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La détermination de saccharose en presence de glucose et fructose par la polarisation directe au moyens de l'addition de borate de soude. J. Fernández B., J. Marinello M., et A. Lloreda C. *Pages* 107–111

Des essais dans lesquels on a ajouté borate de soude à des solutions de proportions variées en saccharose, glucose et fructose ont montré que des complexes se formaient avec tous les sucres et que la polarisation directe de saccharose en présence des deux autres sucres par l'addition de borate de soude n'est pas une méthode analytique exacte.

Berechnungen der Kombination von Mahlen und Diffusion von Zuckerrohr. Teil 1. H. Brüniche-Olsen. *Seiten* 99–101

Man entwickelt eine theoretische Gleichung für Berechnung des Verhältnisses zwischen der Zuckergehalt (Polarisation) in Bagasse und derselbe in Diffusionssaft aus einem kintinuierlichen Diffusionsapparat, in der Form des Saftes im vorgemahlten Rohr, des Saftfliessens durch den Diffusionsapparat, des in den Entwässerungsmühlen für Rückführung in den Diffusionsapparat extrahierten Saftes, der Länge des Diffusionsapparat und eines Faktors, der von der Natur des Rohrs und seine Bereitung abhängt. Man wird die Gleichung in einem folgenden Teil anwenden, um die Einwirkungen von mehreren veränderlichen Faktoren auf die Leistungsfähigkeit des Diffusionsapparates zu erforschen.

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Likör-Saturation. Teil 1. Einwirkungen von Unreinheit auf Filtrierbarkeit. M. C. Bennett. *Seiten* 101–104

Man beschreibt Methoden für Bestimmung der Filtrierbarkeit von Saturationslikören, mit Berücksichtigung auf ein Laboratoriumsfiltrationsversuch auch auf die Betriebsangaben der Filtrationsstation einer Raffinerie. Man glaubt, dass die Veränderung von Filtrierbarkeit mit Kalkdosis und, daher, mit Konzentration von Calciumcarbonat ein wenig Trennung von mechanischen und chemischen Einwirkungen ermöglicht: als Beispiel vergleicht man einige Ergebnisse für einen saturierten, südafrikanischen Likör mit denselben für einen westindischen Likör.

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Technische Analyse von Ionenausschluss für Saccharose-Gewinnung aus Rübenmelassen. Teil 2. Datenanalyse und Kostenprojektierung. E. Lowe, J. B. Stark und W. G. Schultz. *Seiten* 104–107

Man hat statistische Methoden für Umwandlung von Leistungsangaben einer Laborkolonne (in Teil 1 beschrieben: *I.S.J.*, 1967, **69**, 35–38) in Gleichungen angewandt; diese Gleichungen verwendet man für die Berechnung der Kosten einer Anlage von volltechnischer Grösse, welche unter in den Vereinigten Staaten bestehenden Verhältnissen arbeitet. In Abhängigkeit von den Kosten der Verdampfung von Wasser aus dem Strom von verdünntem Produkt, würde die Anlage täglich 50–120 Tonnen von Melasse behandeln, und man würde ihre Kosten völlig oder ganz völlig in einer Kampagne von 150 Tagen ausgleichen.

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Die direkte polarimetrische Bestimmung von Saccharose in der Gegenwart von Glukose und Fruktose mittels Borax-Beifügung. J. Fernández B., J. Marinello M., und A. Lloreda C. *Seiten* 107–111

Versuche, in den Borax zu Lösungen von verschiedenen Verhältnissen an Saccharose, Glukose und Fruktose hinzugefügt wurde, zeigten, dass Komplexe mit allen drei Zuckern sich bildeten, und dass die direkte Polarisation von Saccharose in der Gegenwart der anderen zwei Zucker mittels Borax-Beifügung nicht eine exakte analytische Methode ist.

Cálculos de la molienda/difusión combinada de caña de azúcar. Parte I. H. Brüniche-Olsen. *Pág.* 99–101

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Carbonatación de licor. Parte I. Efectos de impurezas sobre la filtrabilidad. M. C. Bennett. *Pág.* 101–104

Métodos para amillarar la filtrabilidad de licor carbonatado se describen con referencia a una prueba de laboratorio de la filtración y tambien a dados de la marcha del estación de filtros de la refinería. El autor sugiere que el cambio de filtrabilidad con dosis de cal, y por consecuencia concentración de carbonato de calcio, permite una separación parcial de efectos quimicos y mecánicos; como ilustración, se comparan resultados de un licor carbonatado originado en Sud-Africa con los de un licor de las Indias Occidentales Británicas.

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Análisis técnico de la exclusión de iones como técnica para la recuperación de azúcar desde melaza remolachera. Parte II. Análisis de dados y proyección de costos. E. Lowe, J. B. Stark y W. G. Schultz. *Pág.* 104–107

Técnicas estadísticas se usen para convertir dados de operación de una columna de laboratorio (que se describe en Parte I; *I.S.J.*, 1967, **69**, 35–38) a ecuaciones que se usen para calcular los costos de una planta de escala comercial que opera sobre condiciones que aplican en los E.U.A. Dependiente del costo de evaporación de agua del corriente de producto diluido, la planta tratía 50–120 toneladas de melaza diariamente y la inversión sería completamente o casi completamente recuperada en una sola campaña de 150 días.

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La determinación polarimetrica directa de sacarosa en la presencia de glucosa y fructosa por la adición de bórax. J. Fernández B., J. Marinello M. y A. Lloreda C. *Pág.* 107–111

Ensayos en que bórax se añade a soluciones de varias proporciones de sacarosa, glucosa y fructosa indican que complexos se forman entre el bórax y los tres azúcares y que la polarización directa de sacarosa en la presencia de los dos otras azúcares no es un método exacto de análisis.

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Notes & Comments

British Sugar Corporation 1965/66 report.

The 1965 crop proved to be the second largest in the Corporation's history. The total quantity of beet delivered to the factories amounted to 6,705,471 tons —an average of 15·30 tons per crop acre, which had only been exceeded by the record crop in 1960. The 1966 crop is of a similar tonnage and sugar content to the 1965 crop.

The cool, wet summer of 1965, however, was not conducive to a high sugar content and the average at 15·61% was 2·11% below that of the previous year. The output in terms of white sugar was 846,134 tons, the third highest ever achieved. The total amount of molasses produced was 317,314 tons. Dried molassed pulp production was a record at 548,236 tons. This included a substantial quantity in the form of nuts, which continue to gain in popularity, as well as nuts with added magnesium as a precaution against hypomagnesaemia in cattle and sheep. The newer product, kibbled pulp, has proved to be eminently suitable for feeding to cattle in conjunction with rolled barley. Plant has been installed at the factories for a substantial increase in the output of these products.

Adoption of modern labour-saving techniques in crop production has been increased; 76% of the total acreage was sown with precision drills, compared with 65% in 1965, and the use of chemicals for weed control on 40% of the acreage showed a 75% increase over the previous year. Wide experience was gained with genetic monogerm seed, which greatly helps to reduce the time-consuming operation needed to single the plants when multigerm seed is used; commercial quantities of approved varieties are now available to growers.

The acreage harvested mechanically showed a further small increase to 94% of the total and 50% of the beet delivered was passed through cleaner-loaders to reduce dirt tares, compared with 37% in the previous year.

Abnormally heavy rains in September and December, and unusually severe frosts in mid-November, made harvesting conditions the most difficult for many years, but the crop was delivered to the factories with negligible harvesting losses. However, substantial tonnages of beet were exposed to frost before delivery; this reduces sugar content and extraction and can lead to rejection of beet owing to its unsuitability for sugar manufacture.

Whilst some frost damage occurred before the crop could be harvested, failure adequately to protect clamped beet was a significant factor, and more positive action by many growers in this respect is necessary.

The policy of increasing factory capacity is continuing and is essential to avoid unduly extended campaigns. New plant for this purpose has been installed at Bardney, Cantley, King's Lynn and Spalding, although a substantial part of the capital budget had to be earmarked for essential replacements. The average daily capacity increased by about 2000 tons beet to 54,000 tons per day. In 1967 it is intended to increase the capacity at Brigg, and expand still further at Bardney.

Beet reception facilities have been further extended to enable factories to deal efficiently with the increasing number of road vehicles due to larger factory capacities, and the closing down of rail loading stations. Installation of automatic equipment for sampling and testing to eliminate the human element is continuing and automatic samplers have been erected in five factories. Completely automatic weighing and recording equipment is now available at fifteen factories, three with direct telephone link to the new and larger computer at the Corporation's Central Offices in Peterborough.

The increasing capacity of the factories has necessitated extension of modern pulp presses and pulp drying plant. Experiments with bagging of dried pulp in paper bags have proved so successful that the whole output of the Newark factory was to be packaged in this form during the 1966 campaign, and this system will be extended gradually to replace jute bags. The demand for bulk deliveries of pulp nuts is increasing.

Two additional sugar silos, complete with plant for bulk delivery, have been used for the first time at Spalding and additional silos at Bardney and Felsted were to be used for the 1966 campaign. This increases bulk storage capacity to 220,000 tons.

During the year the design and planning of the new Research Laboratories were completed. Construction was started in July on a site adjacent to the University of East Anglia at Norwich and it is expected that the Research Department will be transferred from Nottingham to Norwich during the summer of 1967. The new laboratories will considerably increase the scope and facilities for research.

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U.K. sugar imports and exports, 1966.

Import and export statistics for U.K. sugar have recently been published by C. Czarnikow Ltd.[1] and are reproduced elsewhere in this issue.

Import statistics for 1966 show that deliveries of raw sugar from the Commonwealth fell by some 100,000 tons during the year to 1,770,259 tons but imports from other countries rose by about 150,000 tons. Largely this reflected a substantial increase in imports from Brazil, which have risen from 15,000 tons in 1963 and 20,000 tons the following year to 52,000 tons in 1965 and 162,000 tons in 1966. Imports from Cuba, at 65,359 tons, were about 25,000 tons down compared with the previous year while, for the first time in many years, no sugar was imported from the Dominican Republic. Imports from South Africa rose to the more normal level of 62,000 tons from the 20,000 tons established in 1965.

The level of imports of refined and white sugar now appears to be remaining quite steady. In 1966 56,000 tons were imported compared with 45,000 tons in the previous year and 56,000 tons in 1964. There is now no tonnage limitation applied to imports of high polarizing sugar, but foreign whites are rarely available to British buyers at below the cost of U.K. refined.

British exports of sugar in 1966, at just below 300,000 tons, were slightly higher than the level established in 1965. There was some improvement in deliveries to Commonwealth countries, which at 112,595 tons reached the highest quantity since 1962, but this was matched by a falling away in shipments to other countries.

The improvement in the Commonwealth offtake was brought about largely by an expansion in shipments to Ghana and to Singapore/Malaysia; among the other countries, however, deliveries to Kuwait dwindled from more than 24,000 tons almost to nothing. Sales to the major markets in Norway and Switzerland remained at satisfactory levels, while there was an increase in the tonnage delivered to the Netherlands.

Looked at purely from a tonnage point of view the figures of the last two years represent a considerable fall when compared with the quantities exported in 1963 and 1964, in both of which more than 400,000 tons were shipped from the United Kingdom. These were exceptional years, however, when trade reflected the low world sugar crops in 1962/63 and 1963/64, and it might be more realistic to compare the recent statistics with the export figures of 1961 and 1962, when shipments reached a little over 300,000 tons in each case.

The recent changes within the Commonwealth have brought about a gradual erosion in the area in which a preferential outlet is available for British goods and this has made it necessary in some cases for new markets to be developed for British refined sugar. Under these circumstances a continuing market in the region of 300,000 tons is no mean achievement.

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U.S. sugar quotas, 1967.

At the beginning of January the U.S. Dept. of Agriculture authorized imports from individual countries during the first quarter of the year in accordance with the total of 900,000 tons permitted imports[2]. On the 18th January, the Department announced the import authorizations which had been determined for the second quarter of the year, totalling a further 1,000,000 tons.

On the 2nd February, the total quota for the year was raised from 10·2 to 10·3 million tons and the Rhodesian quota, held in reserve, was reallocated. Since the import authorizations were not changed this did not affect the domestic market. On the 3rd March the quota was again raised by 100,000 tons to 10·4 million tons.

The import authorizations for January-March and April-June 1967 are listed elsewhere in this issue, together with the new overall quotas for 1967.

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British West Indies Sugar Association 1966 meeting.

The Chairman of the B.W.I. Sugar Association, Sir ROBERT KIRKWOOD, pointed out at the annual meeting of the Association, that sugar producers in the West Indies would sustain losses in spite of the market preferences they enjoy under the Commonwealth Sugar Agreement and the quotas on the U.S. sugar market, since no country is able to produce sugar at the present world market price.

Owing to the sugar sales to the United Kingdom and the United States, B.W.I. sugar producers could offset the low world market price; however, in spite of this advantage, numerous West Indies sugar factories would close the 1966 season with losses.

A useful contribution to the economy of the Association would be the conclusion of an Agreement with Canada, similar to the Commonwealth Sugar Agreement, whereby Canada would pay a price for B.W.I. sugar sufficient to cover costs of production plus a fair profit. This she sought for Canadian fish imported by the West Indies, while paying only a £2 per ton preferential rate over the world free market price for sugar—and this preference is given to other Commonwealth countries and to South Africa.

Unfortunately, Canadian interest in such an agreement had lapsed following a fall in prices from the levels of £90–£100 per ton which Canada had had to pay in 1964 when Britain was paying only half this, thanks to the Commonwealth Sugar Agreement.

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[1] *Sugar Review*, 1967, (800), 31–33.

[2] *I.S.J.*, 1967, **69**, 2.

Calculations on the Combined Milling-Diffusion of Sugar Cane

By H. BRÜNICHE-OLSEN
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PART I

BY the milling-diffusion process, which is the subject of the following calculations, is understood a technique for the extraction of cane sugar normally comprising three steps, i.e. prepressing and preparation of the cane by one or more conventional mills, extraction and lixiviation of the prepared cane by a continuous diffuser, and dewatering of the spent bagasse leaving the diffuser by means of one or more subsequent mills.

In principle, the calculations are made on the same basis as calculations on extraction of sugar beets by a continuous diffuser[1]. The extraction of sugar beets is, however, only a two-step process comprising the extraction of the sliced beets and the dewatering of the exhausted, so-called pulp leaving the diffuser. Furthermore, whereas beet slices are normally of a fairly uniform size, the particle size of cane prepared by knifing and crushing varies widely. For these reasons the milling-diffusion of cane involves substantially more parameters than beet diffusion, which necessitates the introduction of some simplifications when transferring to cane sugar extraction the methods otherwise used for calculations concerned with extraction of sugar from beets.

It is common to all diffusers, whether beet or cane, operating under given conditions, that the proportion between the sugar concentrations in the juice end and the water end remains constant, independent of the absolute values of these concentrations. The proportion between these concentrations can be taken as an indication of the efficiency of the diffuser in question. On the other hand, if this proportion is known it is possible to calculate the operation results which are to be expected. For the milling-diffusion of sugar cane this is illustrated by the following example:

Cane with 15% fibre and 13% sugar is prepressed so that 65% juice on cane is expressed prior to the introduction of the cane in the diffuser. The diffuser is operating in such a way that the proportion between the sugar content of the juice remaining in the bagasse and the sugar content of the diffusion juice is 0·3. The bagasse leaving the diffuser is pressed to a fibre content of 50% corresponding to 30% final bagasse on cane. The total amount of mixed juice produced is 95 kg per 100 kg cane of which, according to the above, 65 kg are expressed by the first mills and 30 kg produced by the diffuser.

Per 100 kg cane the diffuser receives:

$$\frac{85-65}{85} \times 13{\cdot}0 = 3{\cdot}06 \text{ kg sugar}$$

provided that the pol of the juice remaining in the cane is the same as the pol of the juice squeezed out by the first mill.

In the diffuser combined with the dewatering mills from which the expressed diluted juice is returned to the diffuser, the 3·06 kg of sugar is distributed between the 30 kg diffusion juice produced and the 15 kg juice remaining in the final bagasse in such a way that the proportion between the sugar concentration in the two juices is 0·3. If Jp is the sugar concentration or pol of the diffusion juice, the following equation applies:

$$30\,Jp + 15 \times 0{\cdot}30\,Jp = 306$$
$$\text{whence } Jp = 8{\cdot}9.$$

Taking into consideration that the fibre content of the bagasse is 50%, the pol of the bagasse here designated Bp, is:

$$Bp = \frac{0{\cdot}30\,Jp}{2} = 1{\cdot}33.$$

As mentioned above, the proportion between the pol of the bagasse (Bp) and the pol of diffusion juice (Jp) is, under otherwise unchanged conditions, an expression for the efficiency of the diffuser. Fig. 1 shows the influence of variations in the proportion $\frac{Bp}{Jp}$ upon the pol of the bagasse calculated as illustrated above and based upon the same sugar and fibre content of the cane, total amount of mixed juice, and fibre content of the bagasse as used in this example. In the figure are indicated two curves for 45% and 20% juice to diffusion respectively. This obviously means that the prepared cane transferred to the diffuser amounts to 60% and 35%, respectively, including the 15% fibre in the cane, corresponding to an expression of 40% or 65% juice on cane during the preparation of the cane prior to its introduction in the diffuser.

As is to be expected, the calculations plotted in Fig. 1 show that the pol of the bagasse increases with increasing values of the proportion Bp/Jp and with increasing amounts of juice transferred to the diffusion.

The above illustrates in a purely empirical way the relation between the pol of the bagasse and the value of the proportion Bp/Jp. As mentioned, this proportion is independent of the absolute values of the pol of juice and bagasse for a diffuser operating under given conditions. A number of other parameters of

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[1] BRÜNICHE-OLSEN: Solid-Liquid Extraction, with Particular Reference to Extraction of Sugar from Sugar Beets. (Nyt Nordisk Forlag, Copenhagen). 1962.

the milling-diffusion process do, however, influence the value of Bp/Jp, and before proceeding with the calculations it is therefore necessary to establish the theoretical background for calculating the dependence of Bp/Jp on these parameters.

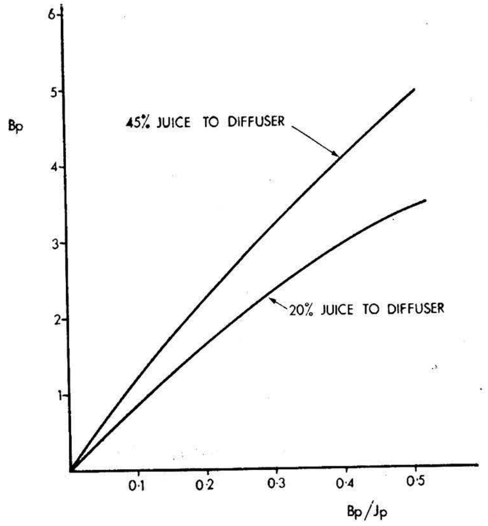

Fig. 1. Varying efficiency of the diffuser.

Fig. 2 shows schematically a counter-current cane diffuser and the corresponding dewatering of the spent bagasse. Per 100 kg fresh cane the prepared cane supplied to the diffuser contains P kg juice, the polarization of which is p. As soon as the prepared cane comes into contact with the juice in the juice end of the diffuser, it absorbs an amount of the juice equivalent to the juice expressed during the preparation prior to diffusion. In accordance herewith, C, the amount of juice carried through the diffuser with the cane, is equal to the weight percentage of juice in the fresh cane. The amount of juice $(C - P)$ is taken from the juice flow J through the diffuser. The remaining quantity $J - (C - P)$ leaves the diffuser as diffusion juice with the polarization y_o. As appears from the above, $C - P$ is equal to the amount of juice squeezed out before diffusion, and consequently J is also equivalent to the total amount of mixed juice produced.

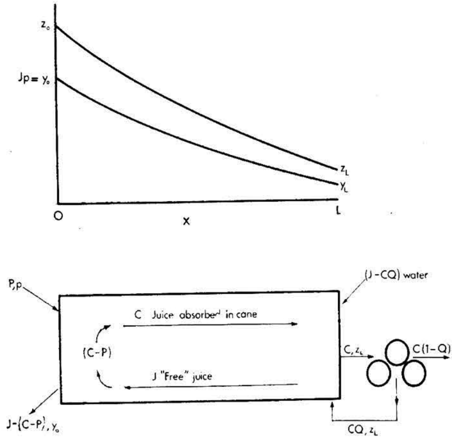

Fig. 2. Variation of bagasse pol (z) and juice pol (y) along the length (x) of a countercurrent diffuser between its ends O and L.

At the other end of the diffuser the wet spent bagasse leaving the diffuser still contains the amount C of juice, but the polarization of this juice has now been reduced to the value z_L. The wet bagasse is pressed in the dewatering mills squeezing out a fraction, Q, of the juice which is recycled into the diffuser whereas the remainder $(1 - Q)$ leaves the system in the final bagasse. To make up for the liquid removed as diffusion juice and in the final bagasse, a further amount of water $(J - CQ)$ is added at this end of the diffuser.

On the analogy of the formulae XIII, 72 and 73 on page 375 of the above-mentioned book "Solid-Liquid Extraction"[1], the main equations for a counter-current diffuser as illustrated in Fig. 2 are as follows:

$$z = c_1 e^{k\left(1 - \frac{C}{J}\right)(L - x)} + c_2$$

$$y = c_1 \frac{C}{J} e^{k\left(1 - \frac{C}{J}\right)(L - x)} + c_2$$

where c_1 and c_2 are integration constants and k is dependent on the character and disintegration of the cane and is also proportional to the retention time for the cane in the diffuser. The symbols C and J have already been defined in connexion with Fig. 2.

The integration constants c_1 and c_2 are determined by the boundary conditions which, for a diffuser operating according to Fig. 2, can be expressed by calculating z_o and y_L. After the prepared cane has been soaked with diffusion juice, the juice absorbed in the cane consists obviously of P parts of juice with the polarization p and $(C - P)$ parts with the polarization y_o. Consequently the polarization of the absorbed juice z_o can be determined as:

$$Cz_o = Pp + (C - P)y_o.$$

At the water-end of the diffuser the "free" juice consists of a mixture of $(J - CQ)$ parts of water and CQ parts of juice with polarization z_L. The polarization y_L of the mixture is consequently determined by the equation

$$Jy_L = CQz_L.$$

Based upon these boundary conditions it is possible to find the complete expressions for z and y. In accordance with what is stated above, it is sufficient for the present calculations to know the proportion Bp/Jp. However, the above formulae only allow of calculating the sugar concentration, z_L, of the juice in the bagasse from which the pol of the bagasse can be determined if the fibre content is known. The solution of the four equations is therefore limited to the proportion $\frac{z_L}{y_o}$, i.e. the proportion between the pol of the juice in the bagasse and the pol of the diffusion juice. The result is:

$$\frac{z_L}{y_\circ} = \frac{C - J}{\frac{C}{J}(CQ - J)\, e^{\left(1-\frac{C}{J}\right)E} + C(1 - Q)}$$

where E denotes the product of the coefficient k and the length of the diffuser L.

This expression gives the relation between $\frac{z_L}{y_\circ}$ and E, where E, as mentioned above, is dependent on the character and disintegration of the cane, on the retention time of the cane in the diffuser, and on the efficiency of the diffuser, whereas E is independent of the other parameters. The value of E can be calculated for any given diffuser based upon knowledge of one set of corresponding values of $\frac{z_L}{y_\circ}$, C, J, and Q.

To be continued

Liquor Carbonatation

Part I. Impurity Effects on Filtrability

By M. C. BENNETT
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INTRODUCTION

THE filtrability of raw sugar has been the subject of considerable attention in recent years and many data are available concerning the nature of filtration-impeding inpurities in various types of raw sugar[1-4]. Most workers now use a filtration test based on the method and apparatus of NICHOLSON and HORSLEY[5], which compares the filtration characteristics of a kieselguhr filter aid in pure sucrose and in the unknown raw. In this test, the effect of the filtration-impeding impurities is mechanical and the additivity of these mechanical effects has been investigated by NICHOLSON, HIDI and MCINTYRE[6] and, more recently, by SUTHERLAND and HIDI[7].

There can be no doubt that these impurities also have a similar mechanical effect on the filtrability of carbonatated liquor: the addition of precipitated calcium phosphate provides a striking example, as vividly described by DE WHALLEY[8]. NICHOLSON[4] has studied the effect of potato starch in carbonatation but has found little evidence for an interaction between the starch and calcium carbonate, the filtrability effect being parallel to that observed in the kieselguhr test.

Nevertheless, because carbonatation is a crystallization process, it must be expected that naturally occurring impurities can have a profound effect upon the nucleation, growth or flocculation processes involved in the formation of the final calcium carbonate conglomerate. The well-known inclusion of anions which form sparingly soluble calcium salts, *e.g.* sulphate and phosphate[9], into the growing calcium carbonate crystal mass is an illustration of the mechanism of interference in the crystallization process.

Recently, KAGA, SUZUKI and YAMANE[10] have compared the filtrability of a carbonatated liquor with its impurity content and have examined liquor from a wide range of origins. They used a batch method of carbonatation and tested the filtrability by the NICHOLSON and HORSLEY method[5], presumably making an addition of kieselguhr to the carbonatated liquor. This method does not therefore distinguish between the mechanical effects in the filter cake and the chemical effects on the crystallization of calcium carbonate.

In the present paper methods of assessing carbonatated liquor filtrability are described with reference both to a laboratory filtration test and to the operational data of the refinery filter station. It is suggested that the change in filtrability with calcium carbonate concentration allows some separation of mechanical and chemical effects; as an illustration, results for carbonatated South African liquor are compared with those for a West Indian liquor.

LABORATORY FILTRATION OF CARBONATATED LIQUOR

The average specific resistance of the filter cake, $\bar{r}$ cm/g, was calculated from a plot of the reciprocal rate dt/dV against volume V using the rate equation

$$\frac{dt}{dV} = \frac{\eta\, \bar{r}\, C}{A^2P} + \frac{\eta R_m}{AP} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where A is the filtration area, P the pressure drop across the cake, η the viscosity of the filtrate, taken

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[1] *Comm. Sugar Mill. Res. Inst.*, 1963, (57).
[2] KORTSCHAK: *Hawaiian Sugar Plant. Res.*, 1952, **54**, 65.
[3] CHANG: *Rpt. Taiwan Sugar Expt. Sta.*, 1964, **34**, 147.
[4] NICHOLSON: *Proc. 10th Congr. I.S.S.C.T.*, 1959, 213.
[5] *Proc. 9th Congr. I.S.S.C.T.*, 1956, (2), 271.
[6] *I.S.J.*, 1961, **63**, 173, 201.
[7] *Trans. Inst. Chem. Eng.*, 1966, **44**, 122.
[8] *Proc. 2nd Tech. Session Bone Char*, 1951, 221.
[9] STACHENKO: *Proc. 7th Tech. Session Bone Char*, 1961, 58.
[10] *I.S.J.*, 1966, **68**, 3.

as that of pure sucrose at the same concentration and temperature, C the mass of cake-forming solids deposited per unit volume of filtrate, i.e. the concentration of suspended matter and R_m the filter septum resistance. dV/dt is the instantaneous filtration rate at cumulative volume V but in practice $\Delta V/\Delta t$ was measured over increments of volume (10–20 ml).

The measurements were carried out using a 250 ml brass cell fitted with an electromagnetic stirrer. Filtrate was collected in a calibrated glass cylinder at atmospheric pressure, both cell and cylinder being mounted in a water thermostat at 75°C. The filter cake was deposited as a perfect cylinder on an area 7 sq.cm.; the septum was either Whatman 42 paper or cotton press cloth on a perforated brass disc, no filter-aid material being used at any time during the measurement. With the cotton cloth septum, a small volume of cloudy runnings was observed initially and data were only recorded when the filtrate became clear; separation of cloudy from clear filtrate was unnecessary for the purposes of the determination.

The filtration cell could be operated over the range 5 to 90 p.s.i.g. but generally measurements were made at 50 p.s.i.g. The cell was filled at atmospheric pressure with carbonatated liquor at 75°C, and after standing 5 min with the stirrer on, the applied pressure was raised from 0 to 50 p.s.i.g. in 1 min. The rate of application of pressure has a large effect on the volume-time plot but, over the region of constant pressure, it does not affect the slope of the $\Delta t/\Delta V$ against V plot. In one experiment, for example, when the pressure was raised to 50 p.s.i.g. in one minute and in thirty minutes, the values of $\bar{r}$ were calculated to be 2·97 and 2·91 × 10^{10} respectively.

These data were obtained using a sample of refinery carbonatated liquor and it is noted that the measured value for $\bar{r}$ lies in the middle of the range, quoted by DONALD[11], from $\bar{r} = 1{\cdot}6 \times 10^8$ cm/g for free-flowing kieselguhr to $\bar{r} = 1{\cdot}5 \times 10^{13}$ cm/g for thixotropic mud.

The average specific resistance $\bar{r}$ is a property of the solid phase which forms the cake, and represents the resistance to the flow of filtrate under standard conditions per unit mass of cake. If C is the concentration of that solid phase in the unfiltered liquor, the product $r\,C$ represents the total resistance to the flow of unit volume of filtrate, and a filtrability term F can be defined as $F = \dfrac{1}{\bar{r}\,C}$ (cm²).

F therefore describes the contribution of the cake solids to the overall filtrability of the carbonatated liquors. In the next section it will be shown that the filtrability is more conveniently expressed as $\sqrt{F}$.

If the cake were composed entirely of calcium carbonate, and the crystalline form were independent of both the lime concentration and the impurity content, hen $\bar{r}$ would be constant and $\sqrt{F}$ must always decrease with increase in C. Of course the cake is not pure calcium carbonate for, as pointed out in the introduction, it contains impurities removed from the liquor both by chemical incorporation within the crystal and by mechanical trapping during filtration.

In fact, in carbonatated liquor, $\bar{r}$ is extremely sensitive to the lime dose and hence to the concentration of calcium carbonate C. Typical plots of $\bar{r}$ against C are shown in Fig. 1 for a West Indian liquor and for a South African liquor carbonatated in a miniature 3-tank continuous system modelled on the refinery plant[12].

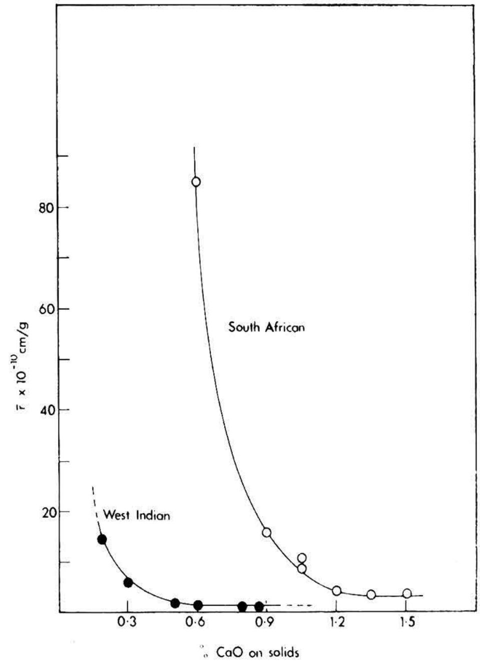

Fig. 1. Typical curves for average specific filtration resistance ($\bar{r}$) *vs.* % CaO in carbonatated West Indian and South African liquors.

It may be seen that the $\bar{r}$ curves show two prominent features:

(a) a region of lower lime doses where $\bar{r}$ tends to very large values,

(b) a region of higher lime doses where $\bar{r}$ is independent of % CaO.

A plot of filtrability against lime dose must therefore pass through a maximum, around the region where $\bar{r}$ becomes constant, and this is shown in Fig. 2 where $\sqrt{F}$ is plotted against % CaO for the two liquors. It is clear that the curves are characteristic of the liquor type, and they therefore provide a useful basis

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[11] Chemical Engineering Practice. Ed. CREMER. (Butterworths, London) 1958, p. 479.

[12] DE WHALLEY: *Proc. 2nd Tech. Session Bone Char*, 1951, 191.

for the comparison of carbonatated liquors. On the particular scale chosen here, the maximum filtrability of the West Indian carbonatated liquor is three times that of the South African, and only half the lime dose is required to achieve it.

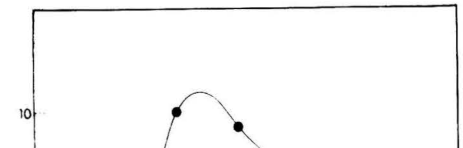

Fig. 2. Typical curves of filtrability ($\sqrt{F}$) *vs.* % CaO in carbonatated West Indian and South African liquors.

FILTRATION OF CARBONATED LIQUOR IN THE REFINERY

HERTZBERG and MOUNTFORT[13] have considered in detail the factors affecting the performance of a factory filter station. They defined a slurry resistance which took into account all the properties of the solid and liquid phases which could affect filtration.

In order to compare the behaviour of various carbonatated liquors in the refinery it is necessary to determine the values of $\bar{r}$ and $\sqrt{F}$ (as defined above) from the operational records of the filter station. An approximate method, giving satisfactory agreement with spot checks in the laboratory or with filtration rate determinations on a single leaf of a filter press, is described below.

The filter press station of a refinery operates, as a whole, at approximately constant filtration rate; this is achieved by an approximately constant rate of use of new filtering area. The general differential equation (1) may be integrated at constant rate to give

$$\frac{\Delta t}{\Delta V} = \frac{\eta \bar{r} C \Delta V}{\Delta A^2 P} + \frac{\eta R_m}{\Delta A . P} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

If the filter cloth resistance R_m is neglected and the applied pressure P is assumed to be constant for all presses over a period of operation,

$$\frac{\Delta t}{\Delta V^2} = \frac{\eta \bar{r} C}{\Delta A^2 P}$$

$$\text{and } \bar{r} = \frac{\Delta t \ \Delta A^2 P}{\Delta V^2 \eta C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

ΔV is the volume of filtrate passed through the station over a period defined by Δt and ΔA. If a total of n press cycles were operated during the period and each press had an area a, then ΔA becomes na and Δt the time for which each press passed clear filtrate (τ).

If Q is the mass of sugar solids filtered in the period, β the % solids and ρ the density of the filtrate,

$Q = \Delta V \rho \beta / 100.$

If L is the mass of lime (CaO) used in the period

$C = 100\, L/56\, \Delta V.$

Making these substitutions in equation (3):

$$\bar{r} = \frac{P \tau \rho \beta \, (na)^2}{Q \eta L} \times 116 \text{ cm/g} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

$$\text{and } F = \frac{1}{\bar{r} C} = \frac{0{\cdot}48 \, Q^2 \eta}{P \tau \, (n c \rho \beta)^2} \text{ cm}^2 \quad \ldots\ldots\ldots\ldots (5)$$

where Q is the sugar solids filtered in a given period (tons), L is the lime used in that period (tons CaO), n is the number of filter cycles operated in that period, a is the area of one press (sq.ft.),   is the time for which each press gives clear filtrate (hr), ρ is the density of the filtrate (g/ml), β is the % solids of the filtrate, η is the filtrate viscosity at filtration temperature (cp), and P is the average pressure drop over the filter station (p.s.i.g.).

It is seen from (5) that under constant operating conditions, $\sqrt{F}$ is directly proportional to Q, the sugar throughput of the filter station. In view of the large changes in F which are observed, it is more convenient to use $\sqrt{F}$, and this term is therefore quoted as an index of carbonatation precipitate filtrability.

Values calculated using shift, daily or weekly average data collected in recent years from Tate & Lyle refineries show that $\sqrt{F}$ ($\times 10^5$ cm) has varied from 2·5 to 7·5 according to the sugar on melt and the lime dosage: corresponding values of $\bar{r}$ ($\times 10^{-10}$ cm/g) range from about 3 to 15. Most of these refinery filter stations experience filtration difficulties when $\sqrt{F}$ ($\times 10^5$ cm) falls below 4; the normal remedy is to reduce the filtrate viscosity (η) and increase the number of press cycles (n).

COMPARISON OF CARBONATATED LIQUOR FILTRABILITIES

The results presented in Figs. 1 and 2 show that any quantitative comparison of these carbonatated liquors depends entirely upon the choice of lime dose for the carbonatation reaction. At 0·5% CaO the filtrability ratio would be 10, at 1·4% CaO the ratio would have decreased to 2.

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[13] *Trans. Inst. Chem. Eng.*, 1959, **37**, 5; 1960, **38**, 347.

These liquors illustrate widely differing filtrabilities under the same carbonatation conditions, and it is clear that the South African liquor is inferior to the West Indian over the whole range studied. With liquors of similar characteristics, the $\sqrt{F}$ *vs.* % CaO curves often cross, so that the order of filtrabilities depends on the lime dose.

At low lime doses, where the impurity:$CaCO_3$ ratio is high and $\bar{r}$ tends to large values, it seems likely that the impurity exerts a dominant effect on cake behaviour, as has been described for inert filter aid additions[7]. At high lime doses $\bar{r}$ becomes independent of the $CaCO_3$ concentration, and the calcium carbonate dominates behaviour. Nevertheless, different liquors show different constant values for $\bar{r}$; in Fig. 1, for example, values of about 4 and 1 ($\times 10^{10}$ cm/g) are reported. It is suggested that some significance can be given to these values and that they provide an indication of the chemical interference in the carbonatation reaction.

Engineering Analysis of Ion Exclusion for Sucrose Recovery from Beet Molasses

Part II. Data Analysis and Cost Projection

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STUDIES were undertaken to analyse, from an engineering standpoint, the operation of an ion-exclusion column for the recovery of sucrose from beet molasses. The experimental work involved and the data reduction techniques employed were discussed in an earlier paper[1]. This article is devoted to an analysis of the results, including the development of empirical equations quantifying the relationship of the various process variables, an examination of the correlation coefficients that are measures of the appropriateness of the statistically derived equations, optimization of the process parameters for maximum net return, a forecast of "production figures" based on the optimized parameters, and a cost projection for a commercial-size installation operated to produce the best possible return on the plant investment.

Least square fit

Multiple regression is a statistical technique for developing a quantitative relationship between a dependent variable and several independent variables[2]. By means of regression, a numerical equation can be developed from experimental data, showing the influence of the various independent variables on the chosen dependent variable. Such equations are, of course, entirely empirical in nature and may be applied only in the range of the data on which they are based. As with all empirically derived equations, injudicious extrapolations can easily lead to highly erroneous results.

A multiple regression FORTRAN programme written for an IBM 7090-7094 digital computer[3] was used to correlate the molasses ion-exclusion data presented in Part I of this paper. The computer was programmed to delete independent variables with coefficients that are statistically indistinguishable from zero, based on the t-test at the 95% probability level. Variables were also deleted if the bivariate correlation coefficient (r) shows less than a 5% dependency between the independent and dependent variables.

The final regression equations are as follows:

$$Y_1 = -0{\cdot}9283 + 0{\cdot}0039X_1 + 0{\cdot}0005X_2 + 0{\cdot}0229X_3 + 0{\cdot}0020X_4 + 0{\cdot}0048X_5 \quad \text{(1)}$$

$$Y_2 = -5{\cdot}7156 + 0{\cdot}0088X_2 + 0{\cdot}2053X_3 + 0{\cdot}0400X_5 \quad \text{(2)}$$

$$Y_3 = -13{\cdot}0217 + 0{\cdot}0410X_2 + 0{\cdot}2859X_5 \quad \text{(3)}$$

$$Y_4 = 0{\cdot}6554X_5 \quad \text{(4)}$$

$$Y_5 = -0{\cdot}8818 + 0{\cdot}3600X_1 + 0{\cdot}1738X_2 + 2{\cdot}6030X_3 - 0{\cdot}2424X_5 \quad \text{(5)}$$

$$Y_6 = 88{\cdot}7671 - 0{\cdot}0286X_2 - 0{\cdot}3483X_3 + 0{\cdot}0251X_4 - 0{\cdot}0374X_5 \quad \text{(6)}$$

where

Y_1 = crystallizable sucrose rate, kg/hr.
Y_2 = waste solids rate, kg/hr.
Y_3 = water evaporation rate from sucrose solution, kg/hr.
Y_4 = water evaporation rate from waste solution, kg/hr.

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[1] *I.S.J.*, 1967, **69**, 35–38.

[2] ANDERSEN: "Statistics for Chemical Engineers", *Chem. Eng.*, 29th Oct. 1962–2nd Sept. 1963.

[3] KUNIN: SNAP, Multiple Regression Analysis Programme, IBM 7090 Programme No. 183, IBM Data Processing Division, White Plains, New York, April 1961.

Y_5 = average total solids concentration of solution to be crystallized, g/litre.
Y_6 = average purity of solution to be crystallized, %.
X_1 = resin bed temperature, °C.
X_2 = total solids concentration of feed molasses, g/litre.
X_3 = volume of feed molasses, as % total bed volume.
X_4 = height of resin bed, cm.
X_5 = effluent flow rate, litres/hr.

Correlation coefficients

The quantity r^2 is a measure of the dependency of one variable on another. A large value of r^2 (near 1·0, or 100 on the percentage basis) means a strong dependency; a small value, a weak one. Interactions between independent variables are shown in Table I.

Table I
Relationship between independent variables, %

	X_1	X_2	X_3	X_4	X_5
X_1	100	1·8	1·4	0·4	3·0
X_2	1·8	100	0·1	0·2	0·1
X_3	1·4	0·1	100	0·2	0·2
X_4	0·4	0·2	0·2	100	0
X_5	3·0	0·1	0·2	0	100

The tabulated values of (100) r^2 for each pair of variables are of importance because they do show that the assumed independent variables are truly independent.

Table II shows the (100)r^2 values for dependent and independent variables. From the table, it can be seen that the dominant independent variable for regression equations 1 to 4 is effluent flow rate (X_5). It accounts for over a third of the variability in the data for Y_1, about a half for Y_2, two-thirds for Y_3, and a dominating 94·5% for Y_4. It is not at all surprising then to find that waste water rate (Y_4) is predictable solely from the data on effluent flow rate (X_5).

Table II
Relationship between independent and dependent variables, %

	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
X_1	20·5	—	—	—	11·8	—
X_2	6·8	25·0	14·4	—	50·2	45·0
X_3	9·1	15·0	—	—	19·1	10·4
X_4	19·5	—	—	—	—	12·5
X_5	36·0	45·6	64·7	94·5	6·2	8·3

Y_5 (solids concentration of sucrose solution) and Y_6 (purity of sucrose solution) are most sensitive to changes in X_2 (solids concentration in feed molasses). In the case of purity, X_2 is more than 3½ times the determinant than is the next most influential independent variable, bed height (X_4).

The multiple correlation coefficient (R) combines the effects of all the relationships among the dependent and independent variables, and yields a single numerical measure of the over-all relationship expressed by the regression equations. The coefficient varies from zero for no correlation to 1·0 for perfect correlation. Typical experimental data rarely yield coefficients above 0·95, and 0·80 is considered good in some applications. Multiple correlation coefficients computed for regression equations 1–6 ranged from good to excellent, and are respectively 0·89, 0·92, 0·88, 0·97, 0·90, and 0·86.

The quantity R^2 is a measure of the variability in the data accounted for by the relationship between the dependent variable and various independent variables. The quantity (1-R^2) is the fraction that can be attributed to experimental error, random fluctuations, and deviations from assumed linearity. The (100) R^2 values show that the relationship expressed by the equation for Y_1 accounts for 79% of the variability in the data on which the equation is based, 84% for Y_2, 77% for Y_3, 94% for Y_4, 81% for Y_5, and 74% for Y_6.

Confidence ranges

From a statistical standpoint, the equation coefficients are estimates of the population parameters and as such are really means with predictable confidence ranges. The narrower the range, of course, the better the estimate. Table III shows the confidence ranges that apply to the various equation coefficients at the 95% probability level. For the reader's convenience, the ranges are expressed as a plus or minus percentage of the mean rather than in the more conventional manner as a numerical interval.

Table III
Confidence range for coefficients at 95% probability level, %

	X_1	X_2	X_3	X_4	X_5
Y_1	13·0	18·6	1·1	0·8	0·8
Y_2	—	6·1	7·0	—	4·1
Y_3	—	9·4	—	—	4·2
Y_4	—	—	—	—	1·6
Y_5	12·5	4·8	8·6	—	10·7
Y_6	—	5·6	12·4	10·6	13·3

Cost optimization

Linear programming is a mathematical technique for determining the optimum solution to a problem, particularly complex problems with many factors on which the solution depends[4]. This technique was employed to determine the maximum net return for the 175 sq.cm. experimental ion-exclusion column, and by projection, for a commercial-size plant capable of handling from 50 to 120 tons of molasses a day depending on the conditions of operation. As in the case of all linear programming problems of any appreciable size, the optimization was arrived at by computer programming[5].

Gross return was figured on the basis of recoverable sugar solids having a net value of 4½ cents a pound entering the crystallizer (6 cents per pound as sugar, less 1½ cents per pound as molasses solids). Deductible cost factors included the expense of evaporating the water from both the product and waste streams, and the cost of the water for elution and regeneration.

Because the cost of evaporation varies widely from plant to plant, optimization was sought at three different cost levels; namely 15, 25, and 35 cents per thousand pounds of water evaporated. The cost of water was estimated at 10 cents per thousand gallons.

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[4] GARVIN: "Introduction to Linear Programming" (McGraw-Hill Book Company, New York) 1960.

[5] IBM 1620-1311 Linear Programming System, 1620-CO-04X, IBM Data Processing Division, White Plains, New York, October 1964.

The net return projected for a plant of commercial size also takes into account the following: (1) depreciation on the ion-exclusion column, (2) depreciation on the auxiliary molasses preheating and filtration equipment, (3) depreciation on the initial resin charge, (4) labour costs, (5) maintenance charges, and (6) the cost of make-up resin.

Depreciation on the column was based on a projected capital cost of 80 cents per sq.cm. of column cross section for a 10-ft tall column[6] amortized over a period of 18 years, 150 operating days per year, 24 hours per day. Auxiliary equipment was valued at $16,000, depreciated over the same period of time. The initial resin charge was estimated at $20 per cubic foot, amortized over an anticipated replacement period of 10 years. In all cases, capital costs include a 6% annual charge for financing.

Labour requirements were estimated at 2 operators per shift at $3.00/hr, plus 2 man-hours per day at $4.60/hr for supervision. Labour costs include a 20% mark-up for overhead.

Yearly maintenance cost was estimated at 3% of the total capital investment.

It was assumed that some resin will be lost in any large commercial operation due to attrition and carryover. The monthly make-up rate was estimated at 1% of the total resin charge.

Optimal for experimental column

Table IV shows the parameter values required for maximum net return from the experimental column when the average purity of the product stream is set at 75. From the table, it can be seen that operating temperature, column loading, and column height are at their upper bound for all three evaporation cost levels. This would suggest that column operation can be improved with higher operating temperatures (possibly at elevated pressures), greater column loading, and taller columns than those tried in the experiments. For commercial-size plants, taller columns should, of course, be a definite possibility.

Table IV

Optimized Parameters—Experimental Column

Cost of evaporating water, cents/1000 lb	15	25	35
Purity, product stream	75	75	75
Temperature, °C	94	94	94
Feed concentration, g/litre	257·2	449·4	449·4
Column loading, %	23·2	23·2	23·2
Column height, cm	300	300	300
Flow rate, litres/hr	157·2	10·2	10·2

Flow rate is at the upper bound for the lowest evaporation cost level and at the lower bound for the two higher cost levels. Conversely, feed concentration is at the upper bound for the two higher cost levels and at an intermediate value for the lowest cost level. It would seem that all of the above is only logical since it may be no more costly to evaporate a great deal of water from a dilute solution at a low unit cost than it would be to evaporate a smaller amount of water from a more concentrated solution at a higher unit cost.

Optimal "production figures"

Table V shows the "production figures" for the experimental column calculated from the parameter values in Table IV. It is quite obvious from the tables that the "production figures" for the two higher evaporation cost levels will be identical simply because the parameter values are the same for the two cost levels.

Table V

Optimized "Production figures"—Experimental Column

Cost of evaporating water, cents/1000 lb	15	25	35
Crystallizable sucrose rate, kg/hr	1·45	0·84	0·84
Waste solid rate, kg/hr	7·59	3·40	3·40
Total solid rate, kg/hr	9·04	4·24	4·24
Sucrose water to 65° Brix, kg/hr	42·47	8·32	8·32
Waste water to 65° Brix, kg/hr	103·03	6·69	6·69
Total water to 65° Brix, kg/hr	145·50	15·01	15·01
Sucrose concentration in product stream, %	8·85	25·6	25·6
Solids concentration in waste stream, %	6·86	33·7	33·7
Purity, waste stream	59·5	57·7	57·7
Purity, spent waste stream	54·5	45·7	45·7
Percent extraction	24·3	30·0	30·0

The figures in Table V indicate that for maximum return, about 73% more sugar will be produced by the column at the lower evaporation cost level than at the two higher cost levels. On the other hand, the higher sugar rate involves the evaporation of almost ten times as much water from the product and waste streams. What all this adds up to is that when water can be evaporated cheaply, the column should be operated with a dilute feed and a high throughput rate for maximum net return. Conversely, when the cost of evaporating water is high, the feed solution should be more concentrated and flow through the column should be at a slower rate.

Interestingly enough, extraction is somewhat more complete at the two higher evaporation cost levels than at the lower cost level.

Cost projection

Table VI shows the cost analysis for a commercial-size column projected from data for the experimental unit on the assumptions that throughput rate is proportional to the effective cross-sectional area, and that column operations are the same in all other respects. The figures are for one or two columns with a total cross sectional area of 73,000 sq.cm. (78·7 sq.ft.). For a single column, this is equivalent to a unit 10 ft in diameter by 10 ft high; for two columns, each would be 7·1 ft in diameter by 10 ft. high. In both cases, the commercial-size installation would have a cross-sectional area 417 times that of the experimental unit.

For maximum net return with an evaporating cost of either 25 cents or 35 cents per thousand pounds of water, the commercial-size unit would be set to handle 56·2 tons of molasses a day. The sugar recovered during a 150-day campaign would have a value of $125,000. During the year, a total of $13,000 would have been spent for water and its subsequent

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[6] SEAMSTER and WHEATON: *Chem. Eng.*, 1960, **67**, (17), 115–120.

evaporation at the lower unit cost; $18,000 at the higher unit cost. Fixed costs for labour, depreciation, maintenance, etc., are the same in both cases, $38,000 per year. This leaves a maximum net return of $74,000 per year when the cost of evaporating water is 25 cents per thousand pounds, and $69,000 when the unit cost is 35 cents per thousand pounds.

Table VI

Cost Analysis—Commercial-size Column

Cost of evaporating water, cents/1000 lb	15	25	35
Tons molasses per day	120	56·2	56·2
Gross return on sugar, $/year	216,000	125,000	125,000
Cost of water, $/year	6,000	500	500
Cost of evaporating water, $/year	72,000	12,500	17,500
Write-off on I-E column, $/year	3,500	3,500	3,500
Write-off on auxiliary equipment, $/year	1,000	1,000	1,000
Write-off on initial resin charge, $/year	1,500	1,500	1,500
Resin make-up, $/year	2,000	2,000	2,000
Operating labour, $/year	27,500	27,500	27,500
Maintenance, labour & parts, $/year	2,500	2,500	2,500
Optimized net return, $/year	100,000	74,000	69,000
Capital investment, $	90,000	90,000	90,000

Note: Figures shown are rounded off to the nearest $500.

An even better return is possible if the cost of evaporating water is 15 cents per thousand pounds. In this case, the column would be set to handle 120 tons of molasses a day. Annual gross return from the recovered sugar would be $216,000, cost of evaporation and water $78,000, fixed costs $38,000, leaving a maximum net return of $100,000 a year. Capital expenditure is estimated at $90,000, so that the initial plant investment is recoverable in just about a year of operation.

Summary

Linear equations were developed quantifying the performance of a small ion-exclusion column used to recover sucrose from sugar beet molasses. Parameters were optimized for maximum net return with an average product stream purity of 75 and the cost of evaporating water from the product and waste streams set for 15 cents, 25 cents, and 35 cents per thousand pounds. On the basis of the optimized parameters, "production figures" were forecast for the process. About 25 to 30% of the sugar in the molasses is recovered by ion-exclusion. This sugar is normally considered waste, as it cannot be recovered economically in any other way. A cost projection based on a commercial-size installation about 400 times the size of the small experimental unit indicates a maximum net return of about $69,000 a year with a water evaporating cost of 35 cents per thousand pounds, approximately $74,000 a year with a cost of 25 cents per thousand, and about $100,000 a year with a cost of 15 cents per thousand. Capital expenditure is estimated at about $90,000 so that most, if not all of the original investment can be recovered in one 150-day campaign.

The Direct Polarimetric Determination of Sucrose in the Presence of Glucose and Fructose by the Addition of Borax

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IN February 1963 there appeared in *The International Sugar Journal* an article by Mr. JOSÉ A. LÓPEZ HERNÁNDEZ entitled "Determination of Sucrose in the Impure Products of the Cane Sugar Manufacturing Process by the Action of Boron Salts".[1] It is claimed in this article that a 2% solution of borax added to a mixture of sucrose, glucose and fructose is sufficient to eliminate the optical rotatory power of glucose and fructose owing to complex formation with the borax, leaving the optical rotatory power of sucrose unaffected.

We do not agree with the premises that the addition of borax will produce an optically inactive complex, and that sucrose cannot form complexes with borax because it does not have vicinal hydroxyls in *cis* positions.

The complexes of one molecule of optically active sugar with a boron salt are asymmetric, and the complexes of two sugar molecules with boron in a tetrahedral configuration also lack a centre of symmetry (see Fig. 1) and, therefore, should be optically active.

As to the possibility that sucrose can form complexes with boron salts, we shall examine first the spatial requirements of complex formation and the known structure of fructose, glucose and sucrose.

It is known[2,3] that for the complexing of a diol with boron salts it is necessary that the hydroxyl

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[1] *I.S.J.*, 1963, **65**, 46–48, 73–73, 107–109.

[2] MAGNANINI: *Gazz. Chim. Ital.*, 1890, **201**, 428.

[3] BOESEKEN: "Advances in Carbohydrate Chemistry," 1949, **4**, 189.

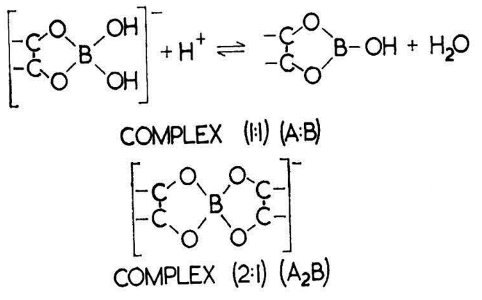

Fig. 1

groups should be close enough to be able to form a cyclic five membered ring complex (see Fig. 1). This requirement is fulfilled by *cis* vicinal hydroxyl groups in furanosic sugars (see Fig. 2), but not by *trans* hydroxyls. However, in pyranosic sugars, the non-planarity of the six-membered ring (Fig. 3*a*) gives rise to a chair form with two distinct conformational isomers.

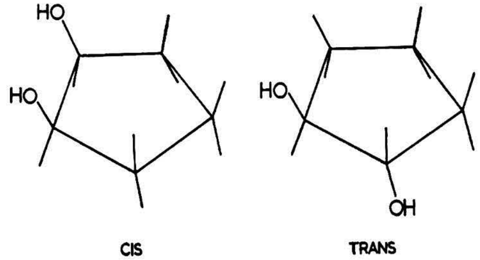

Fig. 2. Hydroxyls *cis* and *trans* in 5-membered rings

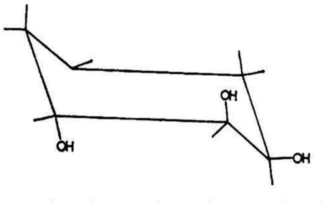

Fig. 3*a*. Hydroxyls *cis* and *trans* in 6-membered rings

The groups attached to the ring can adopt positions close to the plane of the chair (equatorial groups), or positions close to an axis perpendicular to the chair plane (axial groups). When a group is equatorial in a given conformational isomer, it is axial in the other isomer. Vicinal groups in *cis* positions are equatorial-axial (e,a), and although they can form complexes they are not in as favourable a position as in the case of *cis* groups in furanosic rings (see Fig. 3*b*).

Vicinal trans groups can adopt (e,e) positions or (a,a) positions, alternating between them with thermal motion. The (e,e) configuration is capable of complex formation, but the (a,a) is not (see Fig. 3*b*).

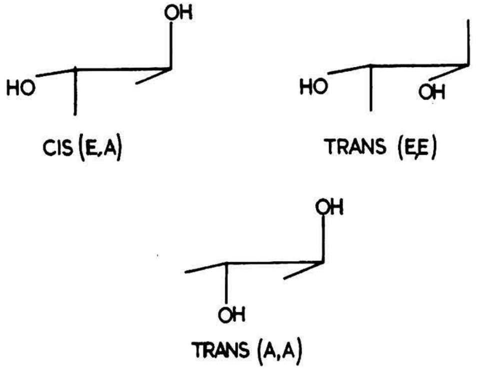

Fig. 3*b*

The structure of fructose shown in Fig. 4 for the α and β forms is of the furanosic type. The α-furanosic form does not have two hydroxyl groups in appropriate positions for complex formation, but β-D-fructofuranose has the hydroxyls of carbons 2 and 3 in favourable *cis* positions. It should therefore form strong complexes with borax.

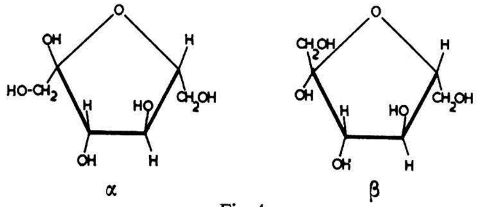

Fig. 4

Either in its α- or β-pyranose forms, glucose can form complexes with borax (see Figs. 5*a*, 5*b*, 6*a* and 6*b*).

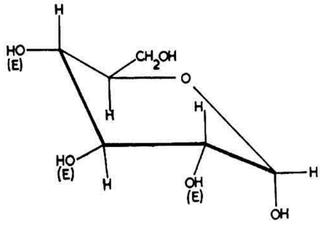

Fig. 5*a*. α-D-glucopyranose

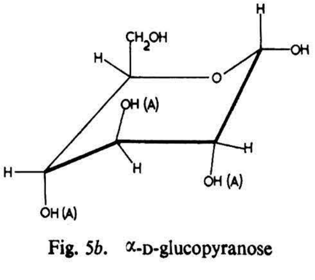

Fig. 5*b*. α-D-glucopyranose

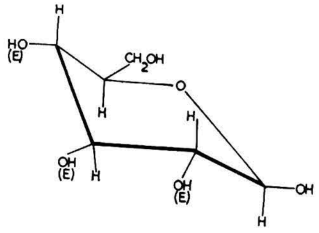

Fig. 6*a*. β-D-glucopyranose

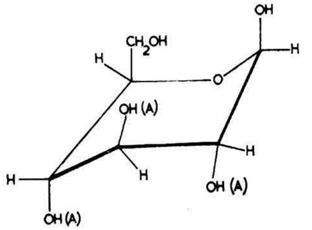

Fig. 6*b*. β-D-glucopyranose

Sucrose, α-D-glucopyranosyl β-D-fructofuranoside, is formed by linking the hydroxyl groups in carbon 1 of α-D-glucose and carbon 2 of β-D-fructose. As β-D-fructofuranose only has the hydroxyl groups of carbons 2 and 3 in a favourable position, elimination of the hydroxyl group of position 2 leaves the fructosyl entity in sucrose incapable of complex formation. However, as can be seen in Figs. 7*a* and 7*b*, the glucosyl part can theoretically form complexes with borax.

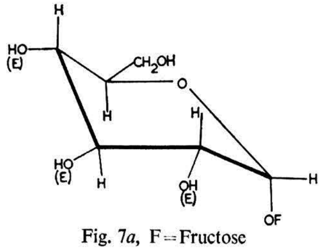

Fig. 7*a*, F=Fructose

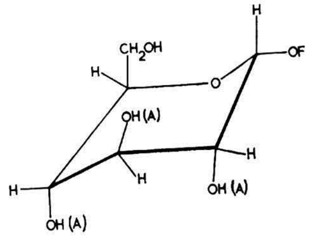

Fig. 7*b*, F=Fructose

Experimental

First, experiments were made with mixtures of sucrose with glucose and of sucrose with fructose similar to those in the article by **López**. The results obtained (see Table XIV) indicate that borax does not produce a polarimetric reading equal to that of pure sucrose, although it does bring the reading closer to it.

The quantity Δ is the difference in the polarimetric reading of sugar solutions with and without borax. Next, a series of measurements with pure glucose, fructose and sucrose was started to test the action of borax on the solutions of these pure compounds.

The results shown in Tables I to XIII and in Fig. 8 indicate that the three sugars form complexes with borax. In the case of glucose and fructose, the readings were at first variable owing to mutarotation phenomena, and the results given are the stabilized readings taken the day after preparing the solutions. Sucrose gave stable readings indicating that no hydrolysis of sucrose occurred under the conditions of the experiment.

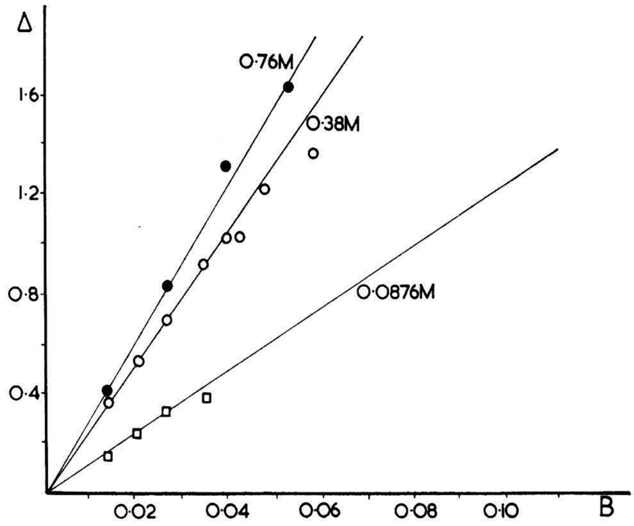

Fig. 8. Variation of difference in polarimetric reading (Δ) of sucrose solutions of various concentrations with different borax concentrations (B) in moles/litre

Table I*

Sucrose: 3 g/100 ml. Polarization: + 11·50

Borax g/100 ml		Δ
0·50	....	—0·15
0·75	....	—0·23
1·00	....	—0·32
1·30	....	—0·37

Table II*

Sucrose: 6·5 g/100 ml. Polarization: + 24·99

Borax g/100 ml		Δ
0·50	....	— 0·28
1·00	....	—0·56
1·50	....	—0·77
2·00	....	—0·94
3·00	....	— 1·22
5·00	....	— 1·78
7·00	....	—2·02

Table III*

Sucrose: 10 g/100 ml. Polarization: + 38·40

Borax g/100 ml	Δ
0·50	—0·29
0·75	—0·42
1·00	—0·67
1·30	—0·80

Table IV*

Sucrose: 13 g/100 ml. Polarization: + 49·90

Borax g/100 ml	Δ
0·50	—0·36
0·75	—0·52
1·00	—0·68
1·30	—0·90
1·50	—1·00
1·60	—1·04
1·80	—1·20
2·20	—1·34

Table V*

Sucrose: 17 g/100 ml. Polarization: + 65·40

Borax g/100 ml	Δ
0·50	—0·54
0·75	—0·59
1·00	—0·81
1·30	—0·92

Table VI*

Sucrose: 26 g/100 ml. Polarization: 100·00.

Borax g/100 ml	Δ
0·50	—0·40
1·00	—0·82
1·50	—1·30
2·00	—1·61

Table VII*

Glucose: 3·42 g/100 ml. Polarization: + 10·45

Borax g/100 ml	Δ
0·50	—0·85
1·00	—1·44
1·50	—1·95
2·00	—2·35
3·00	—3·32
5·00	—4·78

Table VIII*

Glucose: 6·84 g/100 ml. Polarization: + 20·75.

Borax g/100 ml	Δ
0·50	—0·75
0·75	—1·10
1·00	—1·45
1·30	—1·75
1·50	—1·95
1·80	—2·20
2·00	—2·40
2·20	—2·50

Table IX*

Glucose: 13·68 g/100 ml. Polarization: + 42·15

Borax g/100 ml	Δ
0·50	—1·08
1·00	—1·88
1·50	—2·40

*LENGTH OF TUBES: 200 mm; TEMPERATURE: 24°C ± 0·5°C

Table X†

Fructose: 3 g/100 ml. Polarization: —15·18

Borax g/100 ml	Δ
0·50	+ 2·78
1·00	+ 5·21
1·50	+ 7·19
2·00	+ 8·35

Table XI†

Borax g/100 ml	Glucose g/100 ml	Polarization	Δ
0	0·25	+ 0·80	0
0·25	0·25	+ 0·45	—0·35
0·50	0·25	+ 0·25	—0·55
0	0·50	+ 1·60	0
0·50	0·50	+ 0·80	—0·80
0	1·00	+ 3·26	0
0·50	1·00	+ 2·17	—1·09
0	2·00	+ 6·39	0
0·50	2·00	+ 5·10	—1·29

Table XII†

Borax g/100 ml	Fructose g/100 ml	Polarization	Δ
0	0·50	—2·50	0
0·50	0·50	—0·93	+ 1·57
0	1·00	—5·18	0
0·50	1·00	—2·87	+ 2·31
0	2·00	—10·39	0
0·50	2·00	—7·59	+ 2·80

Table XIII†

Borax g/100 ml	Sucrose g/100 ml	Polarization	Δ
0	0·50	+ 1·90	0
0·50	0·50	+ 1·80	—0·10
0	1·00	+ 3·87	0
0·50	1·00	+ 3·76	—0·11
0	2·00	+ 7·72	0
0·50	2·00	+ 7·63	—0·09

†LENGTH OF TUBES: 200 mm; TEMPERATURE: 20°C ± 0·5°C

It should be mentioned that, at very high concentrations of borax relative to glucose and using conditions similar to those of TICHÁ and FRIML[4], the optical rotation of glucose was brought to zero, but we do not believe this to be an indication that the complexes formed are inactive, but rather than the optical activity of the different species present are balanced. Further experiments at high borax concentrations are planned.

Experiments with mixtures were performed and are reported in Tables XIV and XV. The results indicate that the addition of borax approximates the polarimetric reading of a solution of sucrose with glucose or fructose to the value of pure sucrose, but that this procedure cannot be considered at present as an analytical method for sucrose determination.

Table XIV

Borax g/100 ml	Sucrose g/100 ml	Glucose g/100 ml	Fructose g/100 ml	Polarization	Δ
0	13·00	0	0	50·05	
0	13·00	0·50	0	51·25	0
0·50	13·00	0·50	0	40·90	—0·35
0	13·00	0	0·50	47·40	0
0·50	13·00	0	0·50	48·71	+ 1·31

LENGTH OF TUBES: 200 mm
TEMPERATURE: 20°C ± 0·5°C.

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[4] *Listy Cukr.*, 1963, **79**, 57–63.

Table XV

Mixture of 3·42 g/100 ml of glucose plus 6·5 g/100 ml of sucrose

Borax: g/100 ml	Polarization	Δ
0	+ 35·50	0
1·00	+ 33·89	—1·61
2·00	+ 32·90	—2·60
3·00	+ 32·15	—3·35
5·00	+ 30·52	—4·98
7·00	+ 29·40	—6·10

From the change in optical activity of sucrose with addition of borax it has been possible to establish that the sucrose-borax complex is a 1:1 complex[6].

Conclusions

(1) Borax forms complexes with glucose, fructose and sucrose, affecting the optical rotatory powers of these sugars.

(2) The polarimetric determination of sucrose in the presence of glucose and fructose by the addition of borax does not constitute an exact analytical method.

Acknowledgments

We are indebted to Professor JULIO C. GONZÁLEZ MAÍZ for bringing to our attention the work of Mr. LÓPEZ HERNÁNDEZ. We also wish to thank the members of the "Sugar Chemistry Group" at the University of Oriente for valuable discussions, and Miss ANA M. MARINELLO for the figures and graph.

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[6] FERNÁNDEZ, MARINELLO and LLOREDA: "Estudio del Complejo de la Sacarosa y la Bórax," *Paper presented to the 1st National Sugar Forum* (Havana, Cuba), September 1964.

Correspondence

The Editor,
The International Sugar Journal.

Dear Sir,

POST-HARVEST CANE DETERIORATION

The two articles by BRUIJN[1,2] on post-harvest deterioration are of considerable interest, and symptomatic of the increasing concern being shown over diminished sugar content due to delays in crushing, and on the effect of deterioration products on juice processing and sugar quality. The results quoted, presumably obtained with manually harvested cane, are in general agreement with those reported for hand-cut whole stalk cane in Queensland. The only cane stored in Queensland is that held over a week end to allow resumption of crushing early on Monday morning.

However, with the tremendous increase in mechanized harvesting, new problems in deterioration during storage have arisen. This is especially true with chopper harvesters, which provide many additional entry points for micro-organisms. Within three days of harvest, disastrous losses in sugar content can occur in the chopped-up cane under suitable conditions. Changes of considerable magnitude occur in the juice composition during this period, and the picture is quite different to that obtained with whole stalk cane. It is, in fact, similar in many respects to what occurs in frozen cane. Investigations on this aspect have been in progress in Queensland since 1962, and *Leuconostoc mesenteroides* was shown to be the main culprit. Summarized results[3,4,5] from several years showed that after two and a half days' storage between harvest and crushing, chopped-up cane

(i) lost an average of 5 to 12% of the sugar content, with individual losses as high as 25%,

(ii) dropped in purity by 3 to 5·5 units on average, with individual losses of 10–15 units not uncommon,

(iii) dropped in pH from an average of 5·35 to 4·7–5·0, with some as low as 4·0, and

(iv) increased three and a half to seven-fold in gum content on average.

Chopper harvesters have many advantages, but it is essential that the harvested cane be processed as quickly as possible. Changes in juice composition can be detected within 24 hours, although sucrose losses are small at that stage. Storage periods that seemed relatively safe for whole stalk cane are quite unacceptable in chopper harvested cane, and a new awareness of all deterioration problems has come to the Queensland sugar industry.

NICHOLSON and LILIENTHAL[6] in 1958, investigating the polysaccharide formed in stored cane stalks, calculated that it contained approximately 60% 1:4 linkages and 30% 1:6 linkages. BRUIJN's figures of 75% and 25% respectively show that similar non-dextran polysaccharides were formed in each case. NICHOLSON and LILIENTHAL further showed that the presence of *Leuconostoc* was not necessary for formation of polysaccharide.

The position with chopped up cane is likely to be very different, since *Leuconostoc* is present throughout the cane billets, usually in high concentration. The polysaccharides formed under these conditions have not been identified as yet, but at least a substantial portion should prove to be dextrans of the type formed by *Leuconostoc* in culture media.

B. T. EGAN,
Research Pathologist.

Northern Sugar Experiment Station,
Gordonvale, N. Queensland,
Australia.

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[1] *I.S.J.*, 1966, **68**, 331–334.

[2] *ibid.*, 356–358.

[3] EGAN: *Proc. 12th Congr. Int. Soc. Sugar Cane Tech.*, 1965, in press.

[4] EGAN: *Proc. 33rd Conf. Queensland Soc. Sugar Cane Tech.*, 1966, 11–20; *I.S.J.*, 1966, **68**, 371.

[5] EGAN: *Proc. 34th Conf. Queensland Soc. Sugar Cane Tech.*, 1967, in press.

[6] NICHOLSON & LILIENTHAL: *Aust. J. Biol. Sci.*, 1959, **12**, 192–203.

Sugar cane agriculture

Mineral nutrient studies in sugar cane. R. T. BISHOP *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 128–133.—This paper is divided into two parts: (A) Rate of uptake with increasing maturity, and (B) Factors affecting composition of third leaf blade. The absolute amounts of N, P, K, Ca, Mg and Na in the above-ground portions of the plant with increasing maturity were calculated. Correlation coefficients between concentrations of nutrients in the third leaf blade and environmental factors are presented. Among cane growers the question is often asked how soon after planting or cutting of sugar cane should fertilizer be applied? For optimum growth response nitrogen application must be early, especially in the case of a 12-month crop.

* * *

The effects of trash conservation on soil moisture and the sugar cane crop in Natal. G. D. THOMPSON. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 143–157.—It is acknowledged that the effects of an organic mulch on the soil and crop may be extremely complex. Long-term experiments with cane in Natal have shown that a consistent response has been obtained with trash conservation, compared with burning. This has resulted in a mean increase in yield of approximately 4 tons per acre or ½ ton of sugar per acre per annum. This response is due mainly to moisture conservation through the reduction of run-off and evaporation.

* * *

Preliminary studies on depth of soil moisture extractions by sugar cane using the neutron probe. J. M. GOSNELL and G. D. THOMPSON. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 158–165.—The development of neutron-scattering equipment has permitted the measurement of soil moisture contents *in situ* with reasonable accuracy, and actual patterns of soil moisture removal can now be determined. It is hoped that the new techniques may eventually be of value in estimating irrigation requirements with sugar cane.

* * *

Herbicide trials in Natal sugar cane. J. M. GOSNELL. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 171–181.—Results of four herbicide trials and the salient points from a number of other trials are here reported. "Paraquat", alone or with TCA and "Diuron", was applied to the cane row to control watergrass (*Cyperus*), inter-row cultivation being by tractor or mules. Results compared more than favourably with hand weeding entirely, in cost and efficiency. Damage to cane from "Bromacil" was mainly on soils of low organic matter content (less than 3%).

* * *

A new fungus disease of sugar cane. G. ROTH. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 182–186.—A new disease, called Wartberg disease, which attacks cane at the higher altitudes in Natal, is described. So far the fungus responsible has not been named, as cultures have not sporulated or produced spores. The varieties N:Co 376, N:Co 293 and Co 331 are known to be susceptible. Concern is felt about the first two mentioned varieties, as they are widely grown in the Natal midlands.

* * *

Harvesting frequency and its effect on yield, sugar recovery and the fibre content of cane. C. H. O. PEARSON. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 187–194.—The significance of relating per acre yields of sugar cane and sucrose to the time taken for their production is examined in a field trial carried out over a four-year period. It is shown that 34% more cane and 31% more sucrose were derived by cutting cane four times at 12-month intervals, instead of twice at intervals of 24 months. Furthermore, by cutting at a young stage, the fibre %cane is considerably lower than in the older material. Growers are advised that, under normal conditions, highest yields are obtained by cutting the maximum acreage of their cane at 12-month intervals.

* * *

Mineralization studies on virgin and cultivated sugar belt soils. R. A. WOOD. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 195–202.—In experiments concerned with soil nitrogen content, 13 different sugar cane soils were compared with similar soils from adjacent bush or grassland. Large differences were found in nitrogen mineralization which ranged from 370–1610 lb sulphate of ammonia equivalent in virgin soil to 230–630 lb in cane field soil. It is hoped that studies of this kind will make it possible to predict more effectively the most beneficial or economical amount of nitrogen to apply to each individual soil.

* * *

Characteristics of some wattle soils. G. D. DARBY. *Proc. 39th Congr. S. African Sugar Tech. Assoc.*, 1965, 228–230.—In view of the fact that the cultivation of the Australian black wattle tree (*Acacia mearnsii* or *Acacia mollissima*) for tannin or mimosa extract has been on the decline and the land used for other crops, including sugar cane in some districts, a study of wattle soils was considered desirable. These soils are usually deep, freely drained and acid. They were found to be rich in nitrogen and humus, but deficient in other plant nutrients. If these are made good such soils are in general well suited to sugar cane.

* * *

The Central American sugar industry. ANON. *Sugar y Azúcar*, 1966, **61**, (6), 41–45.—The sugar economy of the Central American sugar cane growing countries and the advances in cultivation and production that are taking place are discussed. Rapidly growing populations and improved living standards are responsible for greatly increased local consumption. The countries dealt with include Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

* * *

Long-range planning at British Honduras' Tower Hill. ANON. *Sugar y Azúcar*, 1966, **61**, (6), 46–47.—Details are given of the proposed developments at Tate & Lyle's Tower Hill project, 28 miles south west from their existing Corozal factory in British Honduras. Cane is being produced by the company and by local farmers. To date the company has cleared some 12,000 acres and planted about 8000 acres. Shortage of labour in the area renders the use of mechanical harvesters a necessity. Most of the land is flat or gently undulating.

* * *

Mexico's sugar industry: a review. ANON. *Sugar y Azúcar*, 1966, **61**, (6), 49–51.—Details are given of the present state of the cane sugar industry and of its rapid growth in recent years. Some of the more important plantations are discussed individually. Mexico has the largest sugar mill in the world, San Cristóbal, with a daily grinding capacity of 20,000 metric tons, and perhaps the world's smallest, Maria Cleofas, with a daily capacity of 30 tons.

* * *

A bookkeeping system for the cane farmer. H. A. HALFORD. *S. African Sugar J.*, 1966, **50**, 439–443. The importance to the cane farmer of keeping good and proper records is stressed. Bank managers and accountants agree that the farms showing the highest return on capital investment are those where a good set of books is kept. How this should be done is explained and the functions of a time book, wages book, allocation sheets, log books, stock book, cash book, etc. described.

* * *

The sugar cane nematode problem. J. DICK. *S. African Sugar J.*, 1966, **50**, 477–483.—An informative summary of what is known about nematodes in relation to sugar cane in South Africa is given. The author stresses how much has still to be learned about nematodes in cane fields and the difficulty of finding out which attack sugar cane. Many species found in cane soils feed on decomposing organic matter or associated micro-organisms.

Using perforated pipes in irrigation experiments. P. J. M. ROBILLARD and M. J. STEWART. *S. African Sugar J.*, 1966, **50**, 485–489.—In irrigation trials carried out at Mount Edgecombe, Natal, the upsetting influence on overhead irrigation of the windy conditions that prevail in the summer months is pointed out. "Underhead" irrigation utilizing light, portable 2-inch perforated piping proved very successful for the trials. The method of using it, pressures, etc., are described.

* * *

New spreading device mounted in helicopters. ANON. *Sugar J.* (La.), 1966, **28**, (12), 20.—This new fertilizer spreading device, patented and first developed for treating nutrient-starved cane in Puerto Rico, is capable of spreading 30 tons of granular fertilizer daily by a single light helicopter. A simple conversion permits seed broadcast at rates as low as one pound per acre.

* * *

The influence of recent changes in sugar cane cultivation on the incidence of the cicada pest (*Yanga guttulata*). J. DUBOIS. *Agronomie Tropicale*, 1966, **21**, (6–7), 786–821.—This sugar cane pest is native to Malagasy (formerly Madagascar) where the larvae, several dozen to each plant, may suck the sap from the cane roots and cause withering, especially after harvest, which is during the dry time of the year. Under irrigation or moister conditions the sugar cane plant shows better resistance. Since 1962 this pest has suddenly become a danger in well established plantations on the western coast of Malagasy. The increase in ratoon cultivation and consequent reduction in ploughing, which destroys 95–99% of larvae in the soil, is given as one reason. Another probable reason is considered to be the reduction in the number of "tick-birds" owing to insecticidal poisoning and increased mechanization. Trash burning may also be a significant factor.

* * *

Some suggestions to growers for improved methods of cane planting in northern India. T. KANORIA. *Indian Sugar*, 1966, **16**, 93–94.—The desirability of every grower raising his own disease-free seed cane in selected areas, well fertilized and irrigated, is stressed, early, medium and late varieties to be grown.

* * *

Problems facing the sugar industry in Uttar Pradesh. P. NARANG. *Indian Sugar*, 1966, **16**, 99–100.—It is pointed out that Uttar Pradesh produces 30% of India's sugar crop. Nevertheless the industry is dwindling. Reasons for this are discussed. These include lack of Government financial support for development programmes, especially irrigation, and small obsolete mills in urgent need of modernization.

* * *

The genetic approach to selection of promising sugar cane varieties. J. T. RAO, U. VIJAYALAKSHMI, B. V. NATARAJAN and T. N. KRISHNAMURTHY. *Indian Sugar*, 1966, **16**, 167–171.—The general principles of breeding at Coimbatore and some promising advances that are being made are discussed. New hybrid canes showing resistance to red rot disease and to cane smut are listed.

* * *

Southeast China sugar cane province raises yield by eliminating pests. ANON. *Surv. China Mainland Press*, 1965, (3504), 13–14; through *Hort. Abs.*, 1966, **36**, 431.—The introduction of a red ant, *Tetramorium guneense*, reduced borer infestation of sugar cane in the sub-tropical Fukien province from 10% to 1% and increased sugar yield by 750 kg/ha. This method was more effective than the use of insecticides, which failed to kill borer larvae in the cane stalks.

* * *

Sugar cane: a new insecticide tested. ANON. *Indian Farming*, 1965, **15**, (8), 35–36; through *Hort. Abs.*, 1966, **36**, 431.—Soaking planting setts for two hours in "Telodrin 0·05%" emulsion proved effective against the larvae and very effective against the pupae of stalk borer within the setts. The treatment also enhanced germination. "Malathion 0·1%" emulsion gave still better results.

* * *

Preliminary experiments with fertilizers for sugar cane and their effect on the yield and quality of panela. J. AGUILAR RIVAS and R. E. GOCHEZ. *Circ. Minist. Agric. Ganad.* (El Salvador) 1965, **59**, 1–8; through *Hort. Abs.*, 1966, **36**, 430.—The production of panela or non-centrifugal sugar has long been practised by smallholders in El Salvador. Factors affecting quality of panela are discussed. Heavy applications of ammonium sulphate adversely affected quality unless harvesting was delayed.

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Trash mulching: its effects on soils and crops in South Africa. G. D. THOMPSON. *World Crops*, 1966, **18**, (2), 62–65.—Results of a survey of trash mulching in South African cane fields are given, harvesting being mainly by hand in that country. The advantages of the practice, especially with weed control are pointed out, as well as the disadvantages in some districts. In high altitude areas where low soil temperatures inhibit winter ratooning; only 26% of the growers trash their cane, the rest preferring to burn each crop before harvest. In Pongola, where almost all the land is furrow irrigated, only 10% of the growers use a trash mulch. On the north coast of Natal, where dryland farming predominates and moisture conservation is important, 86% of the farmers use the trash mulch from all save the last crop as a surface mulch.

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A survey of sugar cane diseases in Thailand. J. P. MARTIN. *Sugar Industrial Aid Fund*, Bangkok, 1964, 40 pp; through *Rev. Appl. Mycol.*, 1966, **45**, 218. Observations from a four-month visit are given. Major diseases included "white leaf" or "grassy shoot" disease (virus) which causes more damage than any other disease. Smut (*Ustilago scitaminea*) was widely distributed. Fiji disease (a virus) was confined to two districts. Yellow spot (*Cercospora koepkei*) was widespread, causing moderate to severe damage. An unknown leaf spot also caused damage. Most commercial fields were free of sugar cane mosaic but much loss was sustained in some areas. Ratoon stunting disease was present only in small amounts. Leaf scorch (*Stagonospora sacchari*) was seen on one variety but did not cause serious damage. Brown stripe (*Cochliobolus stenospilus*) was chiefly confined to one district. Leaf scald (*Xanthomonas albilineans*) was present in one area. A further 28 diseases or disorders of minor importance are listed.

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A study of the vegetative characteristics of *Saccharum spontaneum* **in Taiwan.** P. Y. JUANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 17–27.—Reference is made to the establishment of 158 clones of *Saccharum spontaneum* in Taiwan during 1957–59. Observations recorded on a few clones native to Taiwan and data regarding purity of juice and fibre content are given. It is thought that the Taiwan clones may prove useful in breeding work.

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Effects of methyl bromide fumigation of young seedlings of sugar cane. C. C. LO. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 29–40.—Experiments are recorded comparing methyl bromide sterilization with steam sterilization of soil for sugar cane seed sowing. Germination in the methyl bromide-treated soil was slightly inferior to that in the steam-sterilized soil but later mortality of seedlings was lower. The concentration used was one pound of methyl bromide per 120 flats (3 cubic yards). The control of weeds equalled that obtained with steam treatment. Sowing was practical 14 days after methyl bromide treatment.

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Propagation of sugar cane setts under different nursery conditions (third report). T. PAO, S. L. HUNG and Y. T. YEH. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 41–60.—An elaborate series of experiments utilizing setts from tops planted at different concentrations per hectare are reported. Different varieties were used under a series of different soil conditions. 80,000 top cuttings per hectare was regarded as the most favourable spacing.

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The influence of roots on the growth of the sugar cane plant. T. T. YANG and K. C. HSU. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 61–70.—A series of laboratory experiments intended to throw light on the effect of root development on the growth of the sugar cane plant is described. Roots were removed or partly removed from young sugar cane plants at different stages and subsequent growth noted. It was considered that one function of the roots is to produce root pressure which results in high turgidity in the xylem when transpiration is weak. This may aid translocation of nutrients. It was also considered that the root is not essential for guttation to take place from the leaf.

Nitrogen content of different parts of the sugar cane plant. C. S. YEH. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 71–80.—Nitrogen content of the leaf blade (variety N:Co 310) was found to vary according to its position on the stalk. Different parts of the individual leaf blade also showed variation. The nitrogen content of the leaf blade was always higher than that of the adjacent part of the leaf midrib. The leaf sheath also showed variation. In the stem the young or elongating portion showed the highest nitrogen content. The nitrogen content of the node was always higher than that of the adjacent internode.

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A study of the nutrient content and decomposition of green manure plants. S. C. YANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 91–109.—The N-P-K content of three green manure plants and their decomposition after being applied to sugar cane fields were investigated. The plants were the groundnut or peanut (*Arachis hypogaea*), *Sesbania sesban*, and *Crotalaria juncea*. The distribution of N, P and K in all three exhibited a similar trend, being highest in the terminal parts or young stems and progressively less in leaves, older stems and least in roots. The N, P and K contents of all three green manure plants differed slightly at different growing stages, being lower in ripening plants than in young plants.

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Studies on the sugar loss in millable cane caused by stalk borers. C. J. LIANG and J. T. WANG. *Rpt. Taiwan Sugar Expt. Sta.*, 1966, (39), 127–145.—This investigation is concerned with the estimation of sugar loss in cane stalks damaged by cane borers, the variety concerned being N:Co 310. It was found that the loss in sugar in severely damaged or bored cane stalks amounted to 38·22% and in lightly bored cane to 25·38%. During a period of five years the Taiwan Sugar Corporation is considered to have lost some 75,822 tons of sugar as a result of cane borer damage.

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Potash improves sugar cane quality. R. P. HUMBERT. *Sugarland*, 1966, **3**, (1), 64–66.—The growing need to increase potassium in many cane and sugar beet soils in different parts of the world is discussed. The beneficial effects on the cane plant of increasing potash supplies in potash deficient soils, under eight different headings, is also discussed. Potash has been shown to be an important factor affecting juice quality of sugar cane.

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Drainage control through effective use of herbicides. ANON. *Sugarland*, 1966, **3**, (1), 80–81.—The desirability of keeping drainage ditches and ditch banks clear of weed growth by means of chemical weed-killers, until the cane is tall enough to smother grass and weeds, is stressed. Weed growth can impede the flow of water by 30–50% or more. It is considered that "Dowpon" is the most inexpensive method of grass control now available for the effective maintenance of ditch banks.

Rat infestations in cane fields—a difficult problem. ANON. *Australian Sugar J.*, 1966, **58,** 129.—The large amount of damage to cane by rats in northern Queensland is discussed. Reference is made to experimental work with a new raticide "Shoxin", developed in Canada. This poison proved effective with one kind of rat (ground rats) in Queensland but not with the other (climbing rats) and so was not superior to thallium rodenticides.

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Sugar cane top borer, *Scirpophaga nivella fabricius*—**a review.** D. K. BUTANI. *Indian Sugar*, 1966, **16**, (1), 33–38.—This pest occurs throughout all the sugar growing tracts of India and is most destructive in the northern States. Although much work has been done on the pest, little success has been achieved in its control. In order to stimulate research on the problem the author reviews previous work and gives data about the insect. A bibliography is included.

* * *

Improvement of the sugar industry. ANON. *Bol. Azuc. Mex.*, 1966, (201), 20–21.—Reference is made to the drive in Mexico to ensure greater co-operation or liaison between the scientist or specialist and those in charge of sugar cane estates or of field or factory work. The scope of the extension work is to be increased. A list is given of sugar experiment stations in Mexico and the areas they serve.

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Cane dry cleaner testing in Hawaii. ANON. *Sugar J.* (La.), 1966, **29**, (1), 46.—It is considered that the system of dry cleaning cane under factory conditions developed experimentally in Hawaii may prove to be the most important technological improvement in a century of sugar production in that country. Reference is made to further trials to be carried out in an area where the trash is much wetter than that experimented with so far.

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Biometrics in sugar cane breeding. ANON. *Sugarcane Varieties Quarterly Newsletter*, (Coimbatore) 1966, **3**, (2), 3–11.—The various objectives in sugar cane breeding are outlined under four headings: (1) production (quantity) breeding, (2) quality breeding, (3) resistance breeding and (4) specific objectives. The significance of biometrics in sugar cane breeding is discussed.

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Flowering in relation to yield and quality. ANON. *Sugarcane Varieties Quarterly Newsletter* (Coimbatore), 1966, **3**, (2), 12–13.—Reference is made to earlier work on this subject[1]. During the year 1965–66 further studies were made (with varieties Co 419, Co 740, Co 975 and Co 1287). Analysis of flowered and non-flowered canes was carried out at fortnightly intervals. The study revealed that up to 2½–3 months after flowering there was no difference between flowered and non-flowered stalks in weight of stalks and quality attributes. After this period there was evidence of deterioration as a result of flowering. It is desirable to harvest cane within three months after flowering to obtain maximum sugar.

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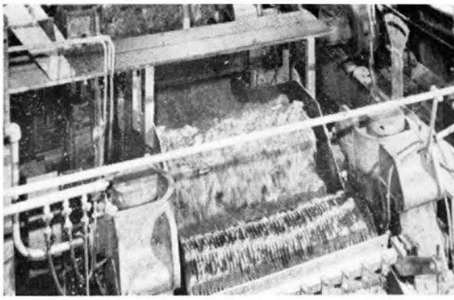
[1] *Sugarcane Varieties Quarterly Newsletter* (Coimbatore), 1965, **2**, (1).

Cane sugar manufacture



White sugar without sulphur. S. C. SHARMA. *Indian Sugar*, 1966, **16**, 139–142.—In view of the reduced availability of sulphur in India (due to foreign exchange difficulties), suggested ways of overcoming the problem are given including limitation of syrup sulphitation to pH 5·4–5·6 in carbonatation factories (instead of pH 5·0) and simple defecation followed by syrup sulphitation to pH 5·4 in sulphitation factories. Boiling schemes are suggested for sulphitation factories adopting simple defecation. In view of the favourable results obtained at one factory using only 0·019% sulphur on cane and melting double-cured *B*- and *C*-sugar (*A*-massecuite was seeded on hopper sugar, double-cured and the sugar bagged), tests were conducted in which sulphitation was omitted from the scheme and the juice limed to pH 7·1. White sugar of satisfactory quality was obtained.

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Recent experience with the DDS cane diffuser. H. BRÜNICHE-OLSEN. *Sugar y Azúcar*, 1966, **61**, (8), 27–29.—Results obtained with DDS diffusers in Tanzania and Réunion are discussed and a brief description given of the diffuser. In Tanzania two mills preceding the diffuser extract 60–65% of the juice on cane, diffusion extracting the remaining 30% of the mixed juice. The raw juice has a pol of about 7 and final bagasse pol is 1·3–1·4. In contrast, the unit in Réunion includes one mill which extracts 40–50% of the juice on cane, while the diffuser extracts 40–45%. The diffusion juice has a pol of 10–12, but the bagasse pol is still only 1·4–1·95. The better ratio between bagasse pol and diffusion juice pol in Réunion is attributed to the processing of 12-month-old cane, compared with 18-month-old cane in Tanzania. Tests with shredded cane showed that extraction was only slightly better than with crushed cane, while the bagasse from the shredded cane was wetter than that from crushed cane, thus contributing to difficulties in the first dewatering mill. An increase in pol extraction from 92·5% with mills to 96·9% with the diffuser at Tanganyika Co. Ltd. compares with an increase from 93·3% to 96·5% in Réunion. Temperature, pH and losses in the diffuser are discussed as is the recycling of press water. Drop in purity from first to final juice is low, being 8·4 units during the first 30 weeks in the 1965–66 season in Tanzania.

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Bagasse briquettes fuel Tarlac complex. ANON. *Sugar y Azúcar*, 1966, **61**, (8), 34–35.—Details are given of the bagasse briquetting plant designed by Swiss Puerto Rican Metallurgical Corp. for Cía. Azucarera de Tarlac, Philippines. The sugar factory crushes 7055 t.c.d. and accumulates a surplus of 40,000 short tons of bagasse over a 5-month season. Some of this serves as fuel for the refinery and distillery adjacent to the factory. Storage of baled bagasse was found to involve difficulties, including fermentation. The bagasse from the mill is fed to a bin with a 40–50 ton capacity, the bagasse being distributed evenly by twin screws of special design. The moisture content is reduced from about 52% to 15% in a dryer provided with a fan and fed with hot flue gases. The briquetting press handles bagasse (with pith) measuring up to 50 mm; this, without binders, is used to produce 5-in briquettes. A depithing machine is also provided for treatment of bagasse intended for use in paper production, etc.

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Automation control selection. A. A. TROY. *Sugar J.* (La.), 1966, **29**, (2), 43–47.—The chief characteristics, advantages and possible cane sugar factory applications of two-position, proportional and proportional-plus-reset automatic control systems are discussed.

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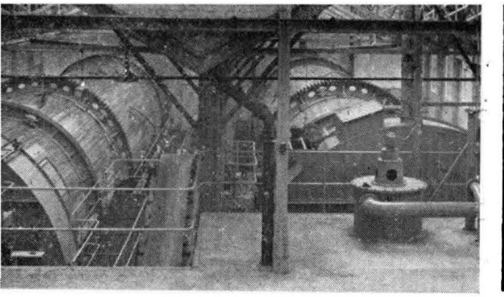
The Rabe clarification process. ANON. *S. African Sugar J.*, 1966, **50**, 628–631, 633.—Details are given of the clarification station at Umzimkulu, which incorporates a Rabe 12-ft dia. flotation clarifier of 2,880 gal capacity (the maximum capacity tested is equivalent to 150 tons of juice per hr) using standard Dorr-Oliver skimming equipment. The raw juice heated to 65°C is treated with milk-of-lime and calcium monophosphate and pumped to a mixer where flocculant is added. In the clarifier the scum rises rapidly to the surface under vacuum, while the clear juice is drawn off by extraction pump. The juice is then heated to 100°C and sent to the evaporator. The mud is skimmed into the mud trough, whence it is pumped to a belt filter, the filtrate from which is sent to the evaporator with the clarified juice. The juice is retained only 10 min in the clarifier, compared with 1½–3½ hr in conventional clarifiers. Starch removal has been in excess of 90%. Refinery tests on Umzimkulu raw sugar have shown the filtrability to be very high (105 and 120 tons of melt passed per filter cycle compared with an average of 54 for sugars from other Natal factories) and the starch content of the melted sugars to be very low (40 and 90 p.p.m. compared with an average of 390 p.p.m. for other Natal sugars). The liquors from the Umzimkulu sugar were considered to be of superior clarity and were more easily decolorized than normal sugars.



Beet sugar manufacture

Normal concentration of beet syrup boiled in 1st product vacuum pans. I. F. ZELIKMAN. *Izv. Vysshikh Ucheb. Zaved., Pishch. Tekhnol.*, 1965, (6), 52–55; through *S.I.A.*, 1966, **28**, Abs. 327.—It is recommended that beet juice should be evaporated to 70°Bx instead of the usual 65°Bx. The consequent large savings in fuel, time, water and pan capacity and improvement in white sugar quality are discussed. The final filtration may need to be carried out before the last vessel of the evaporator. Yellow sugar should be melted at 80°C to ~74°Bx. Tests at Korenovsk factory (U.S.S.R.) with existing pans have shown a reduction in boiling time of 25–35% using concentrated syrup and a 45% reduction in colour formation, partly owing to the use of lower pressure steam.

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Automatic control of pan boiling. W. PARTALE. *Paper presented to the* 18*th Tech. Conf., British Sugar Corp. Ltd.*, 1966.—Conductivity control of boiling is applied in the Süddeutsche Zucker A.G. to raw and after-product massecuites, and B.P.E. control to white and raffinade massecuites. A description is given of the equipment used and its mounting and operation. Boiling point elevation control is more complicated than conductivity control and the problems involved are discussed. It has not been found possible to calibrate the B.P.E. recorder to correspond accurately with supersaturation and the controlled strikes are based on B.P.E. measurements made during manually controlled strikes. A technique is described for the preparation and use of a seeding slurry such that the seed supplied is of consistent size and quantity. The pans do not have mechanical stirrers and, to provide adequate circulation, a fast evaporation rate must be employed; this requires the addition of water to the pan contents and the rates of water and syrup feed are governed in order to maintain a required conductivity set point. In two systems employed the syrup is diluted with water to a constant Brix; in one of these, used at Rain-am-Lech factory, the supersaturation is gradually increased by means of a cam which rotates once in a set time of 6 hr (the boiling time required by the pan). In the second system a level control in the pan alters the supersaturation set point which thus reaches the required final value when the pan is full. In a third system a conductivity controller is used in conjunction with a level controller. The latter is related to time so that the total boiling time is used to complete the strike, so that the level controller governs whether syrup or water is added, depending on whether or not an increase in massecuite level is permitted at the particular time when the supersaturation (conductivity) control requires dilution of the massecuite. An account is given of the costs of the equipment used.

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Automatic control of pan boiling. R. F. MADSEN. *Paper presented to the* 18*th Tech. Conf., British Sugar Corp. Ltd.*, 1966.—An account is given of the automatic control of pan boiling in Danish sugar factories. Controllable variables include supersaturation (measused in terms of conductivity), absolute pressure in the pan, steam pressure in the calandia, syrup feed, massecuite level and boiling time. In the most modern installations the cycle starts with slow opening of the vacuum valve and opening of the syrup valve, steam valve to the calandria and venting valve from the calandria. When the syrup reaches a predetermined level the feed valve closes and the syrup is evaporated until the conductivity reaches a pre-set seeding value. The seeding valve then admits a fixed quantity of icing sugar and the syrup feed valve is opened automatically so as to maintain a constant conductivity during a fixed period during which the crystals grow to the required size. The conductivity is increased in eight steps during a fixed time and reaches a maximum level when the vacuum valve closes and the syrup valve opens. When the massecuite has been thinned sufficiently the vacuum is controlled by an absolute pressure converter with a fixed set point and conductivity slowly decreased in five steps. When the strike is finished the operator changes the control switch to discharge, when syrup, vacuum, venting and levelmeter valves close and valves for direct steam to the top of the pan opens, bringing pressure to atmospheric so that the massecuite can be struck. The empty pan is then closed and steamed out automatically and is ready for a new strike.

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Automatic control of pan boiling. R. M. J. WITHERS and R. J. BASS. *Paper presented to the* 18*th Tech. Conf., British Sugar Corp. Ltd.*, 1966.—An account is given of the progress in automation of pan boiling of white sugar in the British Sugar Corporation, and the experiments in continuous sugar boiling carried out at Wissington in 1961/62 and 1962/63. The advent of mechanical stirrers at Kings Lynn factory for improvement of white sugar moisture content led to further work on automatic boiling because of the reduced variation of temperature throughout the massecuite arising from forced circulation, and the possibility of using the stirrer power demand as a measure of mobility. A fully automatic system was thus applied to pans at Allscott and Cantley, and is described. Absolute pressure is measured by a Honeywell transmitter-recorder-controller which governs the flow of water to the condenser. Initially pan contents level was measured by a bubbler system but this has not been used in the final system. Steam flow is measured in terms of pressure, by a Honeywell recorder/controller which regulates a valve in the steam line. A Honeywell supersaturation meter is used to detect the seeding point, and to govern the flow of feed syrup to the pan immediately after seeding. A Bellingham & Stanley pan refractometer is used to check the supersaturation recorder and the tightness of the massecuite is measured in terms of the power used by the stirrer motor drive, which is measured by an Everett-Edgcombe transmitter which sends a signal to a Honeywell recorder/controller and this governs the feed valve admitting liquor to the pan. Operation of the system is described in detail. Results obtained are as good if not better than with manual control. The cost, however, neglecting the stirrer and discharge valve, amounts to about £3500 per pan and this is difficult to justify on the grounds of labour saving. However, the boiling is faster and a normal 2½-hr strike can be reduced by 20 minutes. In addition, stricter scheduling on the pan floor could benefit overall factory working. Cheaper partial measures are indicated which would ease the work of the pan boiler.

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Validity of electrical conductivity for control and automatic boiling in the beet sugar factory. D. Ahari, J. Genotelle, –. Hodent and R. Michel. *Paper presented to the* 18*th Tech. Conf., British Sugar Corp. Ltd.*, 1966.—Variation of conductivity of impure sugar solutions has been examined; for solutions of equal supersaturation, the resistance (reciprocal of conductivity) falls to a minimum at about 80–87 purity, rising on either side. For purities of 93–95 a variation of 1 unit of purity corresponds to an indication of 0·05 supersaturation. Above 95 purity it is difficult to use conductivity as a measure of supersaturation because of the sharp rise of resistance; nevertheless Pidoux has controlled refinery strikes using a high-sensitivity conductivity meter. Variation of temperature has very little effect on conductivity when the purity is over 77–78, a difference of 5° corresponding to less than 0·01 units of supersaturation measured in terms of conductivity. For a saturated solution, the resistance rose linearly with the proportion of crystals present by weight, being approximately doubled by 40% of crystals. The size of the crystals however, had a negligible effect. A series of curves has been drawn for the variation of resistance with change in mother liquor purity and increasing crystal content, i.e. the conditions applying in pan boiling. These vary in shape with the initial purity of the syrup. With a low volume of seed footing grained and brought to a crystal content of say 40% and then fed with syrup to maintain this crystal content, the mother liquor purity will fall to a particular level at the end of graining and will then remain steady at that value during the whole of the strike, and this is the ideal situation for the use of conductivity control. In practice, however, factors such as heat transmission and circulation affect the strike and the control programme has to be worked out in accordance with these other factors.

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Preparation of diffusion water. S. Zagrodzki and A. Sokolowski. *Bol. Azuc. Mex.*, 1966, (201), 28–39. See *I.S.J.*, 1965, **67**, 376.

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Maintenance in manufacturing plant controlled by a budgetary system with particular regard to the sugar industry. C. R. Bonati. *Ind. Sacc. Ital.*, 1966, **59**, 111.—Modern maintenance is outlined with reference to organization, costs, budgetary control and human aspects.

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What has become of the RT purification process at Oreye since 1960? A. Begasse and J. Huberlant. *Sucr. Belge*, 1966, **85**, 375–385.—While the carbonatation system described previously[1,2] has not necessarily improved juice purification at Oreye (the rise in raw juice and syrup purities from 89·3 to 90·3 and from 93·5 to 94·1, respectively, is considered to be possibly due to numerous other factors), the scheme does have the advantages of lower lime consumption (1·4 kg CaO % on beet compared with 1·8 kg CaO % on beet previously), insensitivity to fluctuations in raw juice quality and hence ease of adaptability to variations in beet quality. Although an extra settling and carbonatation tank were necessary, their installation has permitted the Fives-Lille filter-thickener to treat all the juice from 2700 tons of beet daily, compared with a capacity corresponding to 1800 tons of beet per day previously.

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New antifoaming agents used in the food industry. C. Matasa. *Ind. Alimentara*, 1965, **16**, 360–364. Oxygenated compounds, formed by oxidizing higher hydrocarbons and their high M.W. derivatives, are effective anti-foaming agents and are cheap and non-toxic. Residues obtained from distillation of synthetic fatty acids and of fatty alcohols derived from these acids also have anti-foaming properties. These were tested on a number of sugar factory products, including molasses, predefecation juice and effluent.

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Research on waste water in the sugar industry. II. Possibility of reducing the amount and toxicity of some waste waters. C. Gajban. *Ind. Alimentara*, 1965, **16**, 316–320.—A number of measures for reducing the toxicity and volume of beet factory effluent are discussed. These are intended to reduce the solids content of the effluent, eliminate spillage

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[1] Dormal: *I.S.J.*, 1960, **62**, 101.

[2] *idem ibid.*, 1961, **63**, 348.

from process tanks and pumps, and increase condenser water usage in beet fluming. A 6–10 hour retention of 50% of the effluent in settling ponds is also recommended. A reduction in water consumption from 5·9–6 to 3·9–4 cu.m./ton of beet is considered possible by these means, with a resultant drop in river pollution.

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Liming of sugar beet cossettes. A. E. GOODBAN and R. M. MCCREADY. *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 566–572.—The effects of lime on beet tissue, due primarily to the reactions of pectin under alkaline conditions, are discussed and a brief review given of processes for beet pre-treatment with lime. About 30% of the water-insoluble portion of the beet is pectin, which is stabilized by de-esterification under the action of lime at low temperatures (below 25°C), resulting in an insoluble matrix of calcium pectate, which would hinder colloid extraction during diffusion but allow free sugar diffusion. Lime penetration tests were conducted on beet plugs and cossettes and the results expressed in terms of de-esterification at corresponding depths. The acetyl and methoxyl contents of the marc in cossettes mixed with dry $Ca(OH)_2$ and held at 25°C were measured and expressed as % saponification. The rate of demethylation was greater than the deacetylation rate, the respective maximum saponification percentages being achieved after 20–25 min (about 90%) and 35–40 min (about 68%). Laboratory diffusion and carbonatation tests were carried out after cossette liming by one of four methods, of which preliming at room temperature (below 25°C) with dry lime (0·4% CaO on beet) proved the best. The major differences between (i) normal diffusion juice, (ii) juice from the alkaline cossettes and (iii) juice from pre-limed cossettes which had been neutralized with CO_2 lay in the total lime consumption [2·0%, 0·9% and 1·4% respectively for (i), (ii) and (iii)] and in the lime salts and total anion contents of the 2nd carbonatation juice, which were higher in the juice from the limed cossettes as a result of acetate liberation from the pectin. The increase in anions (calculated as acetate) and in lime salts (calculated as Ca^{++}) is shown to be approx. equivalent to the drop in purity observed for juices obtained from limed cossettes. The diffusion juice from the alkaline cossettes was clear and light in colour, while that from the neutralized cossettes, although darker and containing more colloids, was still lighter and clearer than with normal diffusion juice. Tests showed that lime-treated cossettes, the pulp from which is much tougher than normal pulp, should not prove difficult to press. The pre-liming of the cossettes must be carried out below 40°C, and sufficient time must be allowed for the pectin to be stabilized before it is subjected to heat, although diffusion can then be carried out at abnormally high temperatures. Another advantage of cossette pre-liming is claimed to be production of partially clarified juice suitable for ion-exchange treatment.

Evaluation of sugar beet storage practices by using the percentage purity of the thin juice. S. T. DEXTER and M. G. FRAKES. *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 607–612. Use of thin juice purity as a guide to crystal sugar yield is discussed with brief mention of the laboratory clarification methods of BROWN & SERRO[1] and CARRUTHERS & OLDFIELD[2]. Reference is also made to a formula derived by The Great Western Sugar Co.[3] for calculation of percentage bagged sugar recovery from the results. This formula was used to evaluate the storage properties of various types of beets and in various forms (large and small, of varying sugar content, whole, topped and beet crowns). These were stored for 10 weeks until 10th January under varying conditions: at 32°F in air, in ice water, in brine of 2% salt content, in a factory pile and in a frozen condition. Tabulated results show that storage in the frozen condition appeared to give lower sugar losses with beets of a poorer quality (less than 14% sugar content) than did storage in the factory pile; the same applied to untopped beets and crowns. The beets in the pile shrank to a slightly lesser extent than did the frozen samples, with the exception of the crowns. During the first four weeks losses in the beets stored in ice water were almost the same as those in the company pile, but subsequently increased appreciably in the water-stored beets. Storage in brine did not prevent sugar loss but almost eliminated water uptake.

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Degree of extraction and evaluation of diffusion work. J. ČERNÝ. *Listy Cukr.*, 1966, **82**, 175–176.—Tabulated values of E and E/V, where $E =$ degree of extraction[4] and $V =$ juice draught, and of Al, where $A =$ diffusion constant[5,6] and $l =$ cossette length, showed that at Opava sugar factory the performance of the BMA diffuser was above average, while that of a battery diffuser at Drahanovice was below average. E averaged 97·9 and 94·3 for the BMA tower and battery diffuser, respectively.

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New covers for sugar beet. M. M. VISSARIONOV. *Sakhar. Prom.*, 1966, **40**, (8), 53—55.—The protection of beet piles with paper-laminated polyethylene sheeting has been carried out at Karlamansk sugar factory on an experimental basis since 1961. In the autumn only the sloping sides have been covered, while in the winter-spring period all the pile has been covered. The losses have been lower than in piles protected with rush matting, and no mould has formed on the top surface in contrast to the mat-covered piles. However, it has been found necessary to anchor the plastic sheeting and prevent tearing of the paper at fixing points. Details are given of the technique used and the economics of using polyethylene are discussed. These favour use of the plastic in comparison with rush matting.

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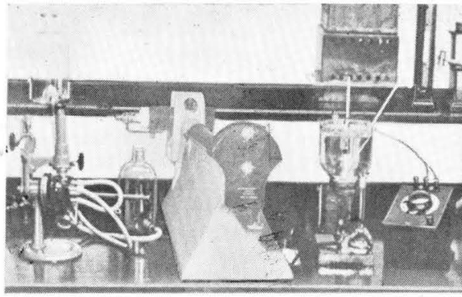
[1] *I.S.J.*, 1956, **58**, 110.
[2] *ibid.*, 1961, **63**, 72–74, 103–105, 137–139.
[3] "Sugarbeet Research". p. 136.
[4] *I.S.J.*, 1966, **68**, 26.
[5] *ibid.*, 1958, **60**, 144.
[6] *ibid.*, 1965, **67**, 150.

Laboratory methods & Chemical reports



Determination of water in molasses by the Karl Fischer method. E. A. Epps. *J.A.O.A.C.*, 1966, **49**, 551–554.—Comparative tests were carried out on determination of molasses water by vacuum drying and by the Karl Fischer method, based on oxidation of SO_2 by iodine in the presence of water. Agreement between the results given by the two methods was good, both giving values in close agreement with the known water contents. The Karl Fischer method gave higher values than vacuum drying but showed less scatter. It is recommended for official adoption.

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Spectrophotometric studies of the browning reaction in model systems and analytical investigation of the browning products isolated from them. V. Prey, R. Goller and F. Stressler. *Zeitsch. Zuckerind.*, 1966, **91**, 379–385.—The studies described earlier[1] were extended to model colouring substances from glyceraldehyde, galacturonic acid and fructose, alone and in the presence of glycine, diglycine and triglycine, so covering all the fragmentation products that can occur in alkaline medium during carbonatation. More precise information on the structure of the colouring substances was obtained by hydrogenation at 110°C and 120 atm w.g. in the presence of Raney nickel followed by hydrolysis with 6N and 2N HCl, respectively, and analysis by paper and thin-layer chromatography[2]. The 265 mμ absorption band was formed exclusively by compounds produced in highly alkaline medium from trioses and methylglyoxal and from hexoses and galacturonic acid. The 230 mμ band constituted products formed from the same compounds as above plus diglycine or triglycine. Hence the maximum at 230 mμ indicates the presence of a peptide as well as carbonyl compounds. The 330 mμ band indicates compounds formed by reaction between the carbonyl compounds mentioned and glycine, diglycine or triglycine, whereby both peptides, in contrast to the amino acid, react with the carbonyl compounds at low concentration. According to whether 2N or 6N HCl was used for hydrolysis, the hydrolysates always contained dihydroxyacetone, glyceraldehyde and methoxyglyoxal plus very little lactic acid, or lactic acid alone, respectively. Trioses and methylglyoxal were found in the colouring compounds formed from methylglyoxal, tri- and hexoses, while amino acids were found besides trioses and methylglyoxal in those colouring compounds formed from the carbonyl compounds and glycine. Neither glucose nor fructose was present in the hydrolysed colouring compound formed from invert sugar. The presence of trioses and methylglyoxal in the colouring compounds was attributed to hydrogenation of glycerol or 1,2-propanediol, the last being found alone in the hydrolysate of the colouring compound formed from methylglyoxal. It is concluded that the majority of the colouring compounds formed during beet sugar manufacture belong to the systems studied.

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Calcium carbonate precipitate as anion exchanger. W. Rathje, H. J. Delavier and H. Gelen. *Zeitsch. Zuckerind.*, 1966, **91**, 386–392.—Experiments were carried out to determine the causes of co-precipitation of non-sugars when calcium carbonate is formed. It was found that the $CaCO_3$ on precipitation becomes charged with Ca ions and adsorbs anions, the amount adsorbed being dependent to a great extent on their concentration in the solution. Adsorption of the di- and tri-basic amino acids studied was optimal at pH 11, while the monobasic acids were not adsorbed. The $CaCO_3$ should be removed at this pH before the adsorbed ions pass back into solution on addition of further CO_2. Second carbonatation serves only to remove the calcium and hydroxyl ions from the juice. Forty-two reference are given to the literature.

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Determination of molasses water content by titration with Karl Fischer reagent (dead-stop method) using a recording potentiometer. H. Schiwek. *Zucker*, 1966, **19**, 396–400.—Karl Fischer reagent was added dropwise to about 50 ml of methanol until the pen started tracing the titration curve for the water in the methanol. Titration was continued to the end-point, and then a pre-weighed molasses sample added to the methanol solution. Mixing was continued until the molasses was completely dissolved (10–25 min) and the water introduced with the molasses titrated. Plotting the tangents on the recorder chart gives the theoretical end-point and the amount of reagent added is read. If the titre of the reagent is known, the water content can be calculated by measuring the length of the trace on the recording chart, to which it is directly related. The sample should be sufficient to introduce 5–10 mg of water, i.e. 50–70 mg of undiluted molasses or 15–20 mg of 1:1 diluted molasses. Dilute samples should first be cooled to about 4°C to prevent evaporation during weighing. The reagent should be added and the solution mixed at a constant rate to give a uniform,

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[1] *I.S.J.*, 1966, **68**, 29.

[2] *See also* Binkley: *I.S.J.*, 1957, **59**, 64–66.

easily evaluated titration curve. Comparison of the results with those obtained by other methods, including vacuum drying and refractometric determination, showed that the proposed method gives results closest to the true water contents.

* * *

Degree of dispersion of colouring compounds in solutions. A. R. SAPRONOV. *Sakhar. Prom.*, 1966, **40**, (8), 10–14.—A concentrated solution of known colouring compounds isolated from sugar was poured into the lower half of one section of a cell, and a 1:4–1:6 dilute solution of the same compounds fed into the other section. The upper half of the first section was filled with distilled water. The cell was placed on the stage of a stereoscopic microscope and the partition separating the top and bottom halves of the first section removed. Measurements were then made, at short time intervals during several days, of the height (x) at which the colour intensity in the first and second sections was identical. The results are shown in graph form. The diffusion coefficient D was calculated by substituting values of x in an equation relating D and the ratio between the initial concentrations of the solutions in the sections, and from D the particle radius r was calculated (using the Stokes-Einstein formula) for the various colouring compounds. Omitting caramelin, which is not found in sugar production, it was found that the particle sizes did not exceed 10·0Å, suggesting that the compounds were on the borderline between molecular and colloidal systems. Subsequent tests with ethyl alcohol and pyridine solutions indicated that, since these generally did not affect the optical density of the colour solutions, most of the colouring compounds must be in a molecular state, only a small proportion being colloidal. No relationship was found between molasses colloid and colour contents. Particle size was found to affect both light absorption and the form of the U.V. spectral curves.

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Determination of saponin in sugar factory products. V. A. NAGORNAYA, R. G. ZHIZHINA and A. K. KARTASHOV. *Sakhar. Prom.*, 1966, **40**, (8), 39–44. While antimony pentachloride has been found to give accurate determinations of saponin in beet juices as well as white sugar[1], it is an unstable compound, giving off chlorine gas during storage and needing protection from moisture. Moreover, glassware that has come into contact with $SbCl_5$ must be rinsed with chloroform and conc. HCl, before washing with water, to prevent formation of a water-insoluble deposit of Sb_2O_5. Other methods of determining saponin are reviewed, and details given of a method using H_2SO_4. After dilution of 5 ml of raw juice to 100 ml with water, it is adjusted to pH 1 with HCl (1:3), boiled for 10 min and filtered hot through kieselguhr on a funnel. The sediment is washed with acidified water to remove all the sugar and dissolved on the filter in 20 ml of methyl alcohol previously heated to 65°C and which is added in small amounts. Five ml of the alcohol solution is transferred to a flask and hydrolysed with 5 ml of H_2SO_4, the red colour formed being measured at 560 mμ. A calibration curve gives the saponin content corresponding to the measured optical density. The mean square deviation was 2·3, and 90–103·5% of the calculated quantity of saponin was found. For saponin determination in pre-defecation mud, 40 ml of methyl alcohol was used instead of 20 ml, and the mean error was 4·15%. For saponin isolation from pre-defecation mud, 10 g of the mud is wetted, gradually dissolved in HCl and diluted with 300 ml distilled water. The pH is adjusted to 1 by adding ammonia and the saponin then precipitated as a floc.

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Entropy changes during crystallization of sucrose. N. A. RAMAIAH and R. C. GUPTA. *Sharkara*, 1965, **7**, 66–69.—The type of information obtainable from knowledge of the change in entropy of a temperature-dependent system is discussed generally and with reference to sucrose crystallization. It is postulated that the solubility of a substance in water increases with the number of hydroxyl groups; in the case of sucrose, which has eight hydroxyl groups, solvation of the molecules is made possible through the bonding of hydrogen with the water molecules. The carbohydrate molecule remains surrounded by water molecules and enters the solution phase, the number of water molecules involved depending on the availability of the hydroxyl groups. The solvated sucrose molecules will not crystallize until sufficient energy is acquired to rupture the water bonds, but even then only those desolvated molecules in which the rotation of the glucose and fructose moieties around the ether linkage permits formation of two hydrogen bonds, simulating formation of a triple bond, will be crystallizable.

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Effect of certain colouring bodies in sugar factory juices and syrups on sugar colour. H. ZAORSKA. *Gaz. Cukr.*, 1966, **74**, 157–162.—See *I.S.J.*, 1964, **66**, 260–262, 285–286.

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The design of an automatic sugar sampler. E. J. BUCHANAN. *S. African Sugar J.*, 1966, **50**, 672–675. An S.M.R.I.-designed sugar sampler for sugar entering and leaving the Durban bulk terminal is described. It consists of a stationary housing enclosing two roller bearings between which rotates a vertical shaft carrying a cutter. This comprises a horizontal arm, with a bevelled upper edge to prevent accumulation of sugar, to the end of which is attached a flat collector plate. The rotating arm passes through the sugar stream (the sampler is primarily intended for installation at the discharge end of a conveyor where the sugar falls freely) and then under a rubber scraper which discharges the sample unto a collecting bin. The dimensions of the sample cutter are such as to allow a 1-ounce sample to be held, the sample size depending also on the speed of rotation.

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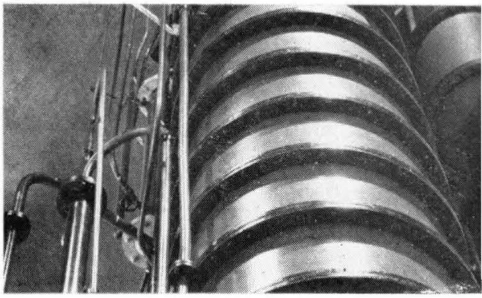
[1] WEST & GADDIE: *I.S.J.*, 1957, **59**, 225.

By-products



By-products of (the) sugar cane industry and their utilization. B. N. Pandey. *Indian Sugar*, 1966, **16,** 205–210.—The by-products discussed include cane trash, which is usable as animal fodder, as compost and, when finely ground, as a filler for plastics or linoleum. (The free sugars in the leaves and tops could be liberated by acid hydrolysis and fermented.) The many bagasse by-products mentioned include paper, board and newsprint, as well as resin and laminated plastic[1], furfural, xylose (for use in fodder yeast) and various pyrolysis derivatives. Carbonatation press mud can be used as manure, while its use for distemper and cement is limited by the presence of phosphate. Sulphitation press mud can yield wax, which it contains in amounts varying between 8% and 20%. Molasses utilization as animal fodder, in production of yeast and other fermentation products is also discussed, as is its use in many other products and as fertilizer, particularly for making up potassium deficiency.

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Sucroglycerides. G. Coppa-Zuccari. *ION Rev. Espan. Quím. Appl.*, **25,** 547–553; through *S.I.A.*, 1966, **28,** Abs. 346.—The properties and uses of sucroglycerides (complex mixtures of sucrose mono- and di-esters with mono-, di- and tri-glycerides) are summarized. Products containing $>70\%$ of sucrose ester are obtained from reaction mixtures containing >3 moles of sucrose/mole of triglyceride (reaction conditions are not given). Sucroglycerides are particularly effective as emulsifiers for water-in-oil systems, being superior to glycerine monostearate at levels of 2–4% on oil phase. Bread containing 1·5% of sucroglyceride expanded more on baking than did bread containing 2% of margarine, and resisted staling for long periods. Oxyethylated sucroglycerides have a very high resistance to alkaline hydrolysis and good detergent power (particularly coconut oil sucroglyceride); the detergency is greater than that of the corresponding sucrose esters.

* * *

Production of fungal protein from waste molasses. J. P. Shukla and S. M. Dutta. *Sharkara*, 1965, **7,** 102–106.—Experiments were made using cane molasses as nutrient for a *Rhizopus* strain, rich in methionine, which has been isolated at the National Sugar Institute. Tests in which the organism was grown on nutrients containing, respectively, sucrose plus a number of salts, and molasses plus salts, gave a mycelium yield of 15·7 g/100 g of sugars, containing 32·3% protein with the sucrose medium, and a yield of 37·12 g/100 g of sugars, containing 15·6% protein with the molasses medium.

Experimental data on the use of penicillin in the production of alcohol on the industrial scale in the north-east (of Brazil). W. Aquarone, J. B. P. Passos and R. Baruffaldi. *Brasil Acuc.*, 1966, **68,** (2), 18–25. An account is given of the effects of treating molasses mash (of 20–22°Bx at pH 4·5) in the whole of the process with potassium penicillin G, at the rate of 519 units/litre during three periods totalling 51 days; treating only the pre-fermentation mash with 1048 units/litre of penicillin during four periods totalling 62 days; and with sulphuric acid to the extent of 0·16 g/litre during three periods totalling 45 days. The results showed that penicillin was a better disinfectant and that the first treatment was preferable to the second, partial, treatment, both in effectiveness and economy.

* * *

Tallow-derived surfactants. A. Berne-Allen and L. Nobile. *Viginia J. Sci.*, 1965, **16,** 229–238; through *S.I.A.*, 1966, **28,** Abs. 579.—The preparation of polyoxyethylated glyceryl hexose tallowate (PGHT) from refined sugar, and some tests of the products are reported. Their properties can be varied by controlling the degrees of esterification, of extraction of glycerides from initial tallow acid esters, or of oxyethylenation, or by blending the various products so obtained. A detergent based on 5% PGHT was superior to two commercial brands based on tetrapropylbenzenesulphonate and a long chain alcohol adduct, respectively. Further possible applications are briefly discussed.

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Biologically degradable sugar esters as detergents. R. M. Ismail and H. Simonis. *Fette-Seifen-Anstrichm.*, 1965, **67,** 345–347; through *S.I.A.*, 1966, **28,** Abs. 580.—The preparation of new sucrose esters of substituted fatty acids is described. Alkyl esters of ϵ-aminocaproic acid were acylated by one of four methods. Equi-molecular amounts of the product and of sucrose were dissolved in non-miscible solvents; on stirring together vigorously, interesterification occurred. The surface tension of aqueous solutions of the resulting acylaminocaproic acid sucrose esters depended on the number of C atoms in the acyl group, reaching a minimum of 30–35 dynes/cm when this number was 8–14.

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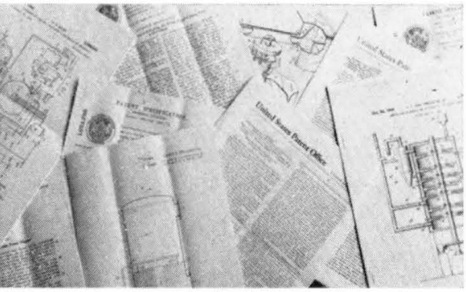
[1] *See also I.S.J.*, 1967, **69,** 43–44.



Patents

UNITED KINGDOM

Producing sugar from sugar-bearing raw material. S. Levinton, K. J. Koehler, E. P. G. Harsanyi and F. G. Lippe. **1,041,075.** 9th May 1963; 1st September 1966.—See U.S.P. 3,215,559[1].

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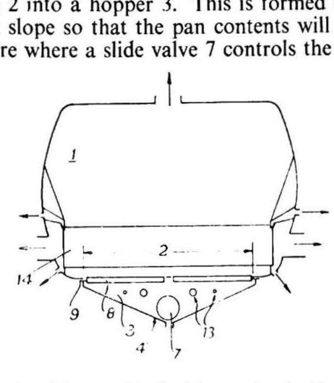
Producing L-glutamic acid. Asahi Kasei Kogyo K.K., of Osaka, Japan. **1,041,734.** 13th March 1963; 7th September 1966.—An L-glutamic acid producing micro-organism [*Microbacterium, Micrococcus, Brevibacterium* or *Corynebacterium* (*Microbact. ammoniaphilum* ATCC No. 15354)] which requires biotin for its growth is inoculated in a culture medium containing biotin (10—100μg/litre) in excess of the amount required for maximum growth, as well as other nutrients (cane molasses, beet molasses, Steffen waste). The micro-organism is cultured under anaerobic conditions, adding (25–500 mg/100 ml) polyethylene glycol monostearate having the formula $C_{17}C_{35}COO.(CH_2.CH_2O)_nH$, where $n = 5–35$ (when the optical density of the medium reaches a value between 0·3 and 0·4).

* * *

(Vacuum pan) draining device. Soc. Fives Lille-Cail, of Paris 8e, France. **1,042,524.** 9th July 1963; 14th September 1966.

The horizontal vacuum pan 1 is provided with vertical heating plates 14 below which is a longitudinal opening 2 into a hopper 3. This is formed of plates 4 which slope so that the pan contents will drain to the centre where a slide valve 7 controls the outflow.



The opening 2 is provided with a valve in the form of a horizontal plate 8 which rotates through 90° about its longitudinal axis between an open position in which it allows the massecuite to drain into hopper 3 without resistance, and a closed position when only a slight opening remains; syrup admitted to the hopper 3 by way of pipes 13 rises through the slight opening, ensuring that it dies not become clogged with crystals, and also providing a uniform feed over the whole length of the pan.

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Purifying sugar solutions and juices. Rohm & Haas Co., of Philadelphia, Pa., U.S.A. **1,043,102.** 26th March 1964; 21st September 1966.—The solution or juice is first contacted with a strongly acidic, relatively highly cross-linked cation exchange co-polymer resin (having a macroreticular structure) in which the cross-linking agent is present to the extent of 10·5–50% by weight, and subsequently with a relatively less cross-linked strongly acidic cation exchange copolymer resin in which the cross-linking agent is present to the extent of 1–10% by weight. Both resins are in the H^+-form and contain sulphonate or sulphate groups as strongly acidic polar groups. The first resin is regenerated with dilute sulphuric or hydrochloric acid, while the second is regenerated by treatment first with aqueous ammonia and/or caustic soda and/or sodium chloride, and subsequently with dilute hydrochloric or sulphuric acid.

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Extraction of sugar from molasses. Soc. Italiana per l'Industria degli Zuccheri, of Genova, Italy. **1,043,655.** 12th March 1965; 21st September 1966.—Molasses [of $\not>$45°Bx (15–30°Bx)] is treated with an aqueous solution of a water-soluble salt (chloride, nitrate or acetate) of an alkaline earth metal (barium) and (subsequently) with a solution of an alkali metal hydroxide (KOH, NaOH) or ammonia (at 60°–100°C) to precipitate the basic saccharate of the alkaline earth metal. The precipitate is separated and decomposed in the presence of water by means of carbon dioxide to give sucrose in solution and an insoluble carbonate which is separated and treated with acid to convert it to the original salt and to liberate CO_2 for use in decomposing further saccharate.

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Multi-tube evaporators. Soc. Fives Lille-Cail, of Paris 8e, France. **1,045,168.** 17th June 1963; 12th October 1966.

The single-pass evaporator is provided with an assembly of tubes mounted between upper and lower

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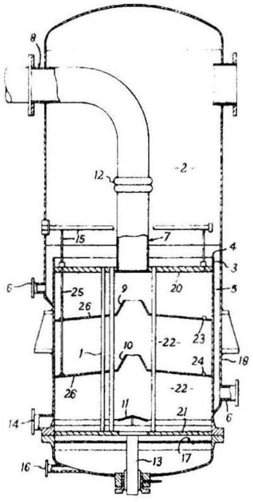
[1] *I.S.J.*, 1967, **69**, 92.

Copies of Specifications of United Kingdom Patents can be obtained on application to The Patent Office, Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent (price 4s 6d each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C. 20231 U.S.A. (price 50 cents each).

tube plates 20 and 21 within the casing 3. Steam is supplied from above through an inlet pipe 8, 7 the upper and lower parts of which are separated by an expandable bellows 12. Condensate formed on the outside of the tubes falls onto sloping plates 26 and so drain to the periphery of the chamber where channels in the plates allow it to fall to the bottom of the chamber, to be withdrawn through axial pipe 13 or peripheral pipe 14. Baffles 9, 10, 11 are arranged to distribute the steam throughout the whole height of the tube chamber and holes 23 in plates 26, provided with flanges 24, allow free upward passage of incondensable bases. Alternatively these gases are collected from below each plate 26 by pipes 25 and are removed through extraction pipes 15.



The juice fed to the evaporator through inlet pipe 16 is heated in its passage up the tubes and leaves the upper tube plate 20 as a mixture of vapour and concentrated juice. It is held above the plate 20 by a peripheral flange at the top of casing 3 so that the concentrated juice overflows the edge 4 and collects in the annular chamber 5 between the tube casing 3 and outer casing 18. From this chamber it is withdrawn through port 6 which may be at any height appropriate to the product, as indicated by the two alternatives illustrated.

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Producing sucrose benzoate. Velsicol Chemical Corporation, of Chattanooga, Tenn., U.S.A. **1,045,182.** 16th July 1963; 12th October 1966. Benzoyl chloride (6–10 moles), $(12\frac{1}{2}$–$33\frac{1}{3}\%)$ aqueous sucrose (1 mole) and an alkali (KOH, NaOH) are intimately mixed in the presence of a water-immiscible solvent [having a boiling point of 30°–175°C (benzene, toluene, xylene, ethylbenzene, chlorobenzene, chlorotoluene, methylene dichloride, chloroform carbon tetrachloride, tetrachloroethylene, ether, di*iso*propyl ether, or a combination of two or more of these)] which is capable of dissolving benzoyl chloride and sucrose benzoate but is inert to the reactants, maintaining at —15° - 50°C, and thereafter separating the solvent and its content of sucrose benzoate (10–75%), (washing with alkali) and distilling off the solvent.

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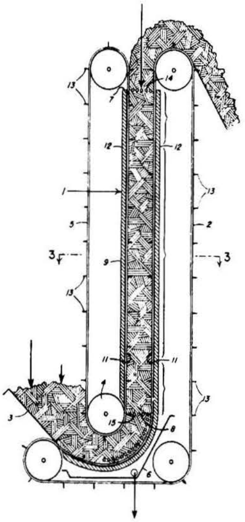
Cane juice extraction. Honolulu Iron Works Company, of Honolulu, Hawaii, U.S.A. **1,045,190.** 16th August 1963; 12th October 1966.

The extraction device is based on the displacement of sugar containing juice from prepared cane by displacement within an interzone having finite limits which is located between the water zone and the concentrated juice zone. A supply of prepared cane is carried by a conveyor 2 from a saturating tank 3, and brought to the bottom of a vertical displacement apparatus 1. It passes around a roller 4 which carries the end of a conveyor 5, the relative speeds of conveyors 2 and 5 being so arranged that the cane is subjected to a precompression, the rich juice in excess of that required to fill the voids in the mass of cane being expressed and collected in sump 6. The cane then passes up the vessel 1, emerging as a mass of sugar free wet bagasse at the top, ready for dewatering. The cane travels upwards, the initial precompression maintained by the rectangular cross-section of the vessel, slippage being prevented by the flights 11 on conveyors 2 and 5. Its juice content is displaced by water injected through inlet 14 near the top of the vessel, the force of gravity carrying it downwards while juice is withdrawn through the outlet 15 near the feed end 8. The relative rates of cane and water admission and juice withdrawal are such that the interzone remains stationary.



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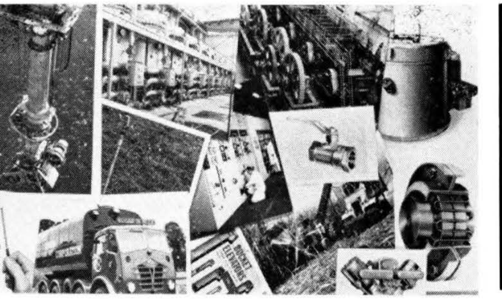
Beet harvester. C. J. Steketee, of Driewegen, Holland. **1,045,390.** 21st September 1965; 12th October 1966.



Trade notices

Statements published under this heading are based on information supplied by the firm or individual concerned. Literature can generally be obtained on request from the address given.

Cane mechanization. Thomson Machinery Co. Inc., Thibodaux, La., U.S.A.

Details are available of the "Duncaña" combine harvester and of the "Atlas" portable transloader. Both machines were designed by R. A. DUNCAN, formerly of the H.S.P.A., whose company, International Cane Machinery Corp., was acquired by Thomson Machinery Co. Inc. The "Duncaña" combine is a one-row cut-load harvester, prototypes of which (Fig. 1) in Puerto Rico have attained a 98% pick-up of cane, producing an average of 40 tons of cane per hr (in 65-ton/acre cane under all conditions), at a cost averaging less than half of that with hand cutting of cane. The harvester is powered by one rear-mounted diesel engine and is designed primarily for heavy recumbent cane in the range 35-115 tons/acre. Only one operator is required. A crawler tractor acts as prime mover, with the cutting heads and windrow assemblies in front of the tractor, which may be sold as a separate unit or as a single unit with the "Duncaña" harvester. The harvester operates at 2½ m.p.h. and cuts 2 acres per hr, four or six rows of cut cane being placed on a single heap row for pick-up by grab or by continuous loaders. One of two basic cutting heads is used: one for hilled-up or flat culture cane, and the other for irrigation furrow culture. A new "Duncaña" harvester with two-row continuous cut-windrower mechanism is also scheduled for production.

Fig. 1

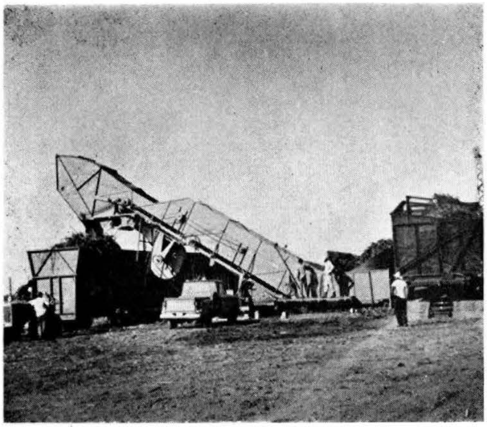


Fig. 2

The "Atlas" portable dry cleaner-transloader (Fig. 2) removes trash, dirt and debris from the cane during transloading by a dry cleaning process, increasing its value by an average of 20–40 cents per ton.

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PUBLICATIONS RECEIVED

DELIMING OF THIN JUICE WITH "IMAC" RESIN. Industrieele Mij. Activit N.V., Postbox 240-C, Amsterdam, Holland.

Full details are given of the process for deliming thin juice by replacing the Ca^{++} ions in the juice with Na^{+} ions to prevent evaporator scaling, so maintaining rapid processing, particularly when deteriorated beets are being processed.

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PERMUTIT ION EXCHANGE WATER SOFTENERS. The Permutit Co. Ltd., Pemberton House, 632/652 London Rd., Isleworth, Middx., England.

Technical Publication No. 93, a new booklet from The Permutit Co. Ltd., explains the advantages and uses of softened water in various industrial fields including application for boiler feed water treatment. Operation of Permutit ion exchange softeners is described with notes on selection of the appropriate type, and descriptions given of the range of automatic and manually controlled water softeners and ancillary equipment offered by Permutit, including an automatic water hardness tester.

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Dunford & Elliott licensing agreement with CEKOP.—Dunford & Elliott Process Engineering Ltd. have signed a 10-year licensing agreement with CEKOP, of Poland, providing for the manufacture and sale to the sugar and chemical industries in Poland and all Comecon countries of "Rotary Louvre" dryers and coolers designed by Dunford & Elliott. This agreement follows the sale of five sugar dryers to CEKOP for delivery in March 1967.

Commission International Technique de Sucrerie

13th CONGRESS, 1967

The programme of the 13th Congress of the C.I.T.S. in Falsterbo has been announced, as follows:

Monday, 5th June 1967

Registration at the office of the C.I.T.S. in the Falsterbohus Hotel.
17.00 Reception by the Svenska Sockerfabriks Aktiebolaget (Swedish Sugar Corporation)

Tuesday, 6th June 1967

9.30 Working session
13.30 Luncheon
15.00 Working session
9.30 An excursion by motor coach will be arranged for the ladies. Luncheon will be served during the excursion.

Wednesday, 7th June 1967

9.00 Working session
12.00 Luncheon
13.30 Departure by motor coach for the technical research laboratories of the Swedish Sugar Corporation in Arlöv.

Thursday, 8th June 1967

9.30 Working session
13.00 Luncheon
15.00 Working session
19.00 Dinner for the members and their ladies by invitation of the Swedish Sugar Corporation (*Informal dress*)

Friday, 9th June 1967

9.30 An excursion by motor coach will be arranged to the beet sugar factory in Ortofta and the refinery in Arlöv. Luncheon will be surved during the excursion.

Further papers to be presented* at the Congress include the following:

Crystallization

D. AHARI and J. GENOTELLE (France): Utilisation des ultra-sons pour le contrôle de la cristallisation—Application à la cuisson industrielle.

F. HEITZ and N. TIKHOMIROFF (France): Utilisation du microcalorimètre Calvet pour l'étude de la cristallisation des solutions sucrées.

G. MANTOVANI and F. FAGIOLI (Italy): Sucrose dissolution in the presence of non-sugars.

G. MANTOVANI, G. GILLI and F. FAGIOLI (Italy): Habital variation of sucrose in the presence of non-sugars relating to its crystalline structure.

G. PIDOUX (France): Le problème du choix d'une température de cristallisation.

W. J. DUNNING (U.K.): Some features of the surface of sucrose crystals and their rôle in crystal growth.

Miscellaneous

D. GROSS (U.K.): The fractionation and characterization of sugar colour by modern separation methods.

* See also *I.S.J.*, 1967, **69**, 94.

Brevities

Sugar school in Australia[1].—The Minister for Education announced in December that a sugar chemistry training centre is to be set up in Mackay, Queensland. Two courses will be available: a cane tester's course of 20 weeks and a certificate course in sugar chemistry which will comprise a four-year course, each with 20 weeks at the school in the off-season and work at the mills during the crushing season. Applications should be addressed to Mackay Technical College. Mackay was chosen as the site for the centre because it is central in Queensland and in the sugar industry, it has a research centre and experiment station, and there are mills close to the city.

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Mauritius sugar crop, 1966.—Harvesting of the 1966 crop started on the 22nd June and ended on the 20th December[2]. The 23 mills crushed 4,766,649 long tons, i.e. about 1,124,000 tons less than the record figure of 1965. Total sugar output amounted to 552,915 tons; average sugar recovery was 11·60% and the average cane yield reached the figure of 23·3 tons per acre as against 29·0 tons per acre in 1965. The yield of sugar per acre amounted to 2·71 tons. The 1966 crop was thus very disappointing and showed a drop of more than 100,000 tons over the 1965 crop; the fall in sugar production was due to a cyclone and a prolonged drought which affected plantations materially. Local sales of sugar amounted to 28,520 tons, compared with 27,871 tons in 1965, while exports totalled 561,559 and 569,282 tons, respectively. The largest proportion was imported by the U.K. (424,769 tons) while the remainder was sold to Canada (111,970 tons), the U.S.A. (14,500 tons) and Malaysia (10,320 tons).

Hawaiian cane weeds[3].—A new "Handbook of Hawaiian Weeds", a fully-illustrated guide, has been published by the H.S.P.A. It is a paperback volume of almost 500 pages, and provides information on the family name, botanical name, common name, description, propagation, habitat, and history of several hundred weeds, each provided with a full-page sketch. The book is available from the Experiment Station, H.S.P.A., 1527 Keeaumoko St., Honolulu, Hawaii, 96822 U.S.A., at a cost of $5.00.

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Portuguese East Africa sugar production, 1965/66[4].—Production in the 1965/66 season amounted to 235,750 tons, compared with 212,018 tons in 1964/65.

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Libyan beet sugar project[5].—The Government of Libya has engaged a Polish institute to carry out a survey and to draw up a report by October 1967 on the growing of sufficient beet in the neighbourhood of Tripoli to supply a sugar factory. The institute has already been engaged for production of a design for such a factory.

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[1] *Producers' Review*, 1966, **56**, (12), 17, 27.
[2] *Mauritius Sugar News Bull.*, 1966, (12).
[3] *Sugar y Azúcar*, 1967, **62**, (2), 46.
[4] *Overseas Review* (Barclays D.C.O.), January 1967, p. 23.
[5] *Zeitsch. Zuckerind.*, 1967, **92**, 38.

United Kingdom Sugar Imports and Exports[1]

IMPORTS	1966	1965
Refined and White Sugar	*Long tons, tel quel*	
Canada	2	2
W. Indies & Guyana	3,307	1,794
Other Commonwealth	21	8
Belgium	87	46
Cuba	—	2
Czechoslovakia	32,021	24,266
Denmark	—	1
France	858	5,151
Germany, East	1,427	1,894
Germany, West	503	1
Ireland	12,530	8,339
Poland	3,721	1,409
U.S.S.R.	1,421	1,624
Other Foreign	91	278
	55,989	44,815
Raws—Cane and Beet		
Australia	415,678	401,758
Barbados	135,583	128,835
British Honduras	17,123	24,063
Fiji	132,297	166,622
Guyana	59,101	119,051
India	96,948	74,120
Jamaica	211,198	257,606
Leeward Is.	35,739	36,744
Mauritius	439,508	404,691
Rhodesia	20,163	34,439
Swaziland	83,977	86,240
Trinidad & Tobago	122,944	139,567
Commonwealth Raws	1,770,259	1,873,736
Argentina	500	—
Brazil	162,191	52,558
Colombia	30,040	—
Cuba	65,359	90,569
Czechoslovakia	—	183
Dominican Republic	—	10,328
France	824	24,204
Haiti	9,470	—
Malagasy	12,612	—
Mexico	12,703	—
Poland	5,882	16,172
South Africa	62,086	19,938
Yugoslavia	250	—
Other Foreign	3	2
Foreign Raws	361,920	213,954
Grand Total Raws	2,132,179	2,087,690

EXPORTS	1966	1965
	Long tons, tel quel	
Bahamas/Turks & Caicos Is.	954	981
Bahrein	270	6,341
Barbados	496	369
Bermuda	684	539
British Honduras	1,072	580
Canada	1,289	538
Ceylon	907	1,944
Cyprus	9,163	10,359
Falkland Is.	90	76
Gambia	807	458
Ghana	19,171	556
Gibraltar	994	1,443
Guyana	70	104
Hong Kong	303	3
Indian Ocean Islands	281	590
Jamaica	93	125
Kenya	3,237	2,123
Leeward Is.	1,000	727
Malaysia	22,691	18,831
Malta	857	1,002
Nigeria	24,918	25,016
Sierra Leone	10,181	10,228
Singapore	9,072	*
South Arabia	473	966
Tanzania	34	82
Trinidad & Tobago	1,294	155
Trucial States	816	9,499
Windward Is.	1,231	596
Other Commonwealth	147	194
Total Commonwealth	112,595	94,425
Belgium	438	27
Bulgaria	—	9,340
Burma	286	149
Cameroons	8	358
Chile	437	5,861
France	124	96
French Pacific	3,730	3,443
Germany, West	593	1,491
Greece	10,997	5,119
Iceland	3,809	1,428
Iran	1,357	975
Iraq	1	—
Ireland	6,061	6,178
Israel	773	276
Italy	105	30
Japan	1	3
Korea, South	1	492
Kuwait	254	24,104
Lebanon	693	2,417
Liberia	735	906
Libya	446	784
Muscat & Oman	53	42
Netherlands	25,044	10,958
Norway	40,613	53,844
Saudi Arabia	514	4,894
Spain	1,349	4
Spanish Possessions Overseas	166	316
Sweden	2,382	1,965
Switzerland	55,219	42,005
Togo	404	284
Tunisia	24,782	20,564
U.A.R.	60	152
U.S.A.	3,657	4,326
Other Foreign	139	281
Total Foreign	185,181	203,112
Grand Total	297,776	297,537

* Export figure for 1965 included in that of Malaysia.

Argentina sugar production restriction[2].—The Argentine Government has limited sugar production in 1967 to 750,000 tons. Under new legislation setting up of new mills is prohibited, as is the expansion of existing ones. On the other hand subsidies and credit facilities will be available to planters who turn to other crops.

* * *

Bagasse board in Argentina[3].—A new factory is to be set up in Tucuman to manufacture board from bagasse for use in the construction of pre-fabricated houses. Cia. Azucarera Tucumana has arranged with the West German firm of Ferrostahl for the supply of equipment and technical assistance. The equivalent of about U.S. $5,000,000 will be invested in the new plant which is expected to produce 3 million square metres of board per year.

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[1] C. Czarnikow Ltd., *Sugar Review*, 1967, (800), 33.

[2] *The Times*, 14th February 1967.

[3] *Fortnightly Review* (Bank of London & S. America Ltd.), 1966, **31**, 615.

Brevities

Irish sugar campaign, 1966/67[1].—Sugar production in the 1966/67 campaign reached 111,492 metric tons, raw value, compared with 117,661 tons in 1965/66, and was produced from 722,485 tons of beet, as against 785,324 in the previous campaign. This harvest represented a better yield, being obtained from 21,840 hectares, which compared with an area of 26,280 ha harvested in 1965.

* * *

Brazil sugar production plans[2].—The Instituto do Açúcar e do Alcool has announced its plan for the 1967/68 sugar crop, which calls for production of 66·5 million bags (3,990,000 metric tons) including 44·3 million bags (2,658,000 tons) in the Centre-South region (output in the State of São Paulo has been fixed at 30·6 million bags or 1,836,000 tons) and 22·2 million bags (1,332,000 tons) in the North and North-East; the States of Pernambuco, Alagoas and São Paulo are to produce raw sugar for export to the U.S.A. The plan was to be revised before the 15th March, when the I.A.A. was to decide the amount of raw sugar to be produced for export and on the production of white sugar.

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West Germany sugar production, 1966/67[3].—The West German Sugar Association has issued the final results of the 1966/67 sugar campaign. Total beets processed amounted to 12,508,232 metric tons, compared with 10,357,148 tons in the 1965/66 campaign. This increase of more than two million tons was due to the more favourable weather conditions during the 1966 growing period. Though the sugar beet area was somewhat less than in 1965 the beet harvest was much greater, nearly reaching the quantity originally expected. Total sugar production amounted to 1,742,246 metric tons, refined value (1,935,810 metric tons, raw value), plus about 20,000 tons extracted from molasses. At this figure, sugar recovery was lower than expected, and production will not be sufficient to meet domestic requirements during the year 1966/67. However, enough sugar will be available from existing stocks as well as from imports under existing trade agreements with France and East Germany so that no additional imports will be necessary.

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Sugar factory proposals for Assam.—The Government of Assam State in India is examining the prospects of setting up two sugar factories during the Fourth Plan, with a crushing capacity of 1000–1500 metric tons of cane per day[4].

* * *

By-products developments in Brazil[5].—The President of the Instituto do Açúcar e do Alcool recently announced that a factory for the production of protein from waste molasses, for enrichment of cattle feed, would soon be completed. Possibilities of utilizing molasses itself for enrichment of cattle feed are to be examined. The Institute is also examining the possibility of making chip-board from bagasse as well as the production of plastics using raw sugar as half the raw material required. The Instituto also plans to construct a sugar terminal at the port of Recife, in Pernambuco.

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Morocco sugar expansion[6].—In the 1965/66 campaign the Sidi Slimane sugar factory in the Gharb district sliced 3000 tons of beet per day while the Souk-es-Sebt factory in the Tadla sliced 3600 tons. The Mechra Bel Ksiri factory will be of 4000 tons/day capacity and will start operations in May 1968. The beet area has risen from 8600 ha in 1963/64 to 9100 ha in 1964/65, 15,000 ha in 1965/66 and 20,000 ha in 1966/67 while the beet worked has increased correspondingly from 178,000 tons to 176,000, 380,000 and 550,000 tons, respectively, yielding 21,900, 23,800, 49,600 and 72,000 tons of sugar.

United States Sugar Supply Quotas, 1967

	Import Authorization *First Quarter*	*Import Authorization* *Second Quarter*	*Total Quota*
	—(*short*	*tons, raw*	*value*)—
Domestic Beet			3,025,000
Mainland Cane			1,100,000
Hawaii			1,252,543
Puerto Rico			1,140,000
Virgin Islands			15,000
Philippines	278,840	243,629	1,126,020
Argentina	11,790	16,833	52,164
Australia	186	—	185,499
Bolivia	—	—	5,048
Brazil	100,120	96,759	424,042
British Honduras	—	5,458	11,370
British West Indies	30,697	44,263	156,078
Colombia	9,080	11,755	44,872
Costa Rica	9,180	15,734	51,379
Dominican Republic	108,379	145,896	424,042
Ecuador	14,075	14,563	61,699
Fiji	65	—	40,707
French West Indies	11,367	12,502	49,097
Guatemala	18,181	16,520	43,298
Haiti	9,539	8,655	23,558
India	—	49,576	74,200
Ireland	—	—	5,351
Malagasy	—	—	8,759
Mauritius	—	—	17,004
Mexico	148,705	150,666	433,578
Nicaragua	11,357	12,502	51,379
Panama	2,763	9,913	31,410
Peru	88,522	68,534	338,225
Salvador	7,432	7,313	31,752
South Africa	31,642	—	54,619
Swaziland	250	—	6,699
Taiwan	3,337	48,149	77,291
Thailand	506	—	17,004
Venezuela	3,967	5,926	21,313
Totals	900,000	1,000,000	10,400,000

Bagasse newsprint in India.—The Union Government proposed to establish a factory for the manufacture of newsprint from bagasse during the Fourth Plan[7]. The project report for the location of the plant has been prepared by a team of foreign experts on the basis of the feasibility study of the National Industrial Development Corporation, which favours location at Motihari.

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Uganda sugar production, 1966[8].—According to an announcement from the Sugar Factories' Association in Kampala, sugar production in 1966 reached 125,476 tons, compared with 115,669 tons produced in 1965 and 123,551 tons in 1964.

* * *

Dominican Republic sugar production targets[9].—Having set production from the 1965/66 season at 876,000 short tons, the Government of the Dominican Republic has now authorized for production from the 1966/67 crop a total of 875,000 short tons of sugar. Of this amount, 130,000 tons will be reserved for domestic consumption while the current entitlement for 1967 in the U.S.A. is 395,000 tons.

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[1] F. O. Licht, *International Sugar Rpt.*, 1967, **99**, (4), 9.

[2] *B.O.L.S.A. Review*, 1967, **1**, (2), 90.

[3] F. O. Licht, *International Sugar Rpt.*, 1967, **99**, (4), 6.

[4] *Indian Sugar*, 1966, **16**, 521.

[5] F. O. Licht, *International Sugar Rpt.*, 1967, **99**, (4), 13.

[6] *Zeitsch. Zuckerind.*, 967, **92**, 38.

[7] *Indian Sugar*, 1966, **16**, 521.

[8] F. O. Licht, *International Sugar Rpt.*, 1967, **99**, (4), 14.

[9] C. Czarnikow Ltd., *Sugar Review*, 1967, (799), 29.