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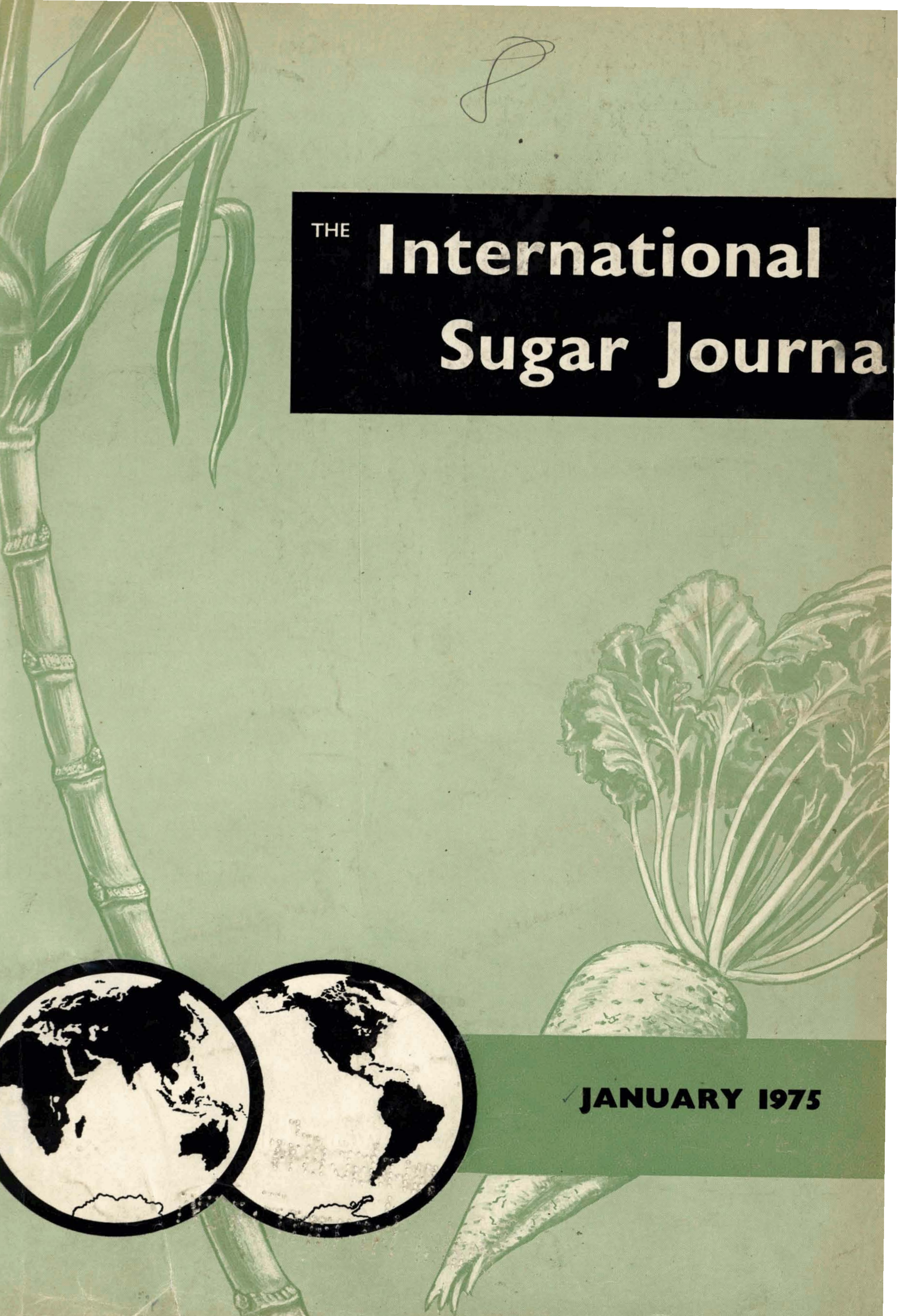

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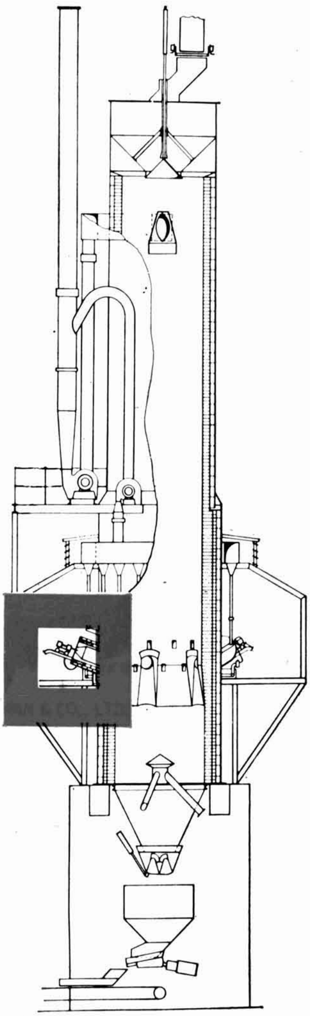

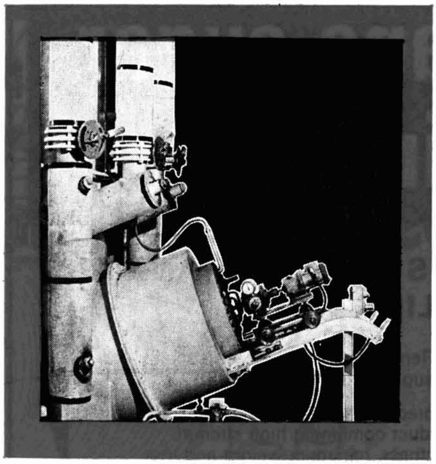

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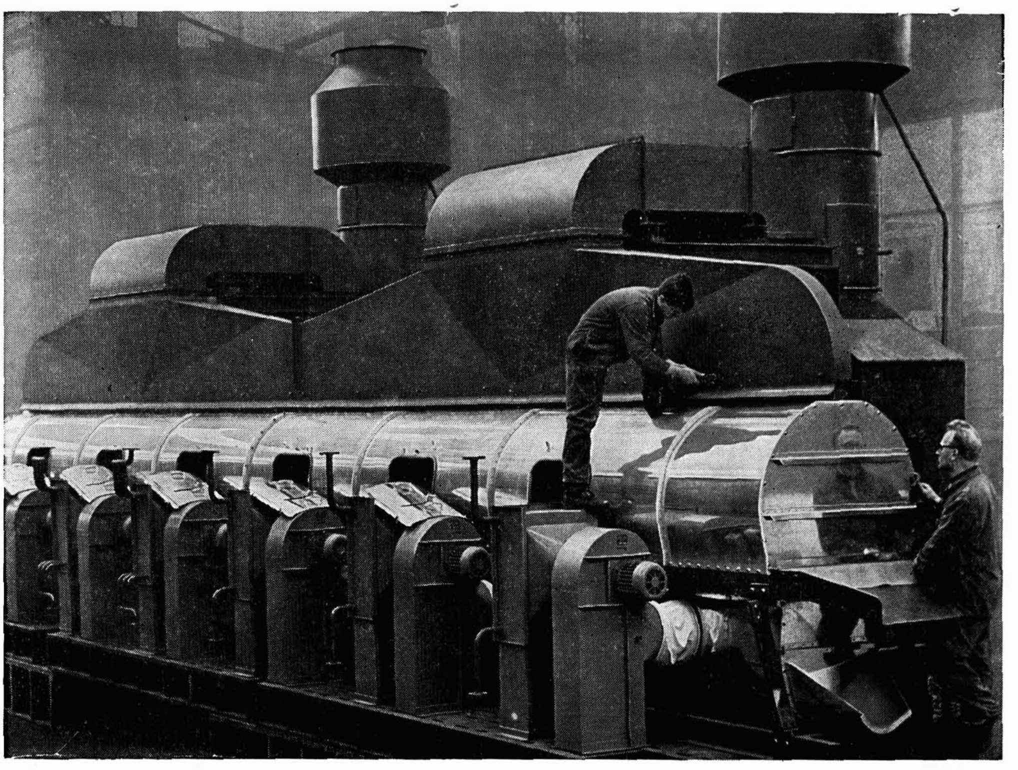

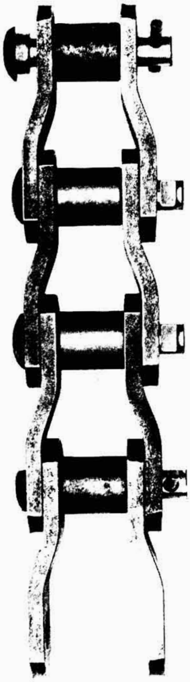

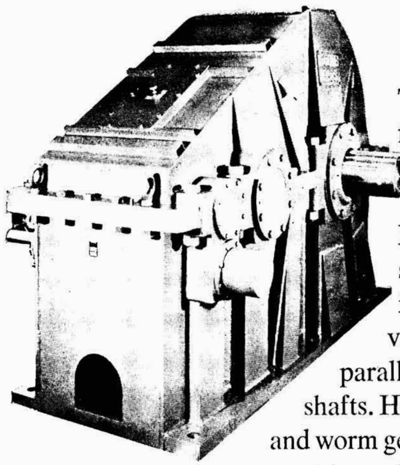

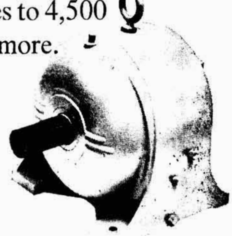

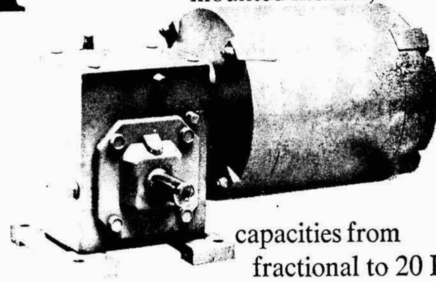

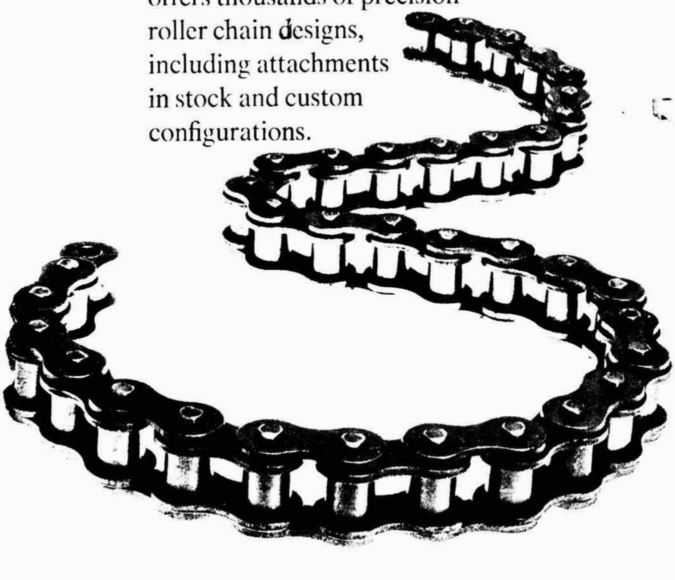

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La régularité du cristal et son influence sur la qualité du sucre. 1ère partie. D. HIBBERT, R. T. PHILLIPSON, W. WOODWARK, B. T. BONNER et B. MACKAY. *p*.3–8

L'efficacité de la séparation de l'égout-mère de la surface des cristaux de sucre blanc s'améliorant d'autant plus que les cristaux individuels se rapprochent de la perfection, des échantillons individuels de sucre blanc des usines de la British Sugar Corporation ont été analysées du point de vue des cendres conductimétriques, coloration, turbidité, pertes au séchage et indice de régularité des cristaux (CRI). Les valeurs hebdomadaires d'échantillons mélangés sont mis en tableau pour chaque usine et sont discutées en fonction des conditions connues du chantier de cuisson, c.à.d. profil de l'appareil à cuire et paramètres d'exploitation.

Les resultats, obtenus au cours des campagnes 1972/73 et 1973/74, révèlent certaines contradictions et quelques cas individuels sont mis en évidence pour être expliqués. L'emploi d'agitateurs dans les appareils à cuire et la compétence du cuiseur se révèlent significatifs pour l'obtention de bons resultats.

* * *

Les constituants du sucre brut qui influencent le raffinage. F. G. CARPENTER, M. A. CLARKE et E. J. ROBERTS. *p*. 9–12

Alors que le jus de canne peut être défini à 96–97% par l'analyse, en termes de constituants connus, la proportion du restant est fortement réduite au cours de la fabrication, à tel point que les substances non identifiées ne se retrouvent qu'en très faibles quantités (ppm) dans le sucre raffiné. Cependant, l'identification et l'analyse quantitative de ces constituants mineurs est nécessaire pour améliorer la fabrication. L'article passe l'état actuel de l'identification et de la mesure de ces constituants mineurs en revue, décrit certains progrès récents et considère que cette nouvelle information peut être utilisée. Le groupe est subdivisé en constituants de cendres, colorants et composants de floc. Une attention particulière est accordée aux métaux lourds dans le sucre brut et raffiné. On relève aussi que, si les pigments végétaux constituent une partie des colorants, d'autres colorants (p.ex. les mélanoïdines et caramels) qui constituent une partie importante de la fraction de colorants totaux du sucre, ne sont pas de pigments végétaux. En outre, certaines substances incolorés sont des précurseurs de coloration. Des techniques d'analyse des colorants sont brièvement décrites.

Regelmässigkeit der Kristalle und ihr Einfluss auf die Qualität. Teil I. D. HIBBERT, R. T. PHILLIPSON, W. WOODWARK, B. T. BONNER und B. MACKAY. *S*. 3–8

Da sich der Muttersirup von der Oberfläche von Weisszuckerkristallen um so besser abtrennen lässt, je vollkommener die Einzelkristalle ausgebildet sind, wurden einzelne Weisszuckerproben aus Fabriken der British Sugar Corporation auf Leitfähigkeitsasche, Farbe und Trübung sowie auf Trocknungsverluste und Index der Kristallregelmässigkeit (CRI) untersucht. Die wöchentlichen Werte für jedes Kriterium sind für die verschiedenen Proben in Tabellen zusammengestellt und im Zusammenhang mit den bekannten Zuckerhausbedingungen, d.h. Form des Kochapparates und Prozessparameter, diskutiert. Die in den Kampagnen 1972/73 und 1973/74 erhaltenen Resultate zeigen gewisse Widersprüchlichkeiten, weswegen für die Deutung einige Einzelfälle ausgesondert wurden. Wesentlich für gute Ergebnisse war der Einsatz von Kochmasserührern sowie eine hohe Fertigheit des Kochpersonals, mit denen die Abwesenheit von Kristallaggregaten gesichert werden konnte.

* * *

Die Zusammensetzung von Rohzucker und ihr Einfluss auf die Raffination. F. G. CARPENTER, M. A. CLARKE und E. J. ROBERTS. *S*. 9–12

Während 96 bis 97% des Rohsaftes bei der Untersuchung auf seine Inhaltsstoffe erfasst werden, wird der Rest im Laufe der Verarbeitung der Menge nach erheblich reduziert, so dass die nicht identifizierten Substanzen nur in sehr kleinen Mengen (mg/kg) im raffinierten Zucker gefunden werden. Die Identifizierung und quantitative Bestimmung dieser in geringer Menge vorhandenen Bestandteile ist jedoch notwendig, damit die Verarbeitung verbessert werden kann. In der vorliegenden Arbeit wird der augenblickliche Stand hinsichtlich der Identifizierung und Messung dieser Bestandteile aufgezeigt. Ausserdem werden neuere Fortschritte beschrieben und Anhaltspunkte dafür gegeben, welchen Nutzen man aus diesen neuen Informationen ziehen kann. Die Gruppe wird in Aschebestandteile, Farbstoffe und Floc-Bildner unterteilt. Besonderes Augenmerk wird auf die im Rohzucker und im raffinierten Zucker enthaltenen Schwermetalle gerichtet. Es wird ausserdem herausgestellt, dass die Pflanzenfarbstoffe nur einen Teil der Farbestoffe bilden; die anderen Farbstoffe (z.B. Melanoidine und Karamelsubstanzen), die den grössten Anteil der Farbstofffraktion im Zucker ausmachen vor, sind keine Pflanzenfarbstoffe. Zudem kommen farblose Substanzen vor, welche die Vorstufe von Farbstoffen sind. Die Methoden, die sich zur Farbstoffanalyse eignen, werden kurz beschrieben.

Regularidad de cristales y su influencia sobre calidad de azúcar blanco. Parte I. D. HIBBERT, R. T. PHILLIPSON, W. WOODWARK, B. T. BONNER y B. MACKAY. *Pág*. 3–8

Creciendo la eficiencia de separación de madre-licor del superficie de cristales de azúcar blanco con la cercanía a perfección de las cristales individuales, se han examinado muestras de azúcar blanco de fábricas de la British Sugar Corporation para ceniza conductimétrica, color y túrbidez tanto como pérdida en secado y indice de regularidad de cristales (CRI). Los valores semanales de muestras compuestos se presentan en forma tabular para cada fábrica y se discuten en términos de las condiciones conocidas de la casa de cocción, es decir, parametros del proceso y diseño de los tachos. Las resultas, obtenido mientras las zafras de 1972/73 y 1973/74, indican algunas inconsistencias y varios casos individuales estan explicado. Para buenas resultas son significativo el uso de circuladores de la masa cocida y alta habilidad de los operadores de los tachos, que aseguran la ausencia de cristales conglomerados.

* * *

Componentes de azúcar crudo que tienen influencia sobre refinación. F. G. CARPENTER, M. A. CLARKE y E. J. ROBERTS. *Pág*. 9–12

Mientras que es posible dar cuenta de 96–97% del jugo de caña por análisis, en términos de componentes conocidos, el residuo se reduce en gran parte durante el proceso, de modo que las sustancias no-identificadas se pueden discubrir solamente en cantidades muy pequeñas (ppm) en azúcar refinado. Sin embargo, identificación y análisis cuantitativo de estos componentes menores es necesario para mejorar el proceso. El artículo es una revista del estado actual en respecto al identificación y medición de estos componentes menores, describiendo algunos nuevos adelantes y considerando como se puede usar esta nueva información. El grupo se trata en sub-divisiones—componentes de la ceniza, materias colorantes y componentes de grumo. Se da atención especial a los metales pesados en azúcar crudo y refinado. Se indica también que, mientras que pigmentos vegetales forman una parte de las materias colorantes, otras materias (por ejemplo melanoidines y caramelos) que forman un mayor parte de la fracción total de colorante, no estan pigmentos vegetales. Además, se ocurren sustancias incoloradas que estan precursores de color. Métodos para análisis de materias colorantes se describen brevemente.

