonnes		
Beet processed	24,507,201	19,235,577	18,544,290
White sugar production	2,826,763	2,262,943	2,380,197
Raw sugar production	564,577	461,642	441,649
Total sugar production, tel quel	3,391,340	2,724,585	2,821,846

Sugar Processing Research Conference. — It has been pointed out that, as a function in cooperation with a US government body, the Department of Agriculture, attendance at the above conference[2] is by invitation and specifically for the sponsoring member companies of Sugar Processing Research Inc. Interested technologists seeking to be invited may write to Dr. Margaret A. Clarke at the address given in our original notice.

Togo sugar production plans. — Togo is establishing its own sugar production facilities and a new 1800-hectare plantation at Anie will shortly be producing 6000 tonnes of sugar a year, enough to cover 60% of domestic consumption. A further 4000-ha complex at Tchaoudjo on the River Mono is planned to increase production by another 30-40,000 tonnes, permitting self-sufficiency and providing an exportable surplus.

Florida sugar factory expansion[3]. — Osceola Farms Company is expanding its capacity to 9000 t.c.d. with installation of four 42 x 84 in three-roller mills with independent drives. A boiler having a capacity of 150,000 lb/hr is also to be installed, the detailed design and engineering work having been provided by IPS Engineers Inc., of Baton Rouge, Louisiana.

US HFCS plant sale[4]. — Anheuser-Busch Co. Inc. has announced that its subsidiary, Busch Industrial Products Corporation, has agreed in principle to sell its corn refining plant in Lafayette, Indiana, to A. E. Staley Mfg. Co. for an undisclosed price. The plant, with a capacity of 35,000 bushels per day, produces corn syrups for use in processed foods as well as starches and waxy maize for food and industrial markets. Staley already operates a corn sweetener plant at Lafayette and others at Decatur, Illinois and Morrisville, Pennsylvania. A fourth is scheduled for completion next autumn at Loudon, Tennessee.

Mauritius 1981 sugar crop[5]. — The 1981 sugar cane harvest in Mauritius began on June 10, 1981 and ended on December 12. The 21 sugar factories crushed 5,302,459 tonnes of cane, yielding 574,526 tonnes of sugar, tel quel, equivalent to 609,744 tonnes, raw value. Average cane yield was 67.5 tonnes per hectare and average sugar extraction was 10.83% on cane. These figures compare with a crop of 475,494 tonnes, tel quel, or 504,214 tonnes, raw value, in 1980, and a crop of 688,383 tonnes, tel quel, or 728,908 tonnes, raw value, in 1979. The disastrous results of the 1981 crop stem from a very severe drought which prevailed during the growing season. The 1980 crop had, for its part, been very severely affected by a tropical cyclone. Mauritius has thus exceptionally experienced two successive disastrous years from the point of view of sugar production.

Giant distillery in Cuba[6]. — During 1982 the largest molasses-based distillery in the world is to go into operation at Santa Cruz, 20 km from Havana, Cuba. It involves an investment of 400 million Austrian schillings and is being erected by Vogelbusch GmbH of Vienna. In additon to alcohol, the distillery will produce rum and bakers' yeast.

Nicaragua sugar expansion plans[7]. — Maximizing of sugar export earnings is a goal of the Nicaraguan government and an expansion program for the sugar sector is under way. Preliminary indications are that a new sugar factory with a 120,000 tonnes capacity will be constructed in the Tipapata area between Lake Managua and Lake Nicaragua. About 19,000 hectares of new sugar cane land will be planted in the area. Plans call for the new project to come on stream in the 1984/85 season. In January construction began on another project, comprising a $250 million plantation and sugar factory of which one-fifth of the finance will be provided as a loan by Cuba. Cuba is also providing technical assistance in the construction of the facility, which will produce 130,000 tonnes of sugar annually when completed. The factory, located 35 km north of Managua, will be the largest in Central America, with a daily cane crushing capacity of 7714 tonnes.

Argentina sugar exports, 1981[8]

	1981	1980	1979
	tonnes, tel quel		
Algeria	10,000	10,500	0
Chile	45,600	132,222	65,567
Egypt	7,600	0	23,499
Haiti	0	0	9,840
Indonesia	0	0	23,916
Morocco	10,482	0	13,971
Portugal	0	0	14,701
Sudan	0	5,000	0
Sweden	0	0	9,602
Tunisia	0	10,000	0
Uruguay	9,046	6,358	20,447
USA	386,192	247,476	139,691
USSR	210,553	67,939	8,301
Venezuela	41,700	10,000	11,000
	721,173	489,495	340,535

Guatemala sugar crop, 1980/81[9]. — The harvested cane area in 1980/81 is estimated at 78,612 hectares, compared with 66,270 ha in the previous crop. Sugar cane production is put at 5,409,394 tonnes against 4,560,129 tonnes in 1979/80. Sugar production rose from 397,712 tonnes to an estimated 447,914 tonnes in 1980/81, but this represents a decline in recovery from 87.22 to 82.80 kg per tonne of cane crushed. One of the main reasons for this was the early start to the campaign at the request of the government; some of the cane crushed was not ripe and sugar yields were low. Excessive exports in 1979/80 had left Guatemala with severely reduced stocks for domestic consumption towards the end of the year.

HFCS plant closure in the US[10]. — A corn wet milling plant at Montezuma, New York, is to suspend operation as the owners, (Clinton Corn Processing Company) state that market conditions have made the production of high fructose corn syrup uneconomical. Production will drop by around 180,000 tonnes per year as a result of the closure.

Sugar-based chemical project in the Philippines[11]. — An agreement has been reached between the United Nations Interim Fund for Science and Technology for Development and the National Science and Development Board covering the production of sugar-based chemicals from indigenous sources. The project will initially concentrate on production of such chemicals as citric acid, gluconic acid, itaconic acid, acetic acid and acetic anhydride, dextrose and fructose, acetone and butanol, and also single-cell protein. At the end of the first phase, technological packages for the production of each chemical are expected to include detailed processes, market surveys and assessment of economic viability. The project is intended not only to conserve and generate foreign exchange, provide employment and promote industrial development but also to diversify the sugar industry and provide it with a fall-back position in times of unstable international markets. Research costing 4½ million pesos will be conducted under the project by the National Institute of Science and Technology (dextrose and fructose production by use of immobilized enzymes, microbiological production of chemicals) and by the University of the Philippines at Los Baños (single-cell protein, alcohol, acetone and butanol, and polyhydric alcohol production by fermentation).

Panama sugar production, 1981[12]. — Sugar production in Panama from the 1981 crop totalled 185,500 tonnes, raw value, a 7.4% reduction from the 1980 outturn of 200,231 tonnes, itself a reduction of 11.2% from the 225,509 tonnes of 1979.

Nepal sugar factory[13]. — A sugar factory is scheduled to be erected at Sunwol, about 250 km south-west of Katmandu, under a Chinese program of economic assistance to Nepal. The proposed factory will have a crushing capacity of 1000 t.c.d. and will produce 10,000 tons of white sugar annually.

1 C. Czarnikow Ltd., *Sugar Review,* 1982, (1583), 22.
2 See *I.S.J.,* 1982, **84,** 32.
3 *Sugar y Azúcar,* 1981, **76,** (11), 10.
4 *Westway Newsletter,* 1981, (98), 16.
5 *Mauritius Sugar News Bull.,* 1981, (12).
6 *Zuckerindustrie,* 1982, **107,** 86.
7 F. O. Licht, *International Sugar Rpt.,* 1982, **114,** 73.
8 C. Czarnikow Ltd., *Sugar Review,* 1982, (1584), 28.
9 *World Sugar J.,* 1982, **4,** (7), 38.
10 C. Czarnikow Ltd., *Sugar Review,* 1982, (1578), 2.
11 *Sugar News,* 1981, **57,** 200, 230.
12 F. O. Licht, *International Sugar Rpt.,* 1982, **114,** S33.
13 C. Czarnikow Ltd., *Sugar Review,* 1982, (1581), 15.

US sugar imports, 1981[1]

	1981	1980
	–short tons, raw value–	
Domestic off-shore		
Hawaii	1,095,977	1,022,568
Puerto Rico	48,361	178,062
Foreign		
Argentina	443,950	197,172
Australia	715,126	350,881
Belize	56,290	71,539
Bolivia	8,090	72,508
Brazil	1,099,351	845,948
Chile	0	7,152
Colombia	166,321	214,374
Congo	0	7,544
Costa Rica	81,513	68,262
Dominican Republic	761,007	615,362
Ecuador	54,673	72,949
Fiji	46,497	51,821
Guatemala	224,213	218,568
Haiti	0	10,044
Honduras	94,528	89,133
Ivory Coast	0	35,318
Madagascar	12,274	20,472
Malawi	87,627	60,118
Mauritius	0	55,216
Mozambique	40,066	87,960
Nicaragua	80,089	62,592
Panama	103,958	156,351
Paraguay	16,160	11,041
Peru	0	52,241
Philippines	239,043	408,998
El Salvador	46,497	51,821
South Africa	0	164,025
Swaziland	191,869	141,935
Thailand	262,059	66,203
West Indies	104,292	214,366
Zimbabwe	92,119	13,620
Other countries	8,767	1,258
	6,158,042	5,675,318

Pakistan sugar factory for Indonesia[2]. – Pakistan and Indonesia have signed a $27.6 million agreement for the construction of a sugar factory in Subang, West Java. The facility is scheduled for completion by December 1983 and will have a daily cane crushing capacity of 3000 tonnes, expandable to 4000 tonnes.

Mexico sugar production, 1980/81[3]. – The decline in Mexico's cane sugar production continued in 1980/81. The amount of cane crushed was 28.6 million tonnes, compared with 31.6 million tonnes in 1979/80, while the area planted to cane was 452,849 hectares against 488,734 ha in 1979/80 and the cane yield declined from 65.65 tonnes to 63.16 tonnes per hectare in 1980/81. Sugar production amounted to 2,517,448 tonnes, raw value, of which 1,065,154 tonnes were produced as refined sugar, 1,105,817 tonnes as "standard" sugar and 195,270 tonnes as "mascabado" raw sugar. As exports of raw sugar have ceased it is expected that only the first two grades will be produced in the 1981/82 crop.

Poland sugar crop, 1981/82[4]. – According to reports from Poland, 15,524,000 tonnes of beets were processed during the 1981/82 campaign and 1,722,000 tonnes of sugar, white value, were produced (equivalent to about 1,872,000 tonnes, raw value). This result not only exceeds the previous campaign's production by more than 400,000 tonnes but is also the highest production result of the past decade.

USDA views on world sugar production and prices[5]. – World sugar production in the 1981/82 season is still forecast at 95.8 million tonnes, raw value, and consumption at 92.0 million tonnes, according to the US Department of Agriculture. This compares with 1980/81 output of 86.7 million tonnes and consumption of around 89.0 million tonnes. The Department also said that global production this season could be lower than indicated because of the drastically reduced estimate for the Soviet Union's crop. This could be offset, however, by higher output in the EEC, Cuba, Argentina and the US. Based on a 3.5 million tonnes increase in world stocks, world prices will be relatively low at between 12 and 16 cents per lb, the Department believes. Cutbacks in output by some major producers could boost prices, particularly if the EEC's stocking proposal is implemented.

Mauritius sugar exports, 1981[6]

	1981	1980
	— tonnes, tel quel —	
France	73,629	54,363
Holland	501	504
Ireland	14,350	0
UK	343,767	548,419
US	0	14,022
	432,247	617,308

USSR beet production target for 1982[7]. – The Soviet production plan provides for a sugar beet production of 98 million tonnes in 1982 (actual production in 1981 was 60.6 million tonnes). The planned target is apparently to be achieved from an unchanged beet area of some 3.7 million hectares. A Moscow agricultural journal said that this increase is to be attained by higher beet yields. The agricultural plants were reported to be sufficiently supplied with seed. On 1.5 million hectares (some 41% of the total area) high quality varieties are to be used as against 500,000 hectares for which such seed were authorized in 1979. On the other hand, a report from the Ministry of Agriculture in Moscow said that much had still to be done by the seed breeders if sufficient high quality seed was to be supplied for 1982.

Sweden campaign results, 1981/82[8]. – In the 1981/82 campaign, the seven Swedish sugar factories processed 2,479,883 tonnes of beet to give 277,786 tonnes of white sugar and 68,977 tonnes of raw sugar, as well as 89,281 tonnes of molasses.

Australia sugar exports, 1981[9]. – Australia sold a record 2,982,057 tonnes of raw sugar on world export markets last year but low prices could reduce returns up to 30% below 1980's record income of $A 1250 million. The Sugar Board, which markets the sugar crop, released its 1981 export figures on February 9; the top buyer was the United States with 811,047 tonnes. Australia's previous record year was 1977 when 2,965,249 tonnes were exported.

Brazil sugar exports[10]. – Total exports from Brazil amounted to 2,670,048 tonnes, raw value, against 2,661,913 tonnes in 1980 and 1,941,589 tonnes in 1979.

Argentina sugar statistics, 1981[11]. – Sugar production in Argentina in 1981, at 1,531,227 tonnes, tel quel, was somewhat below the very good results achieved in 1980 when it reached 1,627,094 tonnes, but it nevertheless maintained most of the improvement over the two previous crops which were rather disappointing at just over 1.3 million tonnes. The 1981 output reflected a yield of 10.288% from the 14,884,200 tonnes of cane harvested from 323,300 hectares of cane land; in 1980 16,431,700 tonnes of cane were harvested from 314,100 hectares. At one time there were plans to reorganize the industry in such a way as to spread activity more evenly throughout the country but Tucumán continues to be the most important sugar-producing province, with nearly 60% of total output in 1981. Exports during the year increased by 47%, from 489,495 tonnes to 721,173 tonnes, and this in part underlines how limited in their effect were the ISA quota controls on exports when they only operated for part of a quota year. The scale of alcohol distillation is not nearly as large as that in neighbouring Brazil; nevertheless, Argentina produced just under 154 million litres in 1981 compared with 212.6 million litres the previous year.

Denmark campaign results, 1981/82[12]. – The six Danish sugar factories operated for an average of 90.5 days and processed 3,626,126 tonnes of beet to produce some 480,000 tonnes of white sugar against an EEC basic quantity (A- plus B-quotas) of 424,629.3 tonnes.

[1] C. Czarnikow Ltd., *Sugar Review*, 1982, (1586), 38.
[2] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 38.
[3] *World Sugar J.*, 1982, **4**, (7), 39.
[4] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 70.
[5] *Public Ledger*, February 6, 1982.
[6] *Mauritius Sugar News Bull.*, 1981, (12).
[7] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, 94.
[8] *Zuckerind.*, 1982, **107**, 172.
[9] *Queensland Newsletter*, February 17, 1982.
[10] F. O. Licht, *International Sugar Rpt.*, 1982, **114**, S66.
[11] C. Czarnikow Ltd., *Sugar Review*, 1982, (1584), 26, 28.
[12] *Zuckerind.*, 1982, **107**, 169.

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