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Notes & Comments

World raw sugar price

The behaviour of the Daily Price on the London Terminal Market over the past few weeks has been even more remarkable than before. From a level of £550 on the 7th November, quoted in our last issue, the price rose steadily and reached the unprecedented level of £650 by the 21st of that month. The rise was stimulated by purchases and rumours of purchases by the USSR, by the prohibition of exports from Poland and by a temporary ban on exports from the Philippines while a survey was carried out to examine the extent of damage to the cane crop caused by a typhoon which had struck the northern part of the country.

The damage was found to be slight and exports were resumed. This instigated a fall in the price and, unsurprisingly, in view of the rapidity of attainment of such extremely high prices, the fall became equally steep, so that by the 4th December—a matter of only nine trading days—the London Terminal Daily Price had dropped by £170 to £480 per ton.

The ban on exports of sugar by the Polish Government is an extremely serious matter for some sugar traders. It is usual for purchasers of sugar to open a corresponding hedge on the terminal exchange; with the ban on deliveries of sugar covering all existing contracts, the traders are unable to receive the sugar they have bought and now show considerable losses on these transactions.

Discussing the future, E. D. & F. Man write[1]: "The background problems that caused the sugar market to go crazy were a statistical shortage subsequently exaggerated by a series of bad crops in the world and the way in which exporters were able to raise prices over the last 12 months. Before normality can be expected, these fundamental factors need to change. Increased production cannot be sufficiently anticipated until next October at the earliest, although by June 1975 one might make a forecast of some accuracy if the sowings and early weather are good. Reduced consumption would be another way of restoring the supply/demand balance but this would take time to appreciate and one must remember that very few final buyers are paying anything like current prices.

"In the short term, and acknowledging that anything over £250 per ton is crazy, opinions are divided as to whether we are going to continue in the £600 range or whether the current setback will lead to a new level. Because of the large amount of buying still ahead we are sure that a firm market will continue for months and we would not be altogether surprised to experience new high levels in our commodity."

World sugar balance, 1973/74

F. O. Licht K.G. recently published their third estimate of the world sugar balance for the crop year September 1973/August 1974[2] and the figures appear below:

	1973/74	1972/73	1971/72
	(metric tons, raw value)		
Initial stocks....	15,704,000	17,039,000	18,919,000
Production	80,522,000	77,149,000	73,908,000
Imports........	24,779,000	24,437,000	24,517,000
	121,005,000	118,625,000	117,344,000
Exports........	24,789,000	24,806,000	24,187,000
Consumption ..	80,629,000	78,115,000	76,118,000
Final stocks	15,587,000	15,704,000	17,039,000

Compared with the previous estimate, both production and consumption are set about half a million tons lower and the new figures represent an increase of 4·37% in production against 1972/73 and consumption higher by 3·22%. The end-stock figure is higher in absolute terms but as a proportion of consumption shows a further decline to 19·33% as against 20·10%.

* * *

EEC imports of Commonwealth sugar

The Foreign Ministers of the nine member-countries of the EEC agreed at a meeting on the 12th November that up to 1,400,000 tons of cane sugar from developing countries should be guaranteed access annually to the Community "on a continuing basis". The Council of Ministers accepted that, in practice, the bulk of this sugar would be supplied in accordance with the traditional patterns of trade, i.e. that it would be sent to Britain for refining and sale. At a meeting of the Agriculture Ministers it was further agreed that the principle of the guarantee would be valid for an indefinite period and that no amendments, other than quota adjustments in the event of shortfalls, would be made with less than five years' notice.

The UK Minister had sought to obtain a price of at least £140 per ton, as agreed for part of the CSA supplies for 1974[3], but the rest of the Community refused to go above the price paid to European sugar producers, equivalent to about £130 per ton, for long-term guaranteed quotas. This led to fears that the Commonwealth sugar exporters would not be willing to supply the Community under the present circumstances of high world prices, but agreement was

[1] *The Sugar Situation*, 29th November 1974.
[2] *International Sugar Rpt.*, 1974, **106**, (32), 1.
[3] *I.S.J.*, 1974, **76**, 353.

reached whereby the price actually paid could exceed the guaranteed basic price by amounts to be negotiated between seller and buyer countries. Such supplementary payments would automatically bring the sugar supplies to the paying countries and, according to a statement by the British Agriculture Minister, should ensure adequate supplies of cane raws for the UK refineries.

* * *

Brazilian sugar statistics[1]

Brazilian statistics for 1973 have recently been issued by the Instituto do Açúcar e do Alcool and are published elswhere in this issue, together with comparative figures for the three preceding years.

The remarkable steps made by the Brazilian authorities in recent years can clearly be seen from these figures. Production during 1970 and 1971 was just over five million tons; the following year it rose to more than 5·8 million tons while in 1973 it reached a figure in excess of 6·6 million tons.

Despite the increase in availability, Brazil has been successful in disposing of her supplies so that the worrying surplus which was such a feature a few years ago, does not now apply. In 1972 the stock position was reduced by about 500,000 tons while in 1973 it fell by a further 400,000 tons. To some extent domestic consumption, which is currently increasing at between 200,000 and 300,000 tons a year, has accounted for this, but there has also been an increase in the number of destinations to which Brazilian sugar has been exported and the tonnages which have been involved over the past two years.

According to the Brazilian statistics, the United States was once again the leading destination with 443,000 tons. This figure is rather lower than the tonnage shown to be imported from Brazil by the USA in the official statistics of that country and presumably the difference is accounted for by sugar being released from bond at the beginning of the year. Just behind the USA came the Soviet Union with 440,000 tons. This is presumably a non-recurring outlet in view of the absence of the USSR as a world market buyer in 1974.

The crop year extends from June until May and authorized production in the 1973/74 campaign exceeded seven million tons. A further expansion has been planned for 1974/75 and authorized production has been set at some 7·5 million tons. However, doubts have been expressed whether this tonnage will be reached, while domestic consumption will almost certainly continue to rise. Accordingly it seems likely that Brazilian exports have reached a peak for the time being. Furthermore the recent prevalence of Government-to-Government business implies that the tonnage of Brazilian sugar in the hands of international traders and for open sale to the world market is likely to fall.

* * *

FAO views on the future of sugar[2]

In its latest *Commodity Review and Outlook*, the Food and Agriculture Organization of the UN suggests that, unless there is a world recession, the demand for sugar is likely to continue to expand strongly.

The FAO points out that, inadequate though it has been, much of the recent production has been in a few low-cost cane sugar producers, or in developed beet producers, and this trend will no doubt be continued. It goes on to say that, although investment in new cane sugar production facilities is increasing, it is concentrated mainly in countries where domestic demand is large and rising strongly and that many exporters appear reluctant to risk large capital expenditure on a major expansion of their export capacities as they fear a return to the financial losses they incurred after the expansion in production and the subsequent fall in prices of a decade ago.

The FAO suggests that it would be to the long term advantage of the world sugar economy and also the high income countries which are dependent on imported sugar to stimulate production of low cost sugar industries in developing countries. This, of course, would require assistance in the provision of investment capital together with international cooperation to ensure that in future periods of surplus the full burden of downward production adjustment would not be borne disproportionately by exporting countries.

* * *

Europe beet sugar production 1974/75

In addition to the poor germination and growing conditions experienced in many parts of Europe, weather conditions have deteriorated since the first estimates of beet sugar production were published by F. O. Licht K.G. in August. As a consequence the second estimate[3] published in mid-October indicates further reductions from the 1973/74 level, despite the larger areas sown. In the EEC only Denmark and West Germany are expected to produce more sugar than last campaign, while increases are also expected for Austria, Greece, Sweden, Turkey and Yugoslavia. Reductions in the crops of all the East European countries are expected except in the case of Czechoslovakia, although news of recent floods indicate the possibility of beets remaining unharvested there. Details of the estimates appear elsewhere in this issue.

* * *

Beet mechanical harvesting losses

A report entitled "The Utilization and Performance of Sugar Beet Harvesters 1973" has recently been published by the UK Ministry of Agriculture, Fisheries and Food[4]. It gives the results of an investigation carried out on the 1973 harvest by Ministry and British Sugar Corporation staff and reports on performance data for the five most popular beet harvesting systems. Harvested beet losses on the surface were measured and a special plough employed to lift roots remaining below ground. The results showed that 8% of the crop was left in the field and the need for operators to pay more attention to machine settings to minimize the losses is emphasized. The loss amounts to about 1 ton per acre, equivalent during a campaign to more than 50,000 tons of white sugar.

A further defect in the systems, more especially with the more expensive multi-stage systems, was inadequate rates of work due in some cases to lack of supervision of transport arrangements resulting in delays in removing the beets from the fields. This is, of course, a management fault rather than a defect in the system itself.

[1] C. Czarnikow Ltd., *Sugar Review*, 1974, (1188), 121, 124.
[2] Through C. Czarnikow Ltd., *Sugar Review*, 1974, (1199), 167.
[3] F. O. Licht, *International Sugar Rpt.*, 1974, 106, (30), 1–2.
[4] Publications Dept., Tolcarne Drive, Pinner, Middlesex, England.

Crystal regularity and its influence on white sugar quality

By D. HIBBERT, R. T. PHILLIPSON, W. WOODWARK, B. T. BONNER and B. MACKAY
(British Sugar Corporation Ltd., Central Laboratory, Peterborough)

Paper presented to the 22nd Tech. Conf., British Sugar Corp. Ltd., 1974

PART I

Introduction

IN sugar manufacture, where the final product arises from a crystallization process, a major factor affecting the quality of the white sugar is the amount of mother liquor remaining on the surface of the crystals. The importance of this outer layer was demonstrated by HIBBERT and WOODWARK[1] in 1951, when they showed that its ash content could be as much as forty times that of the sample as a whole.

Since, in practice, this surface layer can only be removed in the centrifugals it follows that the more nearly every crystal approaches perfection the easier it is to wash the sugar. Thus the standard of crystal perfection, i.e. the absence of conglomerates, in the massecuite might be expected to be of crucial importance to sugar quality.

Before comparisons of the degree of perfection of crystals, on a practical scale, can be instituted it is necessary to have a means of assessing individual samples. WHITE and BATSTONE[2] described, in 1971, a photographic method based on a modified Zeiss-Endter analyser with presentation of the results on a three-dimensional diagram. A simpler technique,

[1] *Paper presented to the 4th Technical Conf., British Sugar Corp.,* 1951.

Table I. Influence of Pan Design and of Operator

	Pan 1		*Pan* 2		*Pan* 3		*Pan* 4		*Average*	
Operator	*Nov.*	*Dec.*	*Nov.*	*Dec.*	*Nov.*	*Dec.*	*Nov.*	*Dec.*	*Nov.*	*Dec.*
					CRI					
A	47·0	51·5	31·4	38·3	24·2	54·2	51·5	41·7	38·5	46·4
B	24·7	—	24·5	—	13·0	—	15·9	—	19·5	—
C	12·3	39·4	15·1	23·8	10·3	38·4	20·1	43·4	14·5	36·3
D	10·0	41·2	13·9	47·1	12·6	51·4	17·9	54·7	13·6	48·6
E	31·9	—	34·5	—	34·9	—	36·1	—	34·4	—
F	—	38·2	—	39·4	—	29·9	—	44·4	—	38·0
Average	25·2	42·6	23·9	37·2	19·0	43·5	28·3	46·1	24·1	42·3
					Ash, %					
A	0·007	0·006	0·011	0·007	0·012	0·006	0·008	0·006	0·0095	0·0063
B	0·010	—	0·013	—	0·015	—	0·022	—	0·0150	—
C	0·012	0·007	0·012	0·009	0·013	0·007	0·010	0·006	0·0118	0·0073
D	0·017	0·006	0·015	0·006	0·015	0·006	0·013	0·006	0·0150	0·0060
E	0·009	—	0·008	—	0·008	—	0·007	—	0·0080	—
F	—	0·006	—	0·007	—	0·007	—	0·007	—	0·0068
Average	0·0110	0·0063	0·0118	0·0073	0·0126	0·0065	0·0120	0·0063	0·0123	0·0066

Table II. Comparison of Sugar Boiled by Operators 'C' and 'E'

Size fraction	*CRI*		*Ash* %		*Water* %*		*Calculated colour*†		*Calculated turbidity*†	
µm	C	E	C	E	C	E	C	E	C	E
Pan No. 1										
850–710	5·5	8·0	0·015	0·011	0·043	0·037	18·0	2·8	29·5	49·6
710–600	8·5	17·5	0·014	0·010	0·044	0·033	23·5	10·5	5·4	7·8
600–425	21·5	30·0	0·013	0·009	0·042	0·034	18·2	11·0	7·0	1·6
425–355	21·5	30·0	0·012	0·009	0·042	0·031	15·3	8·3	32·6	13·2
Average (wtd.)	16·8	24·6	0·013	0·009	0·043	0·034	18·7	9·5	14·4	10·4
Pan No. 2										
850–710	6·5	24·0	0·014	0·009	0·043	0·035	19·3	2·2	29·5	38·8
710–600	12·5	28·5	0·013	0·008	0·041	0·033	19·1	9·2	17·1	5·4
600–425	21·0	37·0	0·012	0·008	0·039	0·033	16·7	8·8	10·9	3·8
425–355	19·0	49·5	0·012	0·008	0·041	0·032	16·2	7·1	17·1	14·8
Average (wtd.)	17·4	34·3	0·012	0·008	0·040	0·033	17·3	7·7	15·4	11·2
Pan No. 3										
850–710	5·0	17·5	0·016	0·009	0·044	0·037	17·7	6·4	31·0	29·4
710–600	13·5	31·0	0·015	0·008	0·042	0·032	23·3	11·4	7·6	2·4
600–425	18·0	41·0	0·013	0·008	0·039	0·033	20·0	10·0	7·6	3·0
425–355	26·0	44·0	0·013	0·009	0·039	0·033	16·8	11·3	18·6	7·8
Average (wtd.)	17·8	35·2	0·014	0·008	0·040	0·033	19·8	10·0	11·6	7·6
Pan No. 4										
850–710	9·0	16·0	0·013	0·009	0·040	0·034	9·2	7·6	49·7	31·0
710–600	14·0	31·0	0·011	0·008	0·038	0·035	21·7	12·2	7·6	1·6
600–425	21·5	41·5	0·010	0·007	0·036	0·033	11·8	6·5	8·5	0·0
425–355	31·0	41·5	0·010	0·008	0·037	0·032	13·5	9·3	17·8	8·6
Average (wtd.)	19·3	37·3	0·011	0·008	0·037	0·033	14·1	8·3	16·5	4·4

(*) All water determinations were made by the Karl Fischer method.
(†) See Appendix II for details of the analytical technique employed.

requiring no very specialized equipment, was developed by HILL[3] and it is a modification of this latter procedure which has been adopted by the present authors. The details of the method used are given in Appendix I.

Influence of pan design and operator

The overall quality of the sugar produced at a given factory is obviously an average of that achieved in each white sugar strike. Thus, any marked disparity between the standards achieved in individual strikes calls for investigation with a view to raising all to the level of the best.

Early in November 1972, and again in late December of that year, samples were taken at Factory M; these involved all four white pans and six of the sugar boilers. These samples were examined for Crystal Regularity Index (CRI) and ash content. The data obtained are summarized in Table I.

All the white pans at this factory have stirrers but, whereas No. 1 is parallel sided with a 4 ft 6 in centre downtake, Nos. 2, 3 and 4 have enlarged diameters above the top tube plate and centre wells of only 3 ft 6 in diameter.

In spite of these differences between the pans it is quite clear from the data for the two series of samples that any "pan effect", if indeed it exists at all, is marginal compared with the influence of the operator.

The danger of conglomerate formation is greatest immediately after the seeding stage in boiling the pan. If the standard liquor Brix is too high, say much in excess of 68°, the grain may not be able to maintain the natural crystallographic form of sucrose and at the same time achieve a sugar deposition rate capable of dealing with the supersaturation level which exists.

Thus, after graining, by using less vacuum, the pan temperature should be allowed to rise to perhaps 80 to 85°C, thereby reducing the degree of supersaturation and allowing time for the nascent crystals to grow and achieve a larger surface area.

Moreover, a rise in temperature at this stage, by increasing the mobility of the pan contents and hence the effectiveness of the stirrers, allows the tiny crystals to move freely through the mother liquor and continually to come into contact with new syrup. In addition, this enhanced mobility or looseness of the pan minimizes mechanical damage to the rapidly growing crystals and thus reduces the incidence of malformed crystals from this cause.

Care must be taken in this early stage to ensure that the ingoing standard liquor has a temperature marginally higher (about 2°C) than the pan contents so as to obviate any chance of the pan going off the boil.

Repeated "proofs" are required at this time to verify that the rates of boiling and of standard liquor intake are not leading to a sugar deposition rate that will give rise to false grain. Later, when the desired grain has been established, the rate of sugar deposition, i.e. of standard liquor intake, can be increased so as to "get high" as quickly as possible without loss of grain.

By making use of the stirrers to ensure rapid turnover of the pan contents, the high rate of sugar deposition which can be achieved in the later stages of boiling the pan more than compensates for the time spent in laying a good foundation in the beginning.

In the interval between taking the first samples in November and the second series in December the boiling technique of each operator was reviewed in accordance with the principles outlined above. Furthermore, by producing photographs of the crystals within fifteen minutes of dropping the strike, quality features could be drawn to the attention of the operator while details of the boiling method were fresh in his mind. By showing these photographs generally amongst the operators it was possible to introduce an element of competition and friendly rivalry, to the ultimate benefit of the CRI of the white sugar being produced.

The markedly lower ash content of the December samples, which clearly reflects the higher CRI values, represents a decisive improvement in sugar quality. This improvement is particularly noteworthy when it is recalled that it has been achieved at no cost in capital expenditure or loss in throughput. Indeed some unquantifiable benefits arise from the improved performance, such as a reduction in the quantity of syrup circulating in the sugar end giving a reduction in the work required from the lower product pans and a commensurate improvement in the quality of their output. It may also be that, by reducing the water used on the white pans, some savings in fuel can be achieved.

The work of two operators (C and E), as represented by other samples taken in November, was examined in detail since, at that time, E was achieving significantly better results than C with the same pans (Table II).

Clearly operator E achieved a considerably better CRI in each of the fractions examined, and in consequence produced sugar of lower ash and water content than did C, irrespective of the pan being considered.

For each pan boiler, and for all four pans, the coarse fraction (850 to 710 μm) has a lower CRI than the other three fractions. This fraction also has the higher ash and water content, thus emphasizing once again the high correlation between CRI and sugar quality. RODGERS and LEWIS[4] also noted that, in the granulated sugar which was being produced at Factory I in 1962, the fraction retained on an 850 μm screen had the highest "loss on drying" and much the highest loss in weight when stored over phosphorus pentoxide for an extended period (120 hours). HILL[3] also reported that the coarse fraction tended to be more conglomerated than the finer ones in the samples he examined.

Because the figure quoted for "calculated colour" is also dependent upon the associated "calculated turbidity" value (see Appendix II) the data in Table II for these two parameters do not present such a clear picture as do ash and water. The "total light absorption", however, (i.e. the sum of calculated colour and calculated turbidity) of the sugar boiled by E is obviously much lower than for C which is to be expected from the CRI values. Moreover, the coarse fractions also give the highest light absorption values for both operators.

[2] *Proc. 38th Conf. Queensland Soc. Sugar Cane Tech.*, 1971, 69–82.

[3] *I.S.J.*, 1965, **67**, 201–204.

[4] *Paper presented to the 15th Tech. Conf., British Sugar Corp.*, 1962.

Table III. Crystal Regularity Index (CRI), Loss on Drying (LD), Conductivity Ash (CA), Colour (C) and Turbidity (T) results on Weekly Composites of Granulated Sugar—Campaign 1972/73

Week Ending:	9/10	16/10	23/10	6/11	20/11	4/12	11/12	18/12	25/12	1/1	8/1	15/1	22/1	29/1	*Arithmetic Mean*
FACTORY A															
CRI, %		49·6	51·6	51·4	45·8	46·5	39·7	54·2	50·0	49·6	45·2	43·4			47·9
LD, %		0·014	0·014	0·017	0·018	0·015	0·016	0·018	0·013	0·015	0·013	0·014			0·015
CA, %		0·006	0·005	0·004	0·005	0·006	0·006	0·006	0·006	0·005	0·006	0·006			0·006
C		17·5	15·0	11·8	8·1	6·0	5·3	7·7	9·1	9·1	9·8	9·8			9·9
T		5·3	4·1	3·6	3·9	4·2	3·8	4·3	3·5	2·9	2·4	4·0			3·8
FACTORY B															
CRI, %	28·3	18·2	27·1	30·1	31·8	33·4	38·7	42·0	44·5	36·6	36·4	25·5	33·6	24·3	32·2
LD, %	0·023	0·023	0·022	0·020	0·021	0·017	0·016	0·014	0·013	0·012	0·013	0·012	0·015	0·016	0·017
CA, %	0·009	0·010	0·008	0·007	0·007	0·006	0·006	0·006	0·006	0·006	0·006	0·007	0·007	0·010	0·007
C	15·0	10·4	7·7	10·0	8·1	7·7	6·5	7·7	7·7	7·9	6·7	8·7	10·0	13·0	9·1
T	14·7	5·7	4·7	5·0	4·1	4·5	3·3	2·9	4·5	3·1	5·9	4·7	3·4	16·3	5·9
FACTORY C															
CRI, %	53·2	43·5	43·9	35·6	45·8	40·6	33·1	46·1	43·2	30·2	40·3	43·2	41·7	40·2	41·5
LD, %	0·018	0·031	0·015	0·024	0·021	0·019	0·012	0·016	0·013	0·015	0·015	0·015	0·012	0·014	0·017
CA, %	0·010	0·007	0·006	0·007	0·006	0·006	0·006	0·006	0·005	0·006	0·006	0·006	0·006	0·006	0·006
C	16·1	9·1	8·3	8·3	8·1	10·2	12·2	13·6	14·2	12·6	13·6	14·4	13·6	11·2	11·8
T	18·2	5·3	6·7	5·5	6·7	5·9	4·3	4·5	4·1	6·3	7·3	4·3	7·3	5·1	6·5
FACTORY E															
CRI, %	50·0	42·9	40·2	44·0	40·4	42·9	41·7	45·9	45·7	38·3	43·1	41·2	46·9		43·3
LD, %	0·015	0·017	0·021	0·020	0·017	0·016	0·016	0·016	0·014	0·013	0·016	0·016	0·015		0·016
CA, %	0·007	0·006	0·006	0·006	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005		0·005
C	7·9	8·5	6·9	8·3	6·9	6·3	7·1	6·9	11·2	8·1	9·8	8·9	9·3		8·2
T	6·3	2·5	3·9	5·3	5·1	5·9	4·5	3·9	3·4	3·7	2·4	2·5	3·7		4·1
FACTORY F															
CRI, %	28·4	26·5	20·9	2[illegible]·2	28·0	28·9	36·8	33·5	25·3	26·7	23·3	25·6	23·4		27·2
LD, %	0·034	0·028	0·025	0·023	0·020	0·016	0·017	0·018	0·019	0·016	0·016	0·016	0·014		0·020
CA, %	0·017	0·014	0·011	0·007	0·008	0·007	0·007	0·007	0·007	0·007	0·007	0·007	0·006		0·008
C	27·8	20·9	12·2	13·8	13·2	11·6	10·8	13·6	11·8	14·2	14·2	15·4	14·8		14·9
T	18·1	8·0	9·9	5·1	12·0	7·1	3·0	4·7	4·5	4·9	5·5	3·5	4·9		7·0
FACTORY G															
CRI, %	43·6	38·6	38·8	38·0	37·1	38·5	40·5	42·8	39·2	39·2	36·5	33·4	30·0	27·7	37·4
LD, %	0·018	0·016	0·018	0·016	0·024	0·018	0·015	0·020	0·017	0·015	0·014	0·014	0·012	0·021	0·017
CA, %	0·007	0·006	0·005	0·006	0·006	0·006	0·006	0·007	0·006	0·006	0·006	0·006	0·006	0·007	0·006
C	8·5	7·3	7·3	6·7	6·9	6·7	6·5	7·1	8·1	7·9	11·0	10·8	10·4	12·2	8·4
T	7·8	4·3	4·5	5·3	4·1	5·3	3·3	4·1	4·1	3·9	3·6	5·1	6·1	7·9	5·0

Week Ending:	9/10	16/10	30/10	13/11	27/11	4/12	11/12	18/12	25/12	1/1	8/1	15/1	22/1	29/1	5/2	*Arithmetic Mean*
FACTORY H																
CRI, %		46·6	33·5	46·9	49·2	50·0	49·6	54·6	49·2	46·0	46·5	48·9				47·4
LD, %		0·018	0·019	0·022	0·018	0·023	0·021	0·018	0·024	0·014	0·013	0·013				0·019
CA, %		0·009	0·008	0·008	0·008	0·009	0·008	0·008	0·008	0·008	0·007	0·007				0·008
C		7·3	8·1	6·5	7·1	6·7	7·3	6·3	9·1	7·9	10·8	10·8				8·0
T		10·4	8·2	7·9	4·5	3·5	5·1	6·5	6·8	4·7	3·6	4·6				6·0
FACTORY I																
CRI, %	24·5	35·5	37·7	47·0	40·9	46·3	45·7	49·5	51·8	39·3	39·0	43·8	41·7	46·4	45·4	42·3
LD, %	0·031	0·022	0·017	0·016	0·017	0·018	0·015	0·017	0·016	0·014	0·017	0·013	0·013	0·014	0·015	0·017
CA, %	0·010	0·008	0·006	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·006
C	9·3	6·5	5·9	5·9	5·9	4·5	6·7	5·7	6·3	5·9	7·9	7·5	6·9	7·3	10·0	6·8
T	9·2	5·3	4·3	4·3	4·7	3·4	3·9	6·1	4·7	5·5	4·3	4·1	4·1	3·5	5·6	4·9
FACTORY J																
CRI, %	35·2	26·4	26·8	26·9	23·0	19·9	19·9	27·6	24·0	21·6	23·0	12·5	13·7	23·0		23·1
LD, %	0·022	0·020	0·023	0·021	0·019	0·021	0·019	0·017	0·021	0·016	0·018	0·015	0·015	0·019		0·019
CA, %	0·008	0·009	0·009	0·008	0·007	0·008	0·007	0·007	0·007	0·008	0·008	0·009	0·009	0·010		0·008
C	12·4	8·1	7·9	6·7	9·1	7·1	8·3	9·8	9·6	9·3	10·6	11·8	11·8	12·4		9·6
T	10·2	6·1	4·9	7·9	5·1	4·7	5·3	5·4	4·6	5·1	2·0	5·7	3·6	5·3		5·4
FACTORY K																
CRI, %		32·2	42·4	41·7	50·1	42·5	45·7	43·3	46·0	40·0	44·4	38·7	37·4			42·0
LD, %		0·022	0·015	0·023	0·016	0·018	0·016	0·018	0·014	0·015	0·015	0·017	0·015			0·017
CA, %		0·008	0·006	0·005	0·006	0·006	0·006	0·007	0·006	0·007	0·006	0·006	0·007			0·006
C		14·8	9·6	8·1	8·9	9·1	11·6	12·8	14·0	11·8	13·4	14·0	16·1			12·0
T		9·2	3·6	5·5	4·3	6·8	5·1	5·3	4·7	4·9	2·0	5·1	3·4			5·0
FACTORY L																
CRI, %	48·9	44·8	36·2	35·1	45·7	33·1	34·1	37·7	39·6	40·7	40·0	30·3	34·4	36·7		38·4
LD, %	0·016	0·015	0·022	0·021	0·018	0·022	0·022	0·021	0·020	0·025	0·015	0·016	0·017	0·019		0·019
CA, %	0·008	0·008	0·009	0·009	0·008	0·007	0·008	0·010	0·008	0·007	0·007	0·008	0·007	0·007		0·008
C	10·4	8·5	11·2	11·2	10·8	13·2	14·0	16·3	14·6	14·6	15·9	17·9	14·2	13·4		13·3
T	10·5	3·9	4·9	5·7	5·5	3·1	5·1	5·6	4·9	5·9	2·6	3·0	3·5	4·7		4·9
FACTORY M																
CRI, %	21·2	20·5	19·0	24·3	25·6	26·0	25·4	34·7	43·8	47·0	42·5	44·1	35·9	45·7		32·6
LD, %	0·030	0·028	0·033	0·026	0·026	0·024	0·023	0·021	0·015	0·014	0·016	0·018	0·015	0·013		0·022
CA, %	0·013	0·014	0·013	0·011	0·012	0·009	0·008	0·008	0·006	0·007	0·007	0·006	0·006	0·007		0·009
C	12·0	12·4	10·8	8·7	9·1	11·0	9·6	11·4	8·3	9·8	11·0	12·0	10·6	10·4		10·5
T	13·8	6·7	5·5	5·7	9·6	5·5	4·8	6·7	6·7	5·2	7·3	7·1	5·9	6·5		6·9
FACTORY N																
CRI, %	42·9	39·1	38·2	39·6	40·7	39·5	45·8	42·8	41·0	27·8	35·2	36·6	34·9	43·6		39·1
LD, %	0·018	0·016	0·020	0·021	0·021	0·021	0·022	0·016	0·021	0·019	0·018	0·021	0·016	0·020		0·019
CA, %	0·008	0·006	0·008	0·007	0·007	0·008	0·008	0·007	0·007	0·008	0·008	0·007	0·007	0·007		0·007
C	12·0	10·8	6·3	6·7	7·3	7·5	6·9	10·2	10·4	10·0	10·2	12·2	12·6	10·4		9·5
T	4·3	4·2	4·7	3·5	4·7	5·7	5·3	7·5	4·8	4·4	3·4	3·4	4·7	5·9		4·8
FACTORY O																
CRI, %	39·7	37·1	43·0	45·0	50·5	54·4	51·6	59·0	53·6	51·0	47·0	42·7	43·0			47·5
LD, %	0·023	0·018	0·019	0·019	0·016	0·016	0·020	0·016	0·017	0·016	0·014	0·018	0·015			0·018
CA, %	0·010	0·008	0·007	0·009	0·008	0·009	0·007	0·007	0·008	0·007	0·007	0·008	0·007			0·008
C	20·3	13·0	10·6	6·1	3·9	6·1	5·5	7·3	10·4	8·1	8·3	7·7	8·5			8·9
T	10·4	7·3	5·0	2·8	4·8	8·9	1·6	3·7	4·2	3·3	3·5	4·7	3·5			4·9

Table IV. Crystal Regularity Index (CRI), Loss on Drying (LD), Conductivity Ash (CA),

Week Ending:	1/10	8/10	15/10	22/10	29/10	5/11	12/11	19/11	26/11	3/12
FACTORY A										
CRI, %		40·6	46·7	45·9	38·8	37·0	41·8	40·9	42·8	41·5
LD, %		0·011	0·010	0·011	0·012	0·011	0·015	0·011	0·015	0·014
CA, %		0·005	0·005	0·006	0·006	0·006	0·005	0·005	0·006	0·005
C		8·7	8·7	8·3	7·4	8·7	9·2	9·2	8·7	13·9
T		5·7	4·5	3·9	3·6	4·4	5·2	2·8	5·2	3·0
FACTORY B										
CRI, %	33·4	38·6	33·2	35·8	35·9	40·1	42·3	30·0	44·4	46·0
LD, %	0·024	0·017	0·015	0·013	0·013	0·014	0·016	0·014	0·013	0·016
CA, %	0·014	0·009	0·009	0·009	0·008	0·008	0·007	0·007	0·007	0·008
C	17·3	12·3	13·9	11·5	10·9	12·3	11·0	10·9	11·6	11·4
T	12·6	7·8	6·1	7·8	4·0	6·5	4·2	3·5	3·7	3·8
FACTORY C										
CRI, %	39·4	44·0	39·8	35·2	33·1	38·4	45·2	41·0	48·4	44·2
LD, %	0·015	0·012	0·013	0·012	0·013	0·016	0·014	0·013	0·012	0·014
CA, %	0·008	0·007	0·007	0·007	0·008	0·008	0·007	0·007	0·007	0·006
C	13·6	13·6	14·6	14·2	14·3	14·7	15·9	17·7	16·9	15·1
T	23·1	9·5	8·6	10·7	6·6	6·7	9·8	11·2	5·1	6·5
FACTORY D										
CRI, %						33·7	31·7	42·5	42·5	39·7
LD, %						0·018	0·020	0·016	0·011	0·016
CA, %						0·010	0·010	0·008	0·008	0·007
C						23·8	17·3	14·1	13·4	20·9
T						19·4	17·1	5·9	10·7	8·4
FACTORY E										
CRI, %		35·3	37·4	35·8	43·8	37·3	41·9	41·4	43·5	46·3
LD, %		0·014	0·015	0·014	0·012	0·013	0·014	0·017	0·011	0·015
CA, %		0·008	0·008	0·007	0·007	0·007	0·007	0·007	0·007	0·007
C		13·4	14·4	12·2	10·4	13·6	14·6	13·6	16·8	18·3
T		11·7	6·4	7·1	4·8	6·5	5·6	3·6	4·9	5·8
FACTORY F										
CRI, %	16·7	10·6	21·9	20·0	15·5	20·0	19·9	25·7	24·0	32·1
LD, %	0·031	0·024	0·020	0·015	0·017	0·018	0·023	0·021	0·017	0·022
CA, %	0·010	0·012	0·009	0·008	0·009	0·009	0·008	0·007	0·009	0·010
C	34·0	27·2	19·1	18·9	18·3	18·0	19·9	16·9	23·8	27·1
T	42·0	20·0	5·5	10·4	9·7	8·8	6·7	5·1	10·0	10·0
FACTORY G										
CRI, %		24·7	25·2	33·1	25·8	36·0	36·9	38·7	37·5	50·9
LD, %		0·022	0·023	0·017	0·018	0·017	0·020	0·023	0·020	0·020
CA, %		0·007	0·008	0·007	0·008	0·007	0·007	0·008	0·008	0·007
C		18·4	16·2	13·8	14·3	13·4	15·0	16·7	17·0	16·9
T		7·8	6·8	6·5	5·6	5·9	4·9	5·0	5·1	5·1
FACTORY H										
CRI, %		35·2	38·2	41·8	39·2	32·2	39·5	39·9	44·2	50·0
LD, %		0·011	0·014	0·015	0·016	0·014	0·016	0·015	0·019	0·023
CA, %		0·009	0·009	0·010	0·011	0·010	0·009	0·008	0·008	0·009
C		13·2	10·0	9·7	12·2	13·0	16·6	14·1	14·1	17·4
T		9·1	8·1	6·6	5·9	8·1	12·1	8·8	8·3	5·0
FACTORY I										
CRI, %	48·0	39·5	39·2	35·5	33·3	42·1	39·5	40·6	42·5	53·3
LD, %	0·028	0·015	0·015	0·014	0·015	0·016	0·019	0·017	0·017	0·017
CA, %	0·008	0·007	0·007	0·006	0·007	0·008	0·007	0·006	0·007	0·006
C	11·2	9·0	9·9	9·8	8·6	9·7	9·6	9·2	10·7	9·4
T	9·6	6·4	4·2	4·2	3·0	4·5	3·8	4·6	3·1	4·0
FACTORY J										
CRI, %	33·2	33·0	30·4	37·0	31·6	37·2	37·3	35·5	41·4	42·5
LD, %	0·016	0·019	0·017	0·012	0·016	0·014	0·019	0·017	0·017	0·017
CA, %	0·010	0·010	0·007	0·008	0·009	0·008	0·008	0·007	0·007	0·008
C	11·4	9·8	10·0	10·2	11·2	9·5	13·4	10·3	14·4	12·9
T	7·6	7·0	4·9	6·3	5·0	5·4	9·4	5·0	4·6	6·0
FACTORY K										
CRI, %	14·5	21·4	39·3	23·9	28·2	29·0	31·5	37·3	39·6	39·8
LD, %	0·022	0·017	0·015	0·017	0·015	0·012	0·018	0·017	0·017	0·017
CA, %	0·011	0·010	0·009	0·009	0·009	0·009	0·008	0·007	0·007	0·008
C	15·4	13·6	13·6	16·9	18·3	17·8	16·4	19·0	14·4	16·9
T	11·8	11·7	9·3	13·3	8·4	8·1	6·2	6·0	4·6	5·9
FACTORY L										
CRI, %	35·9	30·9	26·0	25·5	27·8	26·8	28·6	23·4	36·5	40·9
LD, %	0·026	0·029	0·020	0·023	0·021	0·018	0·016	0·023	0·022	0·017
CA, %	0·016	0·016	0·012	0·013	0·014	0·013	0·012	0·010	0·009	0·010
C	16·1	11·6	13·7	16·4	20·6	21·4	32·0	17·3	18·5	19·1
T	9·9	5·7	5·2	6·7	7·3	4·3	5·9	5·2	7·8	6·3
FACTORY M										
CRI, %	36·6	31·2	43·2	43·3	37·6	53·8	46·1	42·5	43·7	48·2
LD, %	0·016	0·012	0·015	0·014	0·014	0·015	0·016	0·019	0·021	0·014
CA, %	0·011	0·008	0·008	0·008	0·008	0·008	0·007	0·007	0·008	0·007
C	12·4	10·6	8·9	7·7	9·5	9·7	12·1	12·3	11·9	13·8
T	15·5	8·8	5·2	5·7	5·4	4·0	5·1	5·5	6·5	5·0
FACTORY N										
CRI, %		26·1	34·5	35·9	35·5	44·2	43·8	42·0	41·5	41·2
LD, %		0·018	0·017	0·013	0·013	0·011	0·016	0·018	0·020	0·015
CA, %		0·009	0·008	0·007	0·007	0·007	0·007	0·006	0·007	0·008
C		10·6	11·0	8·6	9·6	9·1	11·6	11·5	13·6	14·1
T		8·2	6·6	5·3	7·2	4·3	3·6	3·9	6·8	6·9
FACTORY O										
CRI, %					17·4	34·6	29·2	27·9	35·5	36·4
LD, %					0·021	0·014	0·020	0·021	0·021	0·017
CA, %					0·010	0·008	0·008	0·007	0·008	0·006
C					24·2	21·4	17·3	16·7	15·4	24·9
T					19·1	5·5	5·6	6·2	4·2	4·2

Colour (C) and Turbidity (T) results on weekly composites of granulated sugar—Campaign 1973/74

10/12	17/12	24/12	31/12	7/1	14/1	21/1	28/1	4/2	11/2	18/2	*Arithmetic Mean*
42·0	41·6	38·5	41·4	40·7	41·2	40·0	42·5	33·4	36·4		40·7
0·016	0·019	0·014	0·014	0·014	0·013	0·012	0·013	0·017	0·014		0·013
0·006	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005	0·005		0·005
13·7	11·9	15·3	13·1	14·1	12·1	12·6	11·7	14·1	12·6		11·3
2·6	2·7	3·3	3·6	3·6	3·0	3·7	2·3	3·8	3·5		3·7
41·5	38·5	37·4	41·9	36·9	35·9	38·4	34·9	36·0	39·4		38·0
0·016	0·019	0·021	0·014	0·014	0·015	0·014	0·018	0·021	0·012		0·016
0·008	0·008	0·008	0·007	0·007	0·008	0·008	0·009	0·008	0·009		0·008
11·8	13·1	16·0	16·6	18·8	19·9	14·8	16·7	17·9	21·3		14·5
4·4	5·1	5·4	4·6	4·5	5·6	14·4	5·8	5·2	5·6		6·0
48·2	50·4	42·8	47·7	49·5	41·0	42·2	37·3	33·8	36·5		41·9
0·017	0·018	0·015	0·015	0·013	0·016	0·018	0·013	0·014	0·016		0·014
0·006	0·006	0·006	0·006	0·006	0·005	0·006	0·006	0·006	0·006		0·007
14·5	12·4	14·7	14·0	15·2	15·0	20·4	24·7	17·6	17·8		15·8
5·6	3·8	4·5	5·2	5·7	5·3	8·2	5·4	2·5	5·3		7·5
34·2	36·5	36·3	39·3	37·4	36·0	37·4	31·9	36·3	35·4	31·0	36·4
0·024	0·024	0·014	0·018	0·016	0·015	0·015	0·014	0·013	0·016	0·017	0·017
0·008	0·007	0·007	0·007	0·007	0·007	0·007	0·007	0·007	0·007	0·007	0·008
20·8	15·1	17·0	18·8	19·8	21·5	20·5	22·0	22·6	25·9	26·9	20·0
8·4	7·3	5·1	6·2	7·0	7·7	5·4	6·9	11·8	11·0	8·0	9·1
41·5	39·6	45·7	49·2	46·6	45·6	44·3	43·3	43·1	42·1	39·6	42·2
0·016	0·020	0·014	0·017	0·016	0·015	0·013	0·018	0·016	0·013	0·012	0·015
0·007	0·007	0·007	0·006	0·006	0·006	0·006	0·006	0·006	0·006	0·006	0·007
16·8	19·7	13·2	13·7	15·0	12·9	14·8	17·0	15·4	14·6	13·7	14·7
9·8	8·2	4·0	4·4	7·4	4·8	5·0	5·2	3·8	4·0	5·0	5·9
38·8	40·9	35·5	38·7	39·1	37·7	39·8	38·5	39·6	33·6		29·4
0·023	0·018	0·023	0·016	0·015	0·017	0·018	0·015	0·014	0·017		0·019
0·009	0·007	0·007	0·008	0·007	0·006	0·006	0·007	0·006	0·007		0·008
17·9	18·8	17·7	23·1	21·0	21·3	19·7	21·9	21·9	22·2		21·4
6·8	7·1	5·7	8·0	6·1	5·2	4·3	5·7	5·3	5·0		9·4
38·3	37·0	36·9	38·0	35·4	37·0	37·7	41·2	42·0	35·1	34·2	36·1
0·019	0·024	0·019	0·019	0·018	0·017	0·017	0·015	0·016	0·016	0·018	0·019
0·007	0·008	0·007	0·007	0·007	0·006	0·006	0·006	0·006	0·006	0·006	0·007
17·4	21·0	25·7	23·7	24·3	21·0	27·7	26·4	18·5	19·0	21·2	19·4
6·8	7·1	6·2	5·3	4·7	5·0	5·4	4·2	5·2	6·7	6·5	5·8
43·8	40·2	40·0	43·3	42·2	43·9	42·6	40·7	39·8	44·9		41·1
0·024	0·022	0·021	0·016	0·017	0·013	0·014	0·014	0·016	0·013		0·017
0·009	0·009	0·008	0·007	0·007	0·007	0·006	0·006	0·006	0·005		0·008
14·7	16·5	13·9	12·2	14·9	16·4	19·1	21·1	21·8	16·3		15·1
12·4	7·8	9·0	10·9	7·0	7·2	8·1	7·9	5·0	6·9		8·1
47·9	42·0	40·9	41·6	40·9	39·4	37·5	41·8	41·8	37·1	37·3	41·0
0·021	0·025	0·021	0·016	0·021	0·019	0·017	0·021	0·020	0·013	0·014	0·018
0·007	0·006	0·005	0·005	0·006	0·006	0·005	0·005	0·005	0·005	0·005	0·006
8·8	8·8	10·2	8·8	11·2	17·0	15·0	17·1	21·4	21·3	17·2	12·1
4·3	3·9	3·7	3·6	7·4	4·0	4·6	4·5	5·7	6·8	5·1	4·8
38·6	30·0	34·2	39·6	33·2	36·0	33·9	37·5	35·9			35·7
0·020	0·021	0·025	0·020	0·024	0·017	0·016	0·017	0·014			0·018
0·008	0·007	0·007	0·007	0·007	0·007	0·007	0·008	0·007			0·008
18·4	14·7	17·2	17·7	15·8	18·1	18·2	19·0	19·7			14·3
8·6	5·6	7·5	6·0	4·5	6·1	5·5	6·5	5·5			6·2
42·8	39·6	40·0	40·0	37·9	35·3	35·3	35·2	34·1			33·9
0·019	0·026	0·028	0·017	0·017	0·015	0·019	0·018	0·014			0·018
0·008	0·008	0·009	0·008	0·007	0·007	0·007	0·007	0·006			0·008
18·7	19·9	17·7	19·2	19·3	18·6	22·2	22·9	26·9			18·3
9·3	6·5	7·2	8·9	5·4	4·6	5·7	5·9	8·4			7·4
39·3	39·3	39·4	35·6	36·4	34·5	34·5	35·8	39·2	37·1		31·9
0·029	0·023	0·028	0·023	0·023	0·018	0·020	0·019	0·018	0·017		0·021
0·012	0·009	0·010	0·010	0·009	0·008	0·010	0·007	0·007	0·007		0·011
17·4	18·8	18·2	22·4	20·3	20·3	25·6	23·0	23·9	22·1		19·4
6·3	6·5	5·9	6·8	7·6	8·0	8·3	8·2	6·3	10·7		6·9
45·9	48·3	49·7	47·1	46·0	39·6	39·4	37·0	39·3	35·3		42·7
0·020	0·020	0·020	0·016	0·016	0·015	0·018	0·020	0·016	0·020		0·017
0·008	0·007	0·007	0·007	0·006	0·006	0·007	0·007	0·007	0·009		0·008
15·9	9·5	10·5	12·4	16·1	19·0	22·8	25·4	24·9	29·6		14·8
2·8	4·4	4·4	4·7	5·4	6·4	7·4	8·2	7·1	11·8		6·5
45·5	49·2	42·3	41·8	41·0	44·5	44·6	41·8	40·5	41·6	39·1	40·8
0·018	0·023	0·015	0·015	0·016	0·015	0·016	0·017	0·014	0·018	0·013	0·016
0·008	0·007	0·007	0·007	0·006	0·006	0·006	0·006	0·006	0·006	0·005	0·007
14·2	13·2	16·8	20·3	19·2	19·5	21·7	20·2	20·3	22·0	21·2	15·4
6·3	5·0	4·4	3·7	3·7	5·8	4·5	5·9	4·1	4·7	4·6	5·3
37·2	38·7	33·6	36·8	35·5	35·0	35·0	34·3	30·0			33·1
0·021	0·022	0·018	0·016	0·019	0·016	0·015	0·015	0·016			0·018
0·008	0·007	0·007	0·008	0·006	0·006	0·006	0·005	0·004			0·007
18·0	24·3	19·6	21·9	21·6	18·3	23·7	26·3	25·8			21·3
5·5	4·4	3·5	5·9	6·7	3·9	5·5	3·8	5·4			6·0

Since there is a marked tendency for CRI to improve with decreasing crystal size, in the range 850 to 355μm, it might be expected that a corresponding, consistent, decrease in turbidity, in the same way as for ash, would occur if the turbidity arose largely from a retained layer of mother liquor. This expected decrease is found in the first three size fractions but is followed by a large increase in the fourth fraction. This cannot be due to dusty material which, by virtue of the possible presence of inorganic material such as filter aid, might be expected to contribute disproportionately to turbidity, since 355μm is still a relatively large aperture.

This high turbidity in the finer fraction, for which the authors have, as yet, no explanation, contradicts the findings of PAINE and BALCH[5] who reported in 1926 that, although the ash was largely concentrated in the outer layers of the crystal, colloidal matter was spread relatively uniformly throughout the crystal.

In the samples under consideration the fine fraction constituted approximately 14% of the sugar boiled by C and 13% of that boiled by E. This is a not insignificant proportion when one considers the possible effect on solutions prepared from the sugar for use in various products. Clearly further work is required in this connexion.

Extended testing

The determination of CRI was carried out on a weekly basis for all B.S.C. white sugar factories for the 1972/73 and 1973/74 beet campaigns. The relevant data are presented in Tables III and IV.

As might be expected, where one is dealing with composite samples representing a whole week's production, certain inconsistencies exist in the data. For example, at Factory J during the 1972/73 campaign, some very low CRI values, of less than 20, were recorded but the associated ash and loss on drying figures were only marginally higher than for Factory O where CRI values of over 50 were attained for a period of six weeks in mid-campaign.

The values for Factory F in the early weeks of the 1973/74 campaign gave cause for concern and remedial action had to be taken. As for Factory M, in the previous campaign, this involved spending much more time in establishing a good grain in the early stage of boiling the pan, having a higher temperature at graining, by reducing the vacuum to 20–23 inches of mercury, and by continuing to boil at a higher temperature than had been previous practice, thus minimizing the appearance of false grain.

The improvement achieved in CRI by mid-November was accompanied, as would be expected, by a marked parallel improvement in ash and water levels.

In 1950 FREED and HIBBERT[6] reported that the bulk density of sugar decreased markedly (by as much as 0·8 $lb.ft^{-3}$) if the proportion of conglomerates exceeded 85%.

They used a different technique to establish the incidence of conglomerates from that used in this current work, so that the CRI value at which this decrease in bulk density becomes significant is not as yet known. Nonetheless it is obviously a most important aspect of sugar quality, particularly when one recalls the proportion of our production which is packeted. It is, perhaps, also significant that at the same time Factory F had the low CRI values already mentioned, they had difficulties in the packeting plant, owing to the low bulk density of the sugar, and had to resort to using a larger packet.

In the early 1960's RODGERS and LEWIS[4,7,8] emphasized the advantages arising from the use of stirrers in the white pans. The work we have described shows that attention to the finer points of the art of sugar boiling is still of paramount importance if the resultant sugar quality is to reflect fully the substantial capital outlay involved.

(*to be continued*)

Guyana sugar factory fire[9].—Fire has partly destroyed the electric power station at the Rose Hall sugar factory in Berbice County, Guyana, bringing crushing operations to a halt. Damage to equipment is estimated at some £430,000.

* * *

Hawaii sugar factory reconstruction[10].—A new raw sugar factory has been built to double the capacity of the old Peepekeo factory which it replaces. The $19 million plant is the major part of a $27 million improvement and expansion programme of the Hilo Coast Processing Company, which is owned by the 390 cane grower members of the United Cane Planters Co-operative and Mauna Kea Sugar Co. Inc., a subsidiary of C. Brewer & Co. Ltd. The new facility is to have a capacity to crush 900,000 tons of cane per year, to produce about 90,000 tons of sugar and 20,000 tons of molasses. The Company's Papaikou factory is also to be improved while the Wainaku and Hakalau factories are to be closed after the 1974 crop.

* * *

Bagasse pulp plans for Australia[11].—A consortium of Australian, US and Japanese interests is planning a $A 100,000,000 project to build a plant at Mackay, in Queensland, to use bagasse as a raw material for manufacture of pulp which will then be exported to Japan for making into paper. Australian investors, including the Queensland Government, will hold a 51% interest in the undertaking.

* * *

New Japanese sugar refinery[12].—Completion of a new sugar refinery at Hekinan, about 20 miles south of Nagoya, has been announced. The new plant, belonging to the C. Itoh Group, is located in the Kin-ura Food Industrial Estate and has a daily melt capacity of 800 tons of raw sugar. Automatic controls are extensively used, and the plant produces refined soft sugar, granulated sugar, liquid sucrose and liquid invert sugar.

* * *

Factory closure in Hawaii[13].—McBryde Sugar Co., located on the island of Kauai, has closed its 73-year-old mill and has moved processing to a more modern factory at Koloa, acquired by McBryde when the nearby Grove Farm Company went out of the sugar business. With a cane area doubled to 13,610 acres, McBryde is now the second largest plantation on Kauai and expects to double its sugar production to 60,000 tons.

* * *

North Queensland refinery proposal[14].—The Federation of Chambers of Commerce of North Queensland are to continue to press for the establishment of a refinery to operate as an extension to one of the North Queensland sugar mills in Australia in order to reduce the local cost of refined sugar which, because of the distance involved, costs more than in the capital cities where the separate refineries are located.

[5] *Facts about Sugar*, 1926, **21**, 566.
[6] *Paper presented to the 3rd Tech. Conf., British Sugar Corp.*, 1950.
[7] *Paper presented to the 16th Tech. Conf., British Sugar Corp.*, 1963.
[8] *Paper presented to the 17th Tech. Conf., British Sugar Corp.*, 1964.
[9] *The Times*, 1st November 1974.
[10] *Sugar y Azúcar*, 1974, **69**, (9), 8, 10.
[11] *Australian News*, 1974, (1426), 4.
[12] F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (31), 12.
[13] *Sugar y Azúcar*, 1974, **69**, (8), 11.
[14] *Producers' Review*, 1974, **64**, (8), 56.

Constituents in raw sugar that influence refining

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Introduction

WHEN analysing cane juice by the standard analytical procedures, which were described by ROBERTS & MARTIN[1], one can account for all but about 3 or 4% of the juice in terms of known compounds such as sugars, water, starch, gum, dextran, protein, fat, wax, carboxylic acids, amino-acids and ash. The unknown 3 or 4 % is greatly reduced in the processing of the juice so that the unidentified substances are only in the ppm range in refined sugar. It is to these unknown minor constituents that the refiner must direct his attention.

The known constituents in cane juice or raw sugar have a known effect upon refining. They may be troublesome, but at least the refiner knows what the trouble is, what causes it, and what he can do about it, and whether it is worth doing anything about.

No one knows all the trouble that is caused by the unknown minor constituents, but colour results from these materials and we do know what trouble this causes. Colour is the key component in refining sugar. Every sugar refinery is run to obtain a product of sufficiently low colour value. All the other components, such as invert and ash, are handled easily enough, but every refinery struggles to remove the colour.

Although colour is the key component, relatively little is known about the chemical compounds that make up the colorant: their origin, their eventual destination, or their properties. With no knowledge about what specific materials make up the colorant, no specific method can be used for removal. Instead, general methods must be used. The principal methods are adsorption onto carbon, ion exchange, bleaching, precipitation and crystallization.

If more were known about the individual chemical compounds making up the colorant, it would probably be easier to prevent its formation or to remove it. The waste and sometimes destruction of sucrose and the expense entailed in the general decolorization procedures could be reduced.

But colour is not the only thing in that small unknown fraction of minor constituents in sugar. There must be compounds structurally similar to the colorants but not coloured, colour precursors, substances that produce flavour and odour, perhaps even toxic substances such as pesticide residues or heavy metals.

For further advancement in cane sugar processing, these unknown constituents will first have to be identified; then, analytical procedures must be developed so that they can be easily measured. Only then can improved processing be realised. Many minor constituents have already been identified; for example, ROBERTS & MARTIN[1] reported a long list of known compounds.

It is worthwhile reviewing briefly the present status in identification and measurement of these minor constituents, describing some of the recent advances, and considering what use can be made of this new information.

Ash Constituents

Although measurement of ash is routinely used in processing control, only rarely are the individual ash constituents considered. Practical analytical methods for all the major ash constituents are handbook information[2], and CARPENTER *et al.*[3] showed that the balance of polyvalent anions with polyvalent cations can have a spectacular effect on colour removal by bone char. This balance determination requires only the measurement of total ions (which can double as an ash determination), chloride and calcium. In every refinery, calcium is added in the form of lime, but the control is based on pH, not on calcium.

By controlling calcium, particularly to avoid an unfavourably low level, good decolorization by bone char can be assured. At present only a few refineries practise this method, but many more could use it to achieve better control over the still little understood bone char process.

Very recently considerable concern has arisen over what were formerly very minor ash constituents, namely heavy metals. In a recent survey by POMMEZ & CLARKE[4], a raw sugar and a refined sugar were examined for 25 heavy metals. The only toxic heavy metals above the detection limit were: chromium, selenium, antimony, nickel, cadmium, barium, copper, tin and lead.

Conspicuous by their absence were such famous poisons as arsenic and mercury.

Some of the heavy metals are not toxic but are essential to growth. These are generally referred to as trace elements. A few elements—those that are toxic at high levels but essential at low levels—appear in both categories. The desirable trace elements found in sugar were: vanadium, cobalt, selenium (also toxic), chromium (also toxic), copper (also toxic), molybdenum, manganese, zinc, tin (also toxic) and iron.

All of the toxic heavy metals present were well below the level of concern in refined sugar but unfortunately the essential trace elements were also very low, below the effective dietary supplement range.

In another study by CLARKE *et al.*[5], the levels of various metals were charted from the raw sugar through the refinery to the refined product. Samples from different types of refineries were studied. Table I shows a typical set of results for a few metals from

[1] *Proc. 6th Tech. Session on Bone Char*, 1959, 67–88.
[2] MEADE: "Cane sugar handbook", 9th edn. (Wiley, New York) 1963, 845 pp.
[3] *Proc. 7th Tech. Session on Bone Char.*, 1961, 259–286.
[4] *Proc.* 1972 *Tech. Session Cane Sugar Refining Research*, 1972. In press.
[5] *Proc. Sugar Ind. Tech.*, 1973, **32**, 160–171.

refineries that used various decolorization techniques. Analysis was by atomic absorption spectrophotometry, with the sample in solution atomized in a graphite furnace. The major removal of all of these metals was in the affination and clarification stages. Iron and manganese levels were reduced considerably further by passage over bone char. In some cases the copper level increased between liquors entering pans and refined sugar, probably because of the large quantities of copper in the surfaces to which the hot liquor was exposed.

Table I. Levels of heavy metals in refineries

	Pb	*Ni*	*Co*	*Cd*	*Zn*
			ppm		
Refinery A					
Raw sugar	0·280	0·094	0·022	—	0·005
Affined sugar	0·042	0·037	—	0·002	0·021
Phosphatated liquor	0·076	0·033	—	0·0002	0·010
Char	0·025	0·019	—	0·0005	—
Resin	0·016	0·016	—	0·0004	0·026
Char × 2	0·055	0·018	—	0·0005	0·002
Refined sugar	0·027	0·060	—	—	—
Refinery B					
Raw sugar	0·219	0·093	0·026	0·002	0·895
Remelt liquor	0·795	0·237	0·048	0·005	0·516
Affination + Carbonatation	0·009	0·080	0·013	0·002	0·046
Char	0·009	0·034	—	0·002	0·084
Refined sugar	—	0·066	—	0·004	0·179
Refinery C					
Raw sugar	0·088	0·184	0·058	0·012	0·102
Affination + Phosphatation	0·027	0·040	—	0·012	0·006
Granular carbon	0·028	0·029	—	0·002	—
Refined sugar	0·034	0·040	—	0·002	—
Limit of detection	0·0002	0·005	0·0008	0·0001	0·001

Levels of metals in raw sugars entering the refineries covered a wide range. Differences could be due to soil and weather conditions in the field and to the type and quality of processing in the mills. However, the various combinations of processes in the refineries all gave refined sugars with metals at about the same levels, despite differences in the raw sugar.

For the fact that heavy metals are no problem, the cane sugar industry can be collectively thankful. However, the "safe" levels tend to decrease toward the detection limit. As more sensitive analytical methods are developed it can be expected that problems will arise. The industry must continue to monitor its products by the latest available methods to stay one jump ahead of any possible "scare" that could have catastrophic effects on sugar sales, bring stringent regulations, and precipitate major reorientation of processing.

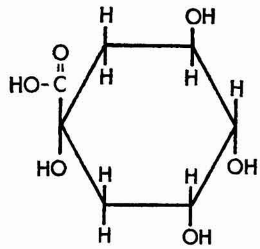
COLORANTS

Identification

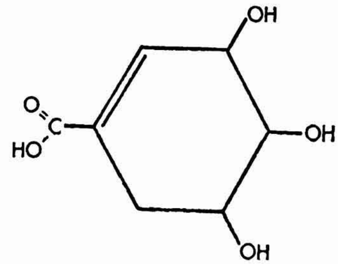
At the 1971 meeting of ISSCT, FARBER & CARPENTER[6] reported on the identification of several plant pigments that occur in raw and refined cane sugars. This work has been continued, and the identity of 21 of these minor constituents whose source is the cane plant is now known[7].

It is interesting to consider the types of compounds found; every compound contained a ring structure. The simplest structure was quinic acid, which has a saturated ring. This compound is common to many plants.

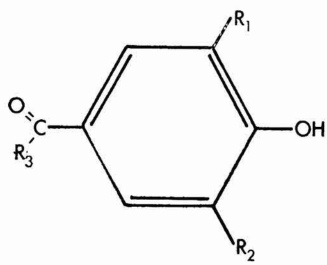
Splitting one molecule of water out of quinic acid gives shikimic acid, which is considered to be involved in the biosynthesis of aromatics.



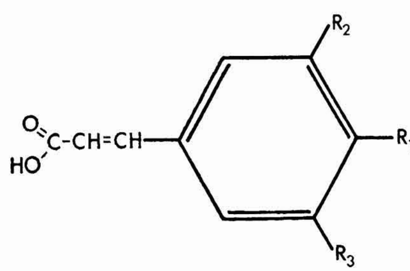
Quinic acid



Shikimic acid



	R_1	R_2	R_3
Vanillic acid	OCH_3	H	OH
Vanillin	OCH_3	H	H
3,4-Dihydroxybenzoic acid	OH	H	OH
3,4-Dihydroxybenzaldehyde	OH	H	H
p-Hydroxybenzoic acid	H	H	OH
p-Hydroxybenzaldehyde	H	H	H
Syringic acid	OCH_3	OCH_3	OH



	R_1	R_2	R_3	
p-Coumaric acid	OH	H	H	
Caffeic acid	OH	OH	H	
Ferulic acid	OH	OCH_3	H	
Sinapic acid	OH	OCH_3	OCH_3	
Chlorogenic acid	OH	OH	H	quinic acid ester
Coniferin	O-glucose	OCH_3	H	alcohol

[6] *Proc. 14th Congr. ISSCT*, 1971, 1589–1600.

[7] FARBER & CARPENTER: *Proc.* 1972 *Tech. Session Cane Sugar Refining Research*, 1972. In press.

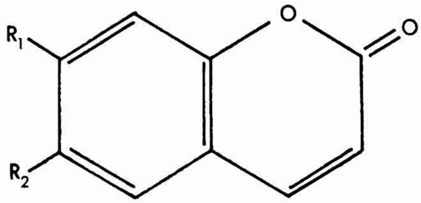
All of the other compounds identified were aromatic.

Seven of the compounds were benzoic acid derivatives or their corresponding aldehydes.

Since none of these compounds is coloured, they are not considered pigments. However, these compounds do have flavour and odour, and can have deleterious effects on products made from sugar.

Six of the compounds identified were cinnamic acid acid derivatives and their corresponding alcohols or esters

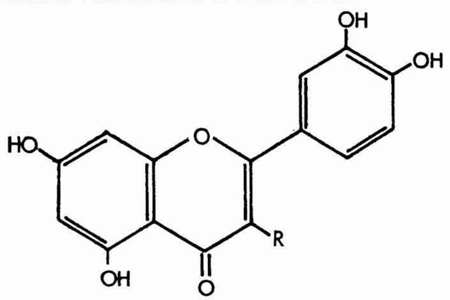
In addition, 3 compounds were coumarin derivatives, although coumarin can be considered the product of ring closure of *o*-hydroxycinnamic acid.



	R_1	R_2
Coumarin	H	H
Umbelliferone	OH	H
Esculin	OH	O-glucose

Three compounds were flavonols.

These last 3 classes of compounds are all coloured, generally yellow, and are more strongly coloured at higher pH. The flavonols are generally more deeply coloured than cinnamic acid derivatives.



	R
Kaempferol	H
Quercetin	OH
Rutin	O-rutinose (= rhamnose glucose)

All 21 of the above compounds were found in the cane plant, 10 were found in raw sugar, and 4 in refined sugar.

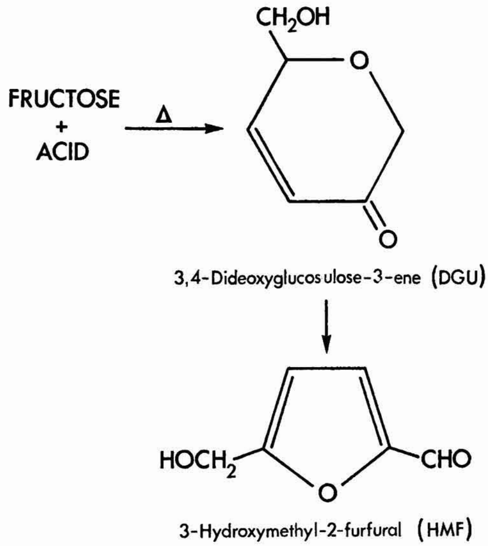
The plant pigments thus far identified are undoubtedly only a small fraction of all the compounds present, many of which will surely be other derivatives in these same classes. It will be interesting to see which additional classes of plant pigments are discovered.

There are, however, two other types of colorants, not plant pigments, that may account for a large fraction of the sugar colorant. These are melanoidins, the reaction products of amines with reducing sugars, and caramels, the decomposition products of sucrose.

BINKLEY[8] and COOKSON *et al.*[9] have studied these other classes of colorants extensively but still have not identified the chemical species of the colorants. They believe that other colorants are far more important than the plant pigments. The melanoidins are undoubtedly very dark, but to the refiner the most important colorants are not necessarily the most highly coloured but the most difficult to remove and thus those most often found in refined sugar.

Melanoidin and caramel-type colour is undoubtedly being made from sugar at all stages of processing. ANET[10] has proposed one route in which fructose under acidic conditions forms 3,4-dideoxyglucosulose-3-ene (DGU) as a precursor to 5-hydroxymethyl-2-furfural (HMF) which in turn is a precursor to colour.

The first step in this mechanism is the inversion of sucrose. The second step is the acid-type decomposition of fructose. However, this representation is vastly oversimplified, because 13 different unidentified materials that have been isolated from acid fructose solutions all convert to DGU.



ANET[11] has also shown that this same intermediate, DGU, can be formed through the Maillard reaction in which the amine fraction splits off, leaving DGU, with the amine then free to repeat the process.

Another mechanism of colorant formation involving amines is through the formation of reductones, reviewed by HODGE[12]. However, the exact compounds involved and the resulting colorant have not been identified.

There is another whole realm of colour formation in the alkaline range which has been much studied. FLEMING *et al.*[13] have evaluated many of the properties of the colorant and colour precursors, but the exact mechanism of formation and nature of the coloured products still remain elusive.

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[8] *Zeitsch. Zuckerind.*, 1970, **95**, 291–295.
[9] *Proc.* 1970 *Tech. Session Cane Sugar Refining Research*, 103–113.
[10] *Aust. J. Chem.*, 1965, **18**, 240–248.
[11] *Advances in Carbohyd. Chem.*, 1965, **19**, 181–218.
[12] *J. Agric. Food Chem.*, 1953, **1**, 928–943.
[13] *Proc.* 13*th Congr. ISSCT*, 1968, 1781–1800.

If the mechanism of the colour formation could be better described or the precursors identified, then it might be possible to interrupt the mechanism to save sucrose or to otherwise react the intermediates to avoid colour.

Measurement

Once some colorants are identified, the next step is to devise simple practical analytical procedures so that the compounds can be followed through processing to determine how much of a problem they actually are.

Chromatography. One obvious analytical technique is gas chromatography; however, GODSHALL[14] showed as many as 80 peaks in cane sugars by gas chromatography, so that peak identification is difficult at best. By using a preliminary solvent extraction for partial separation she was able to reduce the peaks to a manageable number. Her results for four compounds, given in Table II, show that these minor constituents average several ppm in raw sugar but are reduced to well below 1 ppm in refined sugar.

Table II. Minor constituents in sugar by gas chromatography

	Malic acid	*para-Hydroxy-benzoic acid*	*Palmitic acid*	*Oleic acid*
	ppm			
Raw sugar A	13·3	6·8	12·1	24·7
Raw sugar B	0·59	0·93	3·8	6·6
Refined sugar C	<0·01	<0·07	0·33	0·37
Refined sugar D	<0·01	<0·07	0·31	0·36

Fluorescence Methods. Another technique that has analytical possibilities for these minor constituents is fluorescence. Since fluorescence was used extensively in the work in which these materials were detected and identified in sugars, it would seem natural to use it to measure them. CARPENTER & WALL in two papers[15,16] explored the fluorescence in sugar solutions, defined its range, and showed that the fluorescence of many of these minor constituents coincided with the usual fluorescence of sugars. They also showed that fluorimetry was an extremely sensitive technique, far more sensitive than colorimetry for the very low concentrations.

More recently the fluorescence method has been applied directly to electrophoregrams. This technique combines the superior resolving power of high voltage electrophoresis as developed by GROSS[17] with the high sensitivity of fluorescence. The sugar solution is extracted at a suitable pH and Brix with a solvent selected to give substantially 100% extraction of the minor component in question.

Note that this technique would not be possible if the constituent had not been identified. Identification of the constituents is a prerequisite to developing methods for their analysis.

Unfortunately there is no universal solvent or set of conditions; a different extraction has to be made for nearly every different constituent. The extracted component is run on high voltage electrophoresis[6], and the resulting electrophoregram is evaluated with a fluorescence densitometer to obtain quantitative results.

Some results are shown in Table III.

Table III. Minor constituents in sugar by fluorescence densitometer

	Chlorogenic acid	*Umbelliferone*
	ppm	*ppm*
Raw sugar E	4·6	0·030
Raw sugar F	3·2[redacted]	0·014
Raw sugar G	0·07	<0·0001
Refined sugar H	<0·001	<0·0001

These results are at the same level as those obtained for different compounds by gas chromatography.

FLOC CONSTITUENTS

Another area that may be elucidated by identification of constituents in sugar is the nature of beverage floc. The floc problem has been "solved" many times but has not been eliminated. Floc formation seems to result from a combination of several factors and conditions. As an increasing number of minor constituents are identified, it is possible that some correlation will be found between the presence of certain constituents and the formation of beverage floc, or perhaps between the absence of certain other constituents and the non-appearance of beverage floc.

CONCLUSION

Around the world the specifications for refined sugars are surely going to become increasingly restrictive. Under conditions of tightened control, farmers, millers and refiners alike are all going to have to pay more attention to the complete composition of sugars, particularly to the minor constituents.

SUMMARY

The present status in identification of the minor constituents in cane sugars and the effect of these constituents on refining are reviewed. Discussed are ash constituents, including heavy metals, colorants and floc constituents. Analytical methods for these minor constituents are described, and results show them to be in the ppm range in raw sugars and well below 1 ppm in refined sugars. These minor constituents will become even more important as standards for refined sugar are tightened and increasingly affect farmers, millers, and refiners alike.

Swaziland sugar expansion plans[18].—A proposal by Tate & Lyle Ltd. for a joint venture with the Swaziland Government in a third sugar factory is being studied. The project involves an investment of up to R30 million and the new mill would in time produce up to 100,000 tons of raw sugar annually. Together with the two existing factories in the country, the new mill would help make Swaziland one of the largest sugar producers in the Commonwealth. A market appraisal projects 280,000 tons of sales by the Swaziland sugar industry in 1985. With a potential of 100,000 tons for each of the existing factories there is thus room for a new plant of 80,000 tons. This would be located as centrally as possible in the projected cane growing areas so as to minimize cane transport distances. It is estimated that about 20,000 acres of irrigated land will be required to support the proposed factory; areas have been selected where the soil is considered suitable and the terrain generally well adapted for irrigation. Elevations are well below 1000 feet and slopes are gentle, allowing road, drainage and irrigation layouts to be easily planned and effected.

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[14] *Proc.* 1972 *Tech. Session Cane Sugar Refining Research.* In press.
[15] *Proc.* 1970 *Tech. Session Cane Sugar Refining Research,* 157–178.
[16] *Proc.* 1972 *Tech. Session Cane Sugar Refining Research.* In press.
[17] *J. Chromatog.*, 1961, **5**, 194–206.
[18] *Standard Bank Review,* October 1974, 19.

Sugar cane agriculture

Relationship between potential evapotranspiration of sugar cane, pan evaporation and production. F. A. Fogliata. *Rev. Ind. Agric. Tucumán*, 1973, **50**, (1), 5–25.—Lysimeter trials gave a potential evapotranspiration value *Et* (defined as the maximum evapotranspiration possible under existing climatic conditions when the soil is abundantly provided with water and is covered with a complete growth cover) for Tucumán cane of 1331·6 mm per year over a 10-month period. Good correlation was found between weekly stalk elongation and daily use, and a lower correlation between weekly stalk elongation and Class A Pan evaporation (*Eo*). The ratio *Et:Eo* varied from 0·6 to 1·2, with an overall average of 0·9. The daily *Et* during spring was 4·42 mm, in summer 6·09 and in autumn 3·46 mm. In summer the cane consumed 55·3% of the total water requirements, 59·2% of the total stalk length was grown, and 53·3% of the total dry matter produced. Water requirements per ton of cane and ton of sugar are given as 12·55–14·90 mm and 104·9–144·2 mm, respectively.

* * *

Influence of organic arsenical compounds on sugar cane production and rendement. R. P. Cossio. *Rev. Ind. Agric. Tucumán*, 1973, **50**, (1), 39–66.—Experiments were conducted to determine the effects of DSMA (disodium methyl arsenate) and MSMA (monosodium methyl arsenate) used as herbicides for control of *Sorghum halepense* on cane and sugar yields. It was found that although the herbicides did not affect cane sugar content, they did reduce weekly stalk elongation during a 15–20 day critical period after application and hence final millable stalk length. They also caused a reduction in diameter and length of the internodes. In order to avoid damage to the canes, application of the herbicides before planting is recommended.

* * *

A new method of synchronizing flowering in sugar cane. E. D. Paliatseas. *Rev. Ind. Agric. Tucumán*, 1973, **50**, (1), 79–88.—The new method has permitted crossing of early- and later-flowering varieties and of these varieties with wild *Saccharum* species. After greenhouse growing of stubble shoots from 12 varieties during the winter, the best developed tillers were marcotted in the following March, rooted, and transplanted in stovepipe tubes containing a mixture of soil, sand and peat moss. In the April, the plants were removed from the greenhouse and placed on trollies which could be moved in an out of the photoperiod houses. Flower induction treatment was carried out from April to June, inclusive, after which non-inductive short-day treatment was applied until end-July. All 12 varieties showed definite flowering signs, and flower emergence increased from 1st July to end-August, during which period most of the early-flowering *Saccharum* species flower naturally.

* * *

Experiments with silicates. Anon. *Producers' Rev.*, 1973, **63**, (12), 21.—See *I.S.J.*, 1974, **76**, 368.

Half of tractor deaths could be avoided. G. L. McDonald. *Producers' Rev.*, 1973, **63**, (12), 28–29. Referring to the large number of deaths in Australia resulting from tractor accidents, the author points to the advantages of protection frames which, provided they prove satisfactory in proving tests, can prevent most of the fatalities caused when a tractor overturns.

* * *

Controlled-release fertilizers. Anon. *Producers' Rev.*, 1973, **63**, (12), 48–49.—The merits of controlled-release fertilizers are discussed and the basic characteristics of four plastic coatings used to cover soluble fertilizer granules are described. The rate of release from the granules is not affected by bacterial action or changes in soil moisture, but is governed only by temperature. The point is made that although controlled-release fertilizers are more costly than normal fertilizer mixtures in current use, they should permit reduction in losses, e.g. caused by leaching and hence help reduce the application rates.

* * *

Drip and trickle. L. G. Vallance. *Australian Sugar J.*, 1973, **65**, 437–442.—Reference is made to continuous feeding of irrigation water direct to cane roots through narrow-bore plastic tubing, as practised in Hawaii. While it is claimed to have the advantage over conventional irrigation methods of maintaining a regular level of moisture without risk of a period of moisture stress, the method does suffer from a few problems, including high cost and restricted availability of the tubing. However, investigations have shown that both surface tubing (which must be expendable, since it will be destroyed at harvest time) and sub-surface tubing have given better cane growth rates than those obtained with comparable furrow irrigation, although both methods of pipe location have their merits and demerits. Three types of tubing suitable for the task are described; preference is shown for a double-chamber (twin) tube in which one chamber conveys the water at a relatively high pressure (15 psi) and has outlets into the second, low-pressure, chamber which contains the orifices for feeding the water to the plant. Other factors considered are the question of row spacing (Hawaiian cane-growing methods differ appreciably from those in Queensland) and pre-treatment of the irrigation water to prevent blockage of the outlets with impurities.

* * *

Sugar cane transportation for mechanical harvesting. C. Y. Lu. *Taiwan Sugar*, 1973, **20**, 226–231.—Illustrated descriptions are given of three cane transport systems tested in Taiwan to determine which is the most economical for varying conditions with mechanical harvesting. The systems are: (1) the "piggyback" cane car which, in the field, is mounted on a tractor-drawn trailer and, when full, slides down an inclined rail from the trailer onto a narrow-gauge railway line; when 30–35 cars have been made up into a train, they are hauled by locomotive to the factory. (2)

Direct transport by road truck to the factory from a transfer point to which the cane is taken by oxcart. (3) Use of a transfer station, with or without washing equipment, or of a transloader with dry-cleaning equipment. The advantages and disadvantages of the systems are discussed as well as the costs.

* * *

Progress on Queensland coastal irrigation projects. F. B. HAIGH. *Australian Sugar J.*, 1973, **65**, 445–449. Details are given of the various irrigation projects in Queensland coastal areas with mention of investigations into further possible schemes. It is pointed out that the importance of these schemes lies in the fact that more than 30% of the total area under cane is irrigated.

* * *

Water resources development for agriculture and irrigation water management in Taiwan. Y. T. WANG. *Taiwan Sugar*, 1973, **20**, 246–253.—The subject is discussed in relation to various crops in Taiwan, including sugar cane, details being given of the development of ground water sources, economical use of water by means of rotational irrigation, land consolidation to facilitate irrigation, and organization of irrigation and water conservancy.

* * *

***Pyrilla*—a menace to sugar cane and the sugar industry.** A. N. KALRA. *Indian Sugar*, 1973, **23**, 737-739, 743. *Pyrilla perpusilla* incidence in India, the nature of damage and the losses it causes in cane, alternative hosts and natural enemies are discussed. Probable causes of a severe attack by the pest in 1972/73 are listed and methods of control, both chemical and biological, examined.

* * *

Integrated control of sugar cane scale (*Melanaspis glomerata* **G.**). R. A. AGARWAL and S. KUMAR. *Indian Sugar*, 1973, **23**, 741–743.—Methods of control considered are: selection of non-infested seed, use of resistant varieties, mechanical control (stripping of dry leaf sheaths and burning of trash), chemical control (several insecticides have proved effective, particularly against the newly-hatched crawlers and first instar nymphs), colonization of natural enemies, and quarantine.

* * *

An account of red rot disease in Bihar and possible measures to keep it under control. B. SARKAR. *Indian Sugar*, 1973, **23**, 745–750, 753.—The incidence of red rot (*Glomerella tucumanensis*) in Bihar (where it is the most serious cane disease) since 1949 is examined and the changes in the cane varietal pattern and their possible effect on intensity of the disease discussed.

* * *

Significance of soil moisture during simulated freezing for sugar cane survival. O. SINGH and O. S. SINGH. *Indian Sugar*, 1973, **23**, 751–753.—Greenhouse experiments were carried out to establish the possible effect of soil moisture on frost resistance in 60-day plants exposed to a temperature of —3°C for specific controlled periods. At 90% available soil moisture, the vertical height of the mother shoot, leaf moisture content and transpiration rate were greater than at 25% available moisture, although there was no significant difference between the two treatments as regards number of tillers and green leaves. Moreover, there was little difference between the effects at 90% soil moisture and values of the different factors in unfrosted cane at the two moisture levels.

* * *

Iron chlorosis—a devastating disease of sugar cane. U. S. SINGH. *Indian Sugar*, 1973, **23**, 755–756. Areas of India where iron chlorosis has been reported are indicated and soil conditions conducive to the disorder are described as are the symptoms and effective remedies.

* * *

The effect of chemical ripeners on the growth, yield and quality of sugar cane in South Africa and Swaziland. H. ROSTRON. *S. African Sugar J.*, 1974, **52**, 74–85. See *I.S.J.*, 1974, **76**, 207.

* * *

Breeding better sugar cane. ANON. *World Farming*, 1974, **16**, (2), 6–7.—Information is given on the cane breeding programme launched at Houma, Louisiana, to explore the basic *Saccharum* species and cross those with inherently desirable characteristics with established commercial canes. Illustrations show various aspects of the work and a large new greenhouse, with crossing cubicles, seed-maturing racks, automatic temperature controls and facilities for air-layering, which will permit breeding of varieties resistant to mosaic, ratoon stunting disease and smut. In addition, four photo-period houses will also be built.

* * *

Soil conservation's value is much underrated. ANON. *Producers' Rev.*, 1974, **64**, (2), 41.—The need to conserve soil is discussed with reference to the serious situation created by heavy rains in the Mackay district of Queensland in 1973 when much soil was washed away, often into streams, with consequent increased erosion of river banks by the heavily silted water. Means of preventing such occurrences and increasing soil water absorption are briefly described.

* * *

Farm contour scheme has saved their topsoil. ANON. *Producers' Rev.*, 1974, **64**, (2), 42.—How soil loss at one farm in the Mackay district of Queensland was considerably reduced by a farm contour scheme developed in collaboration with the Bureau of Sugar Experiment Stations is briefly described.

* * *

Field transporters handle mud at Isis. ANON. *Producers' Rev.*, 1974, **64**, (2), 49.—The benefits brought to a group of cane farmers in the Isis district of Queensland two infield cane transporters are briefly discussed. The transporters, built by Freighter Industries Ltd., are elevating and side-tipping types of six tons capacity; the aircraft-type tyres help to reduce compaction and damage to ratoons during wet weather harvesting.

* * *

New variety N 52/219 to be distributed. J. WILSON. *S. African Sugar J.*, 1974, **58**, 113.—A progress report from the Director of the Experiment Station at Mount Edgecombe gives information on cane breeding and new varieties, including a description of N 52/219, which is highly resistant to smut as well as mosaic and eye spot. Other aspects covered include the seed cane approval scheme, performance of a McConnel harvester (the base cutter of which worked highly satisfactorily during 80 hours, whereas the topping device was not very effective) which was to be re-appraised before the 1974/75 season, the Fertilizer Advisory Service, infestation by *Eldana saccharina* moth borer and experiments with "Temik" nematicide which has proved effective under certain conditions.

* * *

Engineering properties of sugar cane: their relation to mechanical harvesting. W. J. COCHRAN. *Sugar y Azúcar*, 1974, **69**, (3), 29–37.—With the aim of increasing harvester efficiency, samples from a number of cane varieties were subjected to tests to determine the tensile and compressive modulus of elasticity of the internodes in a longitudinal direction. General equations were developed to define the stresses and strains a cane stalk would endure, and the force and deflection of canes tested as a simple beam were measured. Significant differences were found between the values for top and bottom stalk sections. The moment of inertia and different types of elasticity moduli were calculated, and values obtained (from tests on cane at various stages of maturity and under different conditions) which could be used in the equations describing beam deflection and strength. As an example, design calculations are given for establishing the required diameter of a corner idler sprocket on a harvester.

* * *

Fertilization of ratoons: a preliminary case study. J. G. DA SILVA and E. ABRAMIDES. *Brasil Açuc.*, 1974, **83**, 156–159.—Results of a field trial are reported; the cane was CB 49/260, grown at 3rd ratoon on a latosol in Pirassununga, São Paulo. Application of 500 kg/alqueire of 18-9-28 produced a yield increase as much as 27% or 9 tons per acre (1 alqueire is a local measure equivalent to approx. 6 acres). Half this dosage, on surface application, increased yield by 6% (2 tons per acre) while deep placement also raised cane yield by as much as 21% (7 tons per acre). Control plots, subjected to subsoiling but with no fertilizer, showed an increase of 10% (3 tons per acre).

* * *

Considerations on the symptomatology of micro-nutrients in sugar cane in the north-east of Brazil. E. SULTANUM. *Brasil Açuc.*, 1974, **83**, 168I–168XVI. The symptoms of deficiency of five micro-nutrients (Fe, Mn, Zn, Co and B) are described and illustrated. Deficiencies in these elements are a cause of low productivity in the cane areas of north-east Brazil, and the author points out the association of certain physiological diseases with such deficiencies. He believes that, if the nutritional requirements were met, degeneration of sugar cane varieties would not occur and recommends that a study be made with a view to achieving recovery of some varieties. He also discusses the possibility of using some varieties as indicators of nutritional deficiencies or imbalances.

* * *

Three new sugar cane pests in the state of São Paulo. P. GUAGLIUMI and A. C. MENDES. *Brasil Açuc.*, 1974, **83**, 184–185.—Reference is made to three new cane pests discovered in São Paulo, viz. (i) *Eurybia misellivestis* Stich. (Riodinidae), a green larva 1·5–2 cm long which inhabits the soil and penetrates the base of the cane, (ii) *Hypoeneuma taltula* Schaus (Noctuidae), a yellow borer about the same in size as *Diatraea saccharalis* but not spotted as is the latter, and (iii) *Automeris irene* Cramer (Hemileucidae), which is the caterpillar (also named the "mandarin yellow") of a large butterfly know as the "peacock" or "peacock's eyes". Colour photographs of (ii) and (iii) are reproduced, and information is given on the type of damage caused by the pests.

* * *

Optimum utilization of input resources—nitrogenous fertilizers. S. U. BHAID and P. R. VAKIL. *Sugar News* (India), 1973, **5**, (7), 14–21.—The questions of optimum quantity of fertilizer, type of fertilizer, when and how to apply it are considered in relation to nitrogen and various crops including sugar cane.

* * *

Germination in sugar cane. K. KAR, R. G. SINGH and A. ALI. *Sugar News* (India), 1973, **5**, (7), 22–29.—A survey is presented of the literature on the effects of seed cane quality, seed rate, time of planting, row spacing, planting depth, fertilization, insecticides, herbicides and seed dressings on germination, with mention of packing material for seed cane transported over great distances and activated bud transplanting where setts are buried to combat frost effects.

* * *

Effect of time of application of nitrogen fertilizer on moisture index and juice quality of sugar cane. T. R. SHRINIVASAN, G. S. THANGAMUTHU and M. R. IRUTHAYARAJ. *Indian Sugar*, 1973, **23**, 593–596.—The importance of leaf sheath moisture as an indication of cane growth and maturity is mentioned and reference made to the effect on it of quantity and time of application of fertilizers. Details are given of tests with N, P and K, in which N was applied as ammonium sulphate in two equal doses 45 days and 90, 120, 150 or 180 days after planting with and without P and K. Results showed that sugar recovery fell with length of time N application was delayed beyond 90 days, that P and K application improved juice quality particularly when N application was delayed, that sheath moisture was greatly affected by crop age and time of N application, and that there was a highly significant negative correlation between sheath moisture and juice quality.

* * *

Sugar cane research and development by the private sector. R. R. PANJE. *Indian Sugar*, 1973, **23**, 597–599. An an example of cane research and development work carried on by private sugar companies, the author cites cane varietal selection and propagation by Godavari Sugar Mills Ltd. and makes briefer references to the same company's work on fertilizers, irrigation and other agricultural aspects.

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Some observations on the behaviour of the dispersing larvae of *Bissetia steniella* (Hampson) and their susceptibility to some common insecticides. N. CHAND and S. N. DESHMUKH. *Indian Sugar*, 1973, **23**, 603–605. Commonly known as the Gurdaspur borer, this is a serious pest of cane in India; the larvae feed on a cane until the third instar, then disperse to neighbouring canes. An estimated 5–15% crop yield reduction caused by the pest has been reported in years of normal infestation, although 40–50% is often reached in severely attacked fields. While various control measure have proved unsuccessful in the past, attempts were made to reduce the numbers by spraying with insecticide at the dispersal stage. Results showed that of the five chemicals tested, "Malathion" was the most effective, followed reasonably closely by "Endosulfan", whereas DDT, "Carbaryl" and "Endrin" were only slightly toxic to the borer.

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Co 1007, a new heavy yielder and mid-season sugar cane variety for waterlogged conditions. B. K. MATHUR and N. P. SINGH. *Indian Sugar*, 1973, **23**, 601–602. Details are given of this variety. It is regarded as a suitable replacement for BO 3 which, although a dependable mid-season variety under waterlogged conditions, is also subject to red rot.

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Suction pressure method (a new inoculation technique) for testing sugar cane varieties against spike and grassy shoot virus diseases. A. JHA, H. C. PRASAD and B. MISHRA. *Indian Sugar*, 1973, **23**, 607–611.—Of various methods tested for transmission of the two virus diseases mentioned in the title, the most effective was the suction pressure method in which single-bud setts from healthy plants were dipped in the inoculum and the other end connected to the suction pipe of an electrically-operated pressure device for three minutes. While none of the plants from fifteen varieties exhibited symptoms during the 10 months in the glasshouse, ratoons produced from them during four months did reveal symptoms.

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Nematode pests of sugar cane new to Trinidad. N. D. SINGH. *Plant Disease Reporter*, 1974, **58**, 122.—Brief mention is made of the occurrence of nematodes on cane grown for teaching purposes at the field station of the University of the West Indies in Trinidad. The species identified (*Pratylenchus zeae*, *Trichodorus minor*, *Tylenchorhynchus martini* and *Heterodera* sp.) are believed to be the first reported in Trinidad.

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Content of phosphorus in some sugar cane varieties. II. Second ratoons. M. A. A. CESAR, E. R. DE OLIVEIRA and M. R. MAZZARI. *Brasil Açuc.*, 1974, **83**, 229–233. Phosphate contents of a number of Brazilian cane varieties were measured during the harvesting period and are reported. They remained reasonably constant during the period, but in all cases were insufficient to give good clarification, so that addition of phosphate to juice is recommended.

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Weeds in the US. L. L. LAUDEN. *Sugar Bull.*, 1974, **52**, (10), 8.—Mention is made of brown top and mule weed in Louisiana cane fields[1]. Mule weed, so far resistant to herbicides, has become widespread on many farms and is now found in most areas of the US cane belt. It does not flower until late autumn and, although found in plant cane fields, is not particularly noticeable until ratoon cane is growing, when it becomes large and vigorous.

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Estimates of heritability in sugar cane. A. I. ALLAM, P. E. SCHILLING and K. L. KOONCE. *Sugar J.*, 1974, **36**, (10), 35–37.—In field tests with large numbers of experimental clones for plant, 1st and 2nd ratoon cane, estimates of broad-sense heritability (degree of genetic determination) were obtained for cane and sugar yield. The heritability values increased from plant to 2nd ratoon cane for the variables. The wide range of values of the variables plus the high heritability estimates indicated considerable expected improvement through selection.

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Fertilizer and soil fertility practices for sugar cane production, 1974. O. D. CURTIS, D. T. LOUPE, L. E. GOLDEN and R. RICAUD. *Sugar Bull.*, 1974, **52**, (11), 10–11.—General fertilizer and soil fertility recommendations are given on the basis of results obtained in field experiments conducted throughout the Louisiana cane area. The suggestions are for use when results from soil tests are not available, although it is emphasized that fertilization should be based on soil test results. The recommendations cover rates of application to seed, plant and ratoon cane, time and method of application (split application of N is considered possibly beneficial when it is used at the rate of 120 lb or more per acre), and means of improving soil fertility, including liming, application of rock phosphate in certain areas, and use of filter cake on fallow land or where old stubble is to be uprooted.

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The control of Johnson grass and other weeds in Louisiana sugar cane, spring 1974. E. R. STAMPER and R. MILLHOLLON. *Sugar Bull.*, 1974, **52**, (11), 12–18. Recommendations are given on methods and herbicides to control Johnson grass, Raoul grass and Bermuda grass and other weeds found in the Louisiana cane belt.

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Control of sugar cane shoot borer—problems and prospects. S. SITHANANTHAM. *Indian Sugar*, 1973, **23**, 667–669.—Difficulties in controlling *Chilo infuscatellus*, found in all cane-growing states of India, are discussed and suggestions made regarding possible investigations which could provide a basis for control, including use of the egg parasite, *Trichogramma* sp.

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Observation on chlorotic disease of sugar cane. R. C. KULSHRESHTHA, M. S. VAIDYA, K. A. GURSAHANI, V. K. SAXENA and V. K. PATASKAR. *Indian Sugar*, 1973, **23**, 671–672.—Symptoms of chlorotic streak and the varieties found to be infected with it in Madhya Pradesh are reported. Chlorosis (not caused by virus but by trace element deficiencies) is also discussed. The use of hot air treatment to combat chlorotic streak is mentioned.

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Hot water treatment for control of spike and grassy shoot diseases of sugar cane. J. JHA, H. C. PRASAD and B. MISHRA. *Indian Sugar*, 1973, **23**, 677–681. Tests showed that hot water treatment of setts for 1 hour at 52°C controlled spike and grassy shoot without affecting germination.

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Integrated control of moth borers of sugar cane. A. N. KALRA. *Sugar News* (India), 1973, **5**, (8), 17–20.—It is estimated that some 8% of the total cane crop of India is destroyed by borers (of which there are about a dozen species). The author discusses various means of control, including crop spraying, use of parasites and planting pre-treated seed cane.

[1] LAUDEN: *I.S.J.*, 1974, **76**, 208.

Sugar beet agriculture

Organization of the Agronomic Service (Raffinerie Notre-Dame S.A.) ANON. *Le Betteravier*, 1974, **8**, (73), 33–37.—See *I.S.J.*, 1974, **76**, 180.

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Soil structure problems in sugar beet. A. S. KENNEDY. *British Sugar Beet Rev.*, 1973/74, **41**, 156–158.—To break soil surface caps before sowing, a set of spike-studded cast iron wheels fitted to a tractor hoe is effective. The extent to which the crust is broken is governed by the speed of the towing tractor and the pressure of the wheels on the ground (which is controlled by tension spring). In preliminary trials on beet drilled to 6-inch spacing, an increase of 7000 plants per acre was achieved when the wheels were used after partial emergence of the seedlings. An increase of 7050 was obtained when cap breaking was carried out before emergence. Mention is also made of a power harrow fitted with a crumbler barrel to produce a seedbed on heavy soil. It is not suitable for certain sandy soils, however, since it then produces too fine a bed with consequent difficulties.

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Bolting in early-sown beet. L. A. WILLEY. *British Sugar Beet Rev.*, 1973/74, **41**, 159, 165.—In early-sown bolting plots in 1973 the average level of bolting (more than 8%) was greater than in 1972 and 1971 and coincided with the earliest sowing date (14th March) for more than 10 years. The bolting percentages are given for 10 varieties for 1971–73, for both early and total bolting. While the general level of bolting resistance in recommended varieties is good, it is pointed out that new varieties are being tested which are even better than the recommended varieties in this respect.

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A note on liquid fertilizers. R. C. CRAWFORD. *British Sugar Beet Rev.*, 1973/74, **41**, 168–169, 180.—Chemical weed control in the UK and the various pre- and post-emergence herbicides available are discussed. The types of weeds and the best form of attack are considered, and particular attention is drawn to the benefits of "Phenmedipham" ("Betanal E") post-emergence herbicide and "Venzar" ("Lenacil") pre-emergence herbicide.

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Magnesium fertilizers—some recent results. A. P. DRAYCOTT and M. J. DURRANT. *British Sugar Beet Rev.*, 1973/74, **41**, 161–164.—It is pointed out that in 1972, sugar beet growing on 4500 acres in the UK was still seriously affected by magnesium deficiency, while beet on another 50,000 acres showed signs of slight deficiency. The authors summarize results of 23 annual and 9 long-term field experiments on magnesium fertilization and give latest recommendations for magnesium fertilizer dressings. The experiments showed that addition of magnesium to the seedbed increased sugar yield where there was less than 25 ppm exchangeable Mg in the soil. "Kieserite" (containing 16% Mg) added to the previous cereal crop at the rate of 5 cwt.acre^{-1} increased beet sugar yield by 3·5 cwt.acre^{-1} compared with the untreated contro in trials, while the average sugar yield increased with seedbed application was 4·1 cwt.acre^{-1}. Of the various forms of Mg fertilizer considered, "Kieserite" is thought to be the most suitable. The question of dosage is dependent on soil analysis in the autumn.

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Overwintering of *Meloidogyne incognita* in root galls of sugar beet in the Salinas Valley of California. A. E. STEELE and L. R. HODGES. *Plant Disease Reporter*, 1974, **58**, 88–90.—Roots of sugar beets harvested from a 7-acre field were found to be heavily infested with eggs and larvae of *Meloidogyne incognita* contained in galls, which were also found encased in clods of soil. Tests with tomato plants grown in the greenhouse showed that the nematodes could re-infest susceptible plants after overwintering. Possible forms of field treatment are briefly described.

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Modern technology in sugar beet production. I. S. SIWICKI and Z. KWIATOŃ. *Gaz. Cukr.*, 1974, **82**, 16–20.—The modern approaches to beet agriculture described cover seedbed preparation and precision drilling with prepared seed balls. Since precision drilling requires effective control of weeds, most of the article is devoted to the various herbicides available and their recommended use and doses.

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New trends in protecting sugar beet. M. KUBACKA-SZMIDTGAL. *Gaz. Cukr.*, 1974, **82**, 21–22, 24.—The various chemicals available for pest and disease control are discussed and guidance given on their application.

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Quantitative serological reactions as a function of the tolerance of sugar beet to virus yellows. J. SMRŽ, Z. PETRÁK, J. POZDĚNA and M. FILIGAROVÁ. *Zucker*, 1974, **27**, 136–139.—Serological studies on beet plants artificially infected with virus yellows showed that the virus develops only slowly in tolerant beet. Greatest differences in virus-titre values of beets having different levels of tolerance were found 14-30 days after inoculation, the higher the value the weaker the resistance. However, independently of the degree of tolerance of the beet, the virus population gradually approaches an identical value in both tolerant and susceptible beets during the growth period, and by the end of the period the titre values in the tolerant plants, initially lower than in the susceptible beets, become greater than in the susceptible beets.

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Some (beet) seed parasites. L. VAN STEYVOORT. *Le Betteravier*, 1974, **8**, (74), 11.—Illustrations are given of five principal parasites of beet seedlings: millipedes, wireworms, symphylids, springtails and the pygmy beetle. Suitable pesticides for their control are briefly mentioned. It is pointed out that it is possible to mistake harmless, tiny whitish worms found in the vicinity of seeds or rootlets for millipedes. Use of a magnifying glass reveals, however, that these worms have neither legs nor antennae, while all the parasites described above have legs.

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Control of delivery from microgranulators. R. VANSTALLEN. *Le Betteravier*, 1974, **8**, (74), 14.—Advice is given on control of the application of granular chemicals (e.g. "Temik" pesticide) by means of a microgranulator and the recommended application in $kg.ha^{-1}$ is related to the contents of a sachet needed for application over a distance of 200 m at an inter-row spacing of 45 cm.

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Beet sugar in the USA. L. BEAUDUIN. *Sucr. Belge*, 1974, **93**, 57–70.—As a result of a study tour of the Western United States organized by the American Society of Sugar Beet Technologists and l'Institut International de Recherches Betteravières, an illustrated survey was presented of the beet sugar industry in eight states, particularly beet agriculture with use of rotary sprinkler irrigation.

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The problem of wild beets. L. VAN STEYVOORT and R. VANSTALLEN. *Sucr. Belge*, 1974, **93**, 71–76.—See *I.S.J.*, 1974, **76**, 276.

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The nitrogen crunch—and a cost-saving compromise. D. G. WESTFALL and W. C. MCGUFFEY. *Upbeet*, 1974, **62**, (1), 4–5.—In view of the rising costs of fertilizers and because of the deleterious effects of nitrogen on beet sugar content, the authors emphasize the importance of determining N requirements rather than applying fertilizer which is not needed. (Two other authors report that about half of the beet fields in Colorado have enough residual nitrate to produce an optimum beet crop without N application, while one-third of the beet farmers in Nebraska can probably grow more beet and produce more sugar per acre by not adding any N, about 30% of the soils containing a band of high N content between 3 and 6 ft below the soil surface.) A good balance of total N available to the beet crop can be established by determining the residual nitrate nitrogen carried over from previous crops, the soil samples being taken from levels down to 6 ft, since 65–75% of the available N is found below the top 1 foot of soil.

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The "old reliable"—and durable. E. H. PETERSON. *Upbeet*, 1974, **62**, (1), 7.—A brief report with illustrations is given of a severe hail storm (with hailstones the size of golf balls) which, while causing considerable losses in bean fields, had much smaller effect on beets than expected, so that the yields on the 1300 acres in question were still reasonably good.

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Keys to the ease of sugar beet production. W. C. MCGUFFEY. *Upbeet*, 1974, **62**, (1), 7.—Various factors associated with efficient beet growing are briefly discussed, but the key factor is considered to be random spacing varying between 6 and 18 inches to provide a minimum of 28,500 harvested plants per acre. For successful planting to stand and good emergence, good seedbed preparation is also vital. It is pointed out that most growers sow too much seed; yet, after thinning, the plant population is below the level for maximum yields.

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Plant to stand?—the pros and cons. M. PFAU, G. FRIEDE, D. KNEPKE and C. HEFENIEDER. *Upbeet*, 1974, **62**, (1), 8–9.—The subject is discussed in the context of practices and climatic conditions in certain areas of Colorado. While there is increasing interest in planting to stand, as exemplified by results achieved in isolated cases, the view is expressed that benefits may be small, since these will be governed by a number of variable factors, although it is accepted that by aiming at highest efficiency in seedbed preparation, planting, irrigation and weed control, the farmer will undoubtedly gain. A number of recommendations are given.

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Layby—the way to apply. W. WAGNER, L. HENDERSON and L. BUTLER. *Upbeet*, 1974, **62**, (1), 14–15.—Recommendations are given on application of "Eptam", on its own or with "Treflan", to control weeds which germinate after application of a pre-planting herbicide. While "Roneet" is widely used as a pre-planting herbicide, it has an effective life of only about 6 weeks, so that late-germinating weeds are not controlled.

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Post-spray "503". R. W. HETTINGER. *Upbeet*, 1974, **62**, (1), 15.—Guidance is given on optimum application of "Betanal" (also known as "503" in the USA) in conjunction with "475" as a post-emergence herbicide.

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Public parasite No. 1—the nematode. G. LAPASEOTES. *Upbeet*, 1974, **62**, (1), 16.—Beet infestation with nematodes is discussed and means of detecting and controlling the pest briefly described.

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Nebraska's goal—No. 1 in control. P. BLOME. *Upbeet*, 1974, **62**, (1), 17.—Success being achieved in Nebraska with nematode control is briefly reported.

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Nematode controls. Y. M. YUN. *Upbeet*, 1974, **62**, (1), 18.—While "Temik" is shown to be no better than soil fumigants in controlling nematodes, it does have certain advantages over fumigants on heavy and moist soils, and recommendations are given on its application.

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Mechanization moves ahead. L. C. HENRY. *Upbeet*, 1974, **62**, (1), 19.—The advantage of electronically-controlled beet thinners in terms of sugar yield is briefly discussed and a graph presented which shows that beet growing on 30% of the area owned by The Great Western Sugar Co. is now mechanically thinned.

Root maggot on the run in Wyoming and North Central Colorado. S. WALTER, R. VERGARA and R. W. HETTINGER. *Upbeet*, 1974, **62**, (1), 20–21.—Success achieved in chemical control of the root maggot in the two states named is described and recommended insecticide doses are given.

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Nitrification in soils treated with pesticides in beet growing. J. LIVENS. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1973, 143–149.—Preliminary tests with a number of pesticides used in beet agriculture applied to soil in three plots on two different dates have shown that some can considerably retard nitrification of organic N in the soil, the effect on urea being most marked. The depressive effect seemed to vary with the type of soil.

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Effect of pesticides on the biological activity of soils in beet agriculture. Application of radio-respirometric tests. J. MAYAUDON. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1973, 151–160.—The tests, in which the rate of mineralization of a ^{14}C substrate mixed with a fresh soil sample was measured at 25°C and the biological activity measured in terms of $^{14}CO_2$ (moles per min) liberated by decarboxylation of glutamic acid, showed that certain of the specific pesticides studied had a depressive effect on the biological activity, others had an enhancing effect, while some had no effect at all. No correlation was found between dosage and effect. A positive correlation was established between sugar accumulation and overall biological activity, indicating that, for soils poor in humus, it is desirable to use pesticides which have minimum inhibiting effect on the biological activity and thereby raise the sugar yield.

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Measures, in the ground, of the overall activity of micro-organisms using the method of Koepf. R. SAIVE. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1973, 161–166.—The method used involved burying eternite rings 30 cm in diameter to a depth of 8–10 cm, placing a metal cover on each to provide an air-tight system, and finally determining the CO_2 content in a sample of the air underneath the cover by electrolytic titration. Since differences between the CO_2 contents resulting from different pesticide applications were smaller than variations for the same treatment, the possible effects of the pesticides were completely masked. From the 216 measurements it was concluded that slope of the land had marked effect on the CO_2 emission, so that a more homogeneous terrain is required for such studies, while all possible sources of variation should be eliminated.

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Influence of pesticides applied in beet agriculture on the microbial populations and on the enzymatic activities of the soil (1971-1972). J. P. VOETS and W. VERSTRAETE. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1973, 167–176.—Field studies showed that the different pesticide treatments did not cause any dramatic changes in the populations of the various microbial groups studied. On the other hand, the pesticides reduced soil enzyme activities to a greater or lesser degree, particularly in a soil poor in humus, "Pyrazon" being the worst in this respect.

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When can beets be re-sown? Causes of possible failure. L. VAN STEYVOORT. *Le Betteravier*, 1974, **8**, (75), 9.—When it is and is not advisable to re-sow is briefly discussed and advice offered on herbicide and pesticide application where re-sowing has been carried out. Guidance is also given on diagnosis of disorders from specified symptoms.

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Post-emergence herbicide treatments. J. M. BELIEN. *Le Betteravier*, 1974, **8**, (75), 10–11.—A table is given showing the species of weeds which can be controlled with specified post-emergence herbicides, the effects to be expected by applying given doses of particular herbicides, and most suitable stages in weed development at which to apply the herbicides.

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Beet yellows. L. VAN STEYVOORT and E. SEUTIN. *Le Betteravier*, 1974, **8**, (75), 12.—Advice is given on the best approach to control of beet yellows, which has caused quite high losses in beet in some parts of Belgium during the last two years. Application of "Temik" granules at the time of sowing has given as good results as conventional spraying. Insecticides effective against yellows, aphids and mangold flies, collectively, and others giving excellent control of aphids and yellows but not mangold flies are listed.

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Contributions to the methodology of yield and quality determination in sugar beet. I. Variability of the individual plant in the field population. U. BEISS and A. VON MÜLLER. *Zucker*, 1974, **27**, 173–178.—From statistical evaluation of the mean values and coefficients of variation for beet weight, amino-N, sodium, invert sugar, potassium, soluble ash, sugar content and dry matter, it was concluded that at least 70–80 adjacent beets must be sampled for estimation of beet yield, whereas the sample need contain only 40–50 beets for determination of quality factors.

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Modern technology in sugar beet production. II. S. SIWICKI and Z. KWIATOŃ. *Gaz. Cukr.*, 1974, **82**, 42–46.—The more important aspects of beet fertilization are discussed and references made to various trials during the past 12 years in Poland, concerning N-P-K application and addition of trace elements. The mechanization of beet harvesting is then briefly examined as the one vital element in modern beet agriculture.

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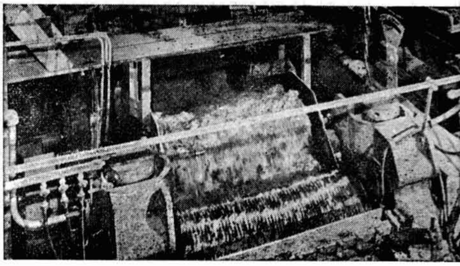
Herbicides as means of simplifying the technology of sugar beet agriculture. H. DOMAŃSKA, Z. LEGOWIAK and L. LESKA. *Gaz. Cukr.*, 1974, **82**, 46–48.—For control of *Echinochloa crus-galli* (cockspur or barnyard grass) best results were achieved with an experimental preparation, IPO H-130 + "Antyperz" (5 + 5 kg. ha^{-1}), although almost as good results were obtained with 4 $kg.ha^{-1}$ "Pyramin".

Cane sugar manufacture



Automation. G. ALEMAN, A. ARVESU and C. REYNALDOS. *Sugar J.*, 1974, **36**, (8), 8–12.—Details are given of the automatic control schemes used at the authors' sugar factory for the cane carrier and feed conveyors, the cane mills, evaporator and pan station. In the milling tandem the carrier speed is controlled as a function of the 1st mill speed (fixed for a given crushing rate), and the cane or bagasse blanket height is maintained at the same value throughout the tandem; the cane turbine drives and intermediate carriers are likewise controlled. Evaporator control is based on the Brix of the syrup being withdrawn from the last effect. Boiling control is based on massecuite target Brix, the Brix probe being the mechanical stirrer itself where such is provided.

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Pollution and the sugar industry. M. F. GLORIA. *Sugar News* (Philippines), 1973, **49**, 359–363.—The subject is discussed within the context of Philippine regulations on pollution and covers the sources of water and air contamination and their control, guidance also being given on organization of a pollution control programme.

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Q.C.C. Report on increasing the surplus of bagasse. H. H. SHEN and C. Y. CHIANG. *Taiwan Sugar*, 1973, **20**, 233–237.—Analysis of steam usage at Kaohsiung sugar factory was undertaken with the aim of reducing steam consumption and thereby increasing bagasse surplus. Details are given of the various analyses made, causes of excessive use of steam and their remedies.

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From S.Q.C. (statistical quality control) programme to T.Q.C. (total quality control) programme of Hsin-ying district sugar factory. D. S. YOUNG. *Taiwan Sugar*, 1973, **20**, 239–245.—The statistical approach to increasing sugar factory efficiency and reducing costs is exemplified by the case of Hsin-ying sugar factory (of which the author is superintendent), details being given of the planned tolerances for a large number of factors, from cane trash content to weight of sugar package, for 1969/70, and the part played by various departments in the total quality control programme.

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Brix curve as an effort to control individual milling. –. SOEMARNO. *Berita Lembaga Pendidikon Perkebunan*, 1973, **5**, (1 & 2), 16–29.—As a contribution to ultimate overall milling supervision in Indonesia, the author advocates first concentrating on the operation of the individual mill, for which a Brix curve is of advantage; however, it is emphasized that use of the Brix curve is limited to those systems using compound imbibition. A Sankey diagram is presented showing the extraction process in a tandem using imbibition, and tabulated data are presented showing pol extraction in a mill over a number of years.

Factory research and development in South Africa. ANON. *Ann. Rpt. Sugar Milling Research Inst*, 1973.

Sampling of shredder and knifed cane for determination of Preparation Index: Tests showed that the facilities installed in all factories by the Central Board for shredded cane sampling could be used to determine the Preparation Index. Details are given of these facilities. Further tests at one factory led to the development of a pneumatically-operated sampling hatch at the bottom of the screw conveyor included in the cane preparation equipment. Shredded cane is sampled through the hatch over a 2–5 minute period and is also sampled over the same period after the prebreaker used for further size reduction. The sample from the screw conveyor is used for leaching while the other sample is disintegrated. (It was found that the former sample was too coarse for complete cold disintegration in the standard 20 minute period.) In an attempt to develop a procedure for determining knifed cane PI, reproducible results have been obtained where the knifed cane is conveyed on a belt, which is stopped for a few seconds to allow about 15 kg of the cane to be scraped into a plastic bag. The sample is weighed, spread on a plastic sheet and all pieces longer than 5 cm separated and weighed separately. The PI is then determined as for shredded cane, the fine sub-sample being used for disintegration. The coarse fraction is assumed to have a PI of 0, so that the PI of the knifed cane is that of the prepared fraction multiplied by a factor dependent on the weight of the coarse fraction. Because of differences between Brix and pol extraction during leaching, the procedure is standardized on Brix.

Survey of cane preparation equipment: In a survey carried out with the aim of determining optimum values for good cane preparation, a PI of 85–90 was regarded as indicating a well-prepared cane, but the power required to attain this ranged from 46 to 85 kW per ton of fibre.hr^{-1}. A subsequent examination of the types of equipment used for preparation showed that, provided cane knives and shredder units were correctly designed and fed with a continuous stream of cane, the required PI could be obtained with a power consumption of 50 kW per ton of fibre.hr^{-1}, but constant attention must be paid to hardfacing of knives and hammer edges, to input power and to settings of overhead anvil plates.

Juice clarification: Tests with the experimental trayless clarifier at Gledhow showed that juice of similar quality to that from a conventional "Rapi-Dorr" at rated capacity and comparable flocculant levels was obtained at a quarter of the retention time. The importance of good pH control for good quality juice from "fast" clarifiers was demonstrated by varying the pH level of the limed feed to both clarifiers. Maximum throughput with the experimental clarifier gave a juice retention of only 21·4 minutes, the size of feed valve being the limiting factor. Indications are that the clarifier could probably operate at higher throughput. A new pilot-plant clarifier installed at Entumeni is designed for short retention times and consists basically of a rectangular tank surmounted by a bank of inclined settling tube modules. Primary separation of the flocculated mud and juice occurs in the tank below the modules, final separation being achieved by passage of the juice up the tubes. Initial tests have shown that operation with a 30-minute retention is possible, and work is in progress to optimize the performance with respect to juice quality and throughput.

Cleaning evaporator tubes: Four unnamed descaling chemicals used on brass and mild steel evaporator tubes loosened the scale but this had to be removed physically. One of the chemicals was effective in removing a heavy, burnt-on oily scale to present a very clean surface. Corrosion rates were found to be very low.

Testing of a bacterial α-amylase: SP 95 bacterial α-amylase, supplied by Novo Industri A/S, was found to have greater thermal stability and a much wider pH range than the preparations commonly used in the sugar industry, and is usable at temperatures above 90°C. Addition of the new enzyme to various evaporator stages and to mixed juice before the heaters was tried, and best starch removal obtained when it was added to the 2nd evaporator effect. The cost of starch removal was somewhat lower than with conventional amylases.

Mud filtration: Despite various difficulties caused by lack of facilities in tests with an "EimcoBelt" filter, the introduction of a steam drying segment in the filtration cycle did appear to lower the moisture content of the filter cake compared with the absence of steam, and would thus reduce the weight of cake to be transported to the fields.

Temperature distribution in a C-pan: Temperature distribution investigations showed sharp fluctuations in massecuite, particularly above and below the calandria, where a stirrer was provided; the temperature changes occurred whether the stirrer was operating or not. Reasons are given for the anomalies in comparison with a C-pan (also provided with a stirrer) at another factory. Obstruction to flow in the downtake, with virtually no massecuite circulation, occurred when the stirrer was stationary.

Simulation of a pan floor boiling cycle: Computer simulation of pan boiling has given encouraging results in initial trials aimed at establishing the maximum number of strikes per unit time under optimum conditions. Future work will include prediction of syrup and steam demands.

Exhaustion of final molasses: Two new empirical expressions have been derived for calculating molasses target gravity purity. They take the form t.g.p. = 38·06 — 15·97 log (reducing sugars:ash), and t.g.p. = 52·07 — 16·47 log (reducing sugars:conductivity). Statistical evaluation shows linearity between results and those obtained on the basis of true purity in terms of the reducing sugars:ash ratio.

Continuous centrifugals: Investigations of low-grade continuous centrifugal capacity and effect of water and steam addition on sugar and molasses purity were carried out at a number of factories with different types of machine. Results indicated that with 25% valve opening, capacity was unaffected by massecuite viscosity, but variations in flow increased with wider valve opening, indicating that friction in the pipe rather than valve size was the limiting factor. Capacity was also seriously affected by the state of the screen and of the massecuite distributor; stroboscopic light observations showed an appreciable proportion of the screen surface to be often ineffective as a result of fouling, which occurs in both screen and massecuite distributor at a much faster rate than is generally realized. The most important factor determining capacity and separation efficiency was found to be massecuite conditioning before it is fed to the centrifugal. The water:massecuite ratio is critical, while steam addition improves performance. The most effective conditioning method was found to be addition of most of the lubrication water by means of a co-axial probe, while facilities should also be provided for adding some water to the outer circumference of the massecuite stream. Washing efficiency was greater with steam than with water. Massecuite grain size affected the water:massecuite ratio, and guidance is given with respect to optimum quantities.

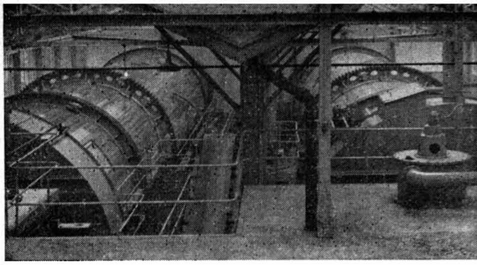
Ageing of sugar: Storage tests with samples of export-quality raw sugar (of pol greater than 99·3) and with a molasses-coated sugar (of 97·5 pol) showed no "ageing" effect, after 30 weeks at 35°C, on the filtrability of the laboratory carbonatated liquor, although the low pol sugar showed a 10% drop in filtrability which was, however, insignificant in comparison with the potential decrease which could be caused by increasing the raw sugar starch content (e.g. addition of 100 ppm starch caused a 25% drop in carbonatation liquor filtrability).

Dust in VHP sugar: To determine the amount of dust in very high purity sugar, a technique was developed which is a modification of the grain size analysis method; this gave recoveries within 0·02 g of the weight of dust added to test samples and had the desired reproducibility. Further work is necessary to correlate the results obtained with the amounts of dust visually observed during discharge of sugar in the Durban sugar terminal.

Water pollution: A pilot plant for biological filtration has been operating continuously on a synthetic effluent made up of molasses, sugar and water; three sets of filters, acting as control, were fed with the effluent only, while the effluent fed to the three test filters had N and P added to make a COD:N:P ratio of 100:2:0·4, earlier found to be optimum for the activated sludge process. An overall COD reduction of 90–95% was achieved at an initial COD of 3000 $mg.litre^{-1}$; the same efficiency was achieved at 5000 $mg.litre^{-1}$ load, but the ammonia content dropped from about 10 $mg.litre^{-1}$ N in the feed to zero in the final effluent, indicating that the organic load cannot be further increased unless the N content in the feed solution is increased.

Air pollution: Serious corrosion in flue gas scrubbers installed at sugar factories was found to be caused by a high chloride and sulphuric acid content in the recirculated scrubber water at a relatively high temperature (80°C); the question of suitability of materials for construction was investigated, and special materials advocated where a combination of coal and bagasse is burnt. Dry cyclones are recommended where coal replaces bagasse.

Beet sugar manufacture



Comparative evaluation of 1st carbonatation juice sediment thickening in clarifiers and filter-thickeners. YU. F. TSYUKALO, YU. V. ANIKEEV, V. A. ZAMBROVSKII, V. T. RUD' and V. S. TSYS'. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1972, 97–106.—Comparative tests demonstrated the advantages, in terms of filtrate colour and turbidity, mud solids content, reduced juice retention time and hence lower losses, of filter-thickeners over clarifiers. Of the two filter-thickeners tested, the FiLS leaf filter[1] proved superior to the DF-80 disc filter and is recommended for general installation.

* * *

Examination of the conductimetric properties of carbonatation juices with the aim of 2nd carbonatation optimization. V. G. SUSOROV and B. A. EREMENKO. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1972, 106–114.—Results of laboratory tests are given, and from the values of electrical conductance, pH, alkalinity and Ca^{++} ion content in 1st carbonatation juice gassed with CO_2 at 85°C and with vigorous boiling, conclusions are drawn on optimum conditions for 2nd carbonatation.

* * *

Methods of calculating the quantity of decomposed sucrose and invert sugar in alkaline solutions. A. K. KARTASHOV, R. G. ZHIZHINA and A. R. SAPRONOV. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1972, 114–132.—The literature on sucrose and invert sugar decomposition in heated pure solution and factory juices is surveyed with 40 references. Of methods developed for calculation of losses in thick juice during evaporation, the most suitable was found to be one proposed by SAPRONOV & KHARIN, in which the pH of the thick juice at its boiling point is calculated and substituted, together with values of the decomposition rate constants (found from a nomogram), in a simple equation: $X = aK^{\tau}$, where X = quantity of sucrose decomposed (%), a = juice invert content after 1st carbonatation (%), K = rate constant and τ = time (min). Comparison of calculated and observed values showed an error of ± 10–20%.

* * *

Kinetics of adsorption of colouring matter in beet syrup and regeneration solutions by ion exchange resin. A. A. IVANYUK and YA. O. KRAVETS. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1972, 133–154.—Investigations showed that the rate of colouring matter adsorption from beet syrup by decolorizing resin was mainly determined by internal diffusion which was related to syrup Brix and purity. Internal diffusion was also the primary mechanism in desorption of colouring matter from the resin by NaOH, the coefficient in this case being related to the concentration of colouring matter in a resin granule. For optimum decolorization and resin regeneration, counter-current treatment with a densely packed moving bed is recommended.

Effect of the ionic composition of non-sugars on the performance of a strongly acidic cation exchange resin in run-off demineralization. V. N. BELOUS and K. P. ZAKHAROV. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Sakhar. Prom.*, 1972, 184–189.—The effects of change in the ionic composition and of specific sulphuric acid consumption in resin regeneration on the exchange capacity and throughput of KU-2-8 cation exchange resin used to treat a molasses solution to which sugar and Ca lactate had been added were investigated. Increase in the Ca salts content from 2 to 7% CaO (on weight of non-sugars) at a constant acid consumption caused a fall in the exchange capacity and in throughput (in terms of non-sugars), the latter factor being dependent not only on the exchange capacity but also on the ionic composition, particularly the number of anions, which increase with Ca salts content. Increase in the acid consumption in regeneration led to increased removal of inorganic and N substances, but acid utilization fell.

* * *

Modern computing techniques and computers in the sugar industry. P. KADLEC and E. SVOBODA. *Listy Cukr.*, 1974, **90**, 31–35.—The subject is discussed (with 30 references to the literature), with particular mention of simulation, using mathematical models, in order to establish optimum process conditions.

* * *

How can evaporator capacity be increased? V. SÁZAVSKÝ. *Listy Cukr.*, 1974, **90**, 37–39.—Because of insufficient vapour for bleeding and juice heating in a number of Czechoslovakian sugar factories, the author examines ways in which the capacity of a triple-effect pressure evaporator (plus concentrator) can be increased. The most effective method is considered to be making the 3rd effect into two No. 2 effects, whereby the temperature of the vapour in the second of the No. 2 effects would be increased by some 8°C compared with the conventional system. Vapour originally bled from the 1st effect to the pan station (16% out of a total of 18%) would instead be passed to the first of the No. 2 effects. Also advocated is thermo-compression of return steam or passage of 1st vapour through a diaphragm into 2nd vapour.

* * *

Automatic control of diffuser by computer. A. CH. BRATSYUN. *Listy Cukr.*, 1974, **90**, 39–41.—Details are given of the computerized system for control of beet diffusion at Lokhvitskii factory in the USSR. Results include a 0·04% reduction in sugar losses, a 4-day decrease in campaign length, increased factory capacity and fuel savings (including a 0·53% cut as a result of a 15·5% reduction in juice draught). The economic effects of the system are also indicated.

* * *

The Azores to produce more sugar and alcohol. H. KAMPF. *Sugar y Azúcar*, 1974, **69**, (1), 30–31.—See *I.S.J.*, 1974, **76**, 344.

[1] RUD' *et al.*: *I.S.J.*, 1971, **73**, 54.

Greatest attention should be paid to sugar factory reservoirs, M. A. SANDLER. *Sakhar. Prom.*, 1974, (2), 29–31.—Attention is called to the need to maintain reservoirs (as constructed at the majority of Soviet sugar factories) in a clean condition and to seek means of increasing water supply where rainfall and melting snow are insufficient, e.g. looking for ground water and examining the feasibility of sinking Artesian wells.

* * *

Beet storage in ventilated piles with air moistening at Merkenskii sugar factory. N. S. SKUGOREV *et al.* *Sakhar. Prom.*, 1974, (2), 47–52.—Storage tests are reported in which beet were ventilated with dry air and with moist air, respectively. The air which had been moistened using a number of sprays reduced the pile temperature by 4·5°C compared with the dry air, and by 7°C compared with an unventilated pile. Resultant losses were lower with moist air than with dry air and very much lower than without forced ventilation.

* * *

Direct current drives for the sugar industry. ANON. *BMA-Information*, 1973, (12), 6–9.—Thyristor-controlled D.C. drives can be used for centrifugals, diffusers, cossette pumps, pre-scalders and pulp dryers, and their advantages over 3-phase drives are discussed, particularly in reference to the BMA fully-automatic "Variant" centrifugal.

* * *

Automatic liming with a dosing device and milk-of-lime density adjustment by the Cukroprojekt system. S. GINAL. *Gaz. Cukr.*, 1974, **82,** 1–5.—A description and diagrams are given of a patented Polish system for automatic adjustment of milk-of-lime density within the range 12–24°Bé and feeding it at a pre-set rate to pre- and main liming and 2nd carbonatation. The system basically embodies a vertical measuring tube from which the milk-of-lime passes into a chamber provided with a bucket wheel. As the wheel rotates, each of the four buckets scoops up milk-of-lime and gradually, as it ascends above the level of the lime in the chamber, empties the contents into a receiving chamber and thence to process. The receiving chamber has a volume which is automatically adjustable through control signals transmitted from a regulator to which samples of juice and lime, respectively, are by-passed from their main feed lines and the free CaO content in the mixture compared with a target value.

* * *

A survey of sugar factory equipment produced in East Germany. H. DABROWSKI. *Gaz. Cukr.*, 1974, **82,** 5–13.—An illustrated survey is presented of various pieces of sugar factory equipment available from East Germany, particularly filters and centrifugals.

* * *

Effect of flow conditions on sucrose crystallization rate. D. SCHLIEPHAKE, H. PETERSEN and F. SCHNEIDER. *Zucker*, 1972, **27,** 113–121.—Simulation in model equipment of the flow patterns occurring in a vacuum pan was followed by determination of their effect on crystallization rate. It was found that natural vapour bubble agitation caused a considerable increase in mass transfer, particularly when the bubbles ascended the calandria tubes. By increasing the vapour bubble agitation, i.e. evaporation rate in the middle phase of the boiling process, it is possible to reduce the boiling time for higher purity products. Adjustment of agitation and evaporation rate to meet the requirements is easier to carry out in continuous than in discontinuous boiling, since such adjustment should be only local. (See also SCHNEIDER & SCHLIEPHAKE: *I.S.J.*, 1972, **74,** 57.)

* * *

Flume water treatment plants in the sugar industry. **H.** BRUNKE and D. VOIGT. *Zucker*, 1972, **27,** 129–135. In a discussion of flume and wash water treatment in a circular settling tank (considered by the authors to be the most economical system, particularly with the tendency for much greater throughputs), guidance is given on optimum dimensions for maximum efficiency, for which a residence time of 1½–2 hours is recommended, and on the best approach to removal of the settled mud, for which a centrifugal pump is thought to be most suitable. Other aspects studied include siting of the plant and pH of the water (which should be alkaline).

* * *

Simple purification with good FK and SK values. –. GIORGI and –. GROULT. *Sucr. Franç.*, 1974, **115,** 117–120.—Pilot-plant studies were made of a process developed by the authors in which 10 litres.hr^{-1} of raw juice is mixed at 85°C for 12 min in a Brieghel-Müller prelimer, to the end compartment of which is added 50 litres.hr^{-1} of 1st carbonatation mud before simultaneous liming and gassing. Comparison was made between the results obtained and those achieved with the method used in some European countries without mud recirculation, while the latter was also compared with mud recirculation systems as practised in Europe and the USA. It was found that the proposed system gave better filtration and settling rates and lower lime salts contents than did the conventional European system without mud recirculation, although the colour was greater. A slight difference in purity between the two systems was not considered significant. The conventional system did not prove as effective as the same system with mud recirculation but was better than the US system except in respect of lime salts and a slight purity difference.

* * *

Nomogram of electrical resistances of sugar solutions. A. I. LAPKIN, V. I. TUZHILKIN and I. N. KAGANOV. *Sakhar. Prom.*, 1974, (3), 25–27.—Although the resistance of massecuite is governed by the supersaturation, crystal content, etc. and thus is an important indicator for use in pan boiling control, the relationship is not single-valued, and one resistance value may correspond to more than one supersaturation coefficient and other massecuite parameters. To help solve this problem, a nomogram has been constructed which permits the resistivity to be found at any Brix and temperature from values obtained for the same material at given Brix and temperature values, using a laboratory apparatus.

* * *

Determination of mathematical indices of the impurity content of sugar factory recirculation waters. V. N. BAZLOV. *Sakhar. Prom.*, 1974, (3), 34–35.—Mathematical expressions are given for calculation of factors (from various analyses) concerning waste water impurity content and treatment efficiency which are of value in organizing a recirculation water system.

Determination of the boiling point of solutions at different pressures. K. S. ALTUNDZHI. *Sakhar. Prom.*, 1974, (3), 35–37.—For approximate calculation of the boiling point of e.g. 75–90°Bx massecuite at any given pressure, two empirical formulae are developed which permit the value to be found within ±0·05°C. (The second formula is for calculation of a constant which features in the first formula.)

* * *

Automatic control of beet supply at sugar factories. I. M. LION, E. G. ORLOV and A. A. KISURKIN. *Sakhar. Prom.*, 1974, (3), 43–47.—Details are given of a fully-automatic system for regulating beet supply from the factory yard to the washers and finally the hopper before the beet slicers.

* * *

Automatic control of the ventilation systems in beet storage. U. A. KOVZIASHVILI *et al.* *Sakhar. Prom.*, 1974, (3), 48–54.—Full details, with circuit diagrams, are given of a system developed for automatic control of forced ventilation of beet piles, which is actuated when the temperature in the middle of the pile exceeds the ambient temperature by 3–4°C. The ventilating air is dampened. Daily sugar losses over a 76-day period were 0·005% compared with 0·0097% over 78 days in a control pile where forced ventilation with moist air was carried out by manual control.

* * *

Scale removal from the inner surface of vacuum filter juice withdrawal tubes. K. P. GONCHAROVA, V. M. CHEKHOV and Z. D. ZHURAVLEVA. *Sakhar. Prom.*, 1974, (3), 57–58.—For de-scaling, the authors advocate a 10% aqueous HCl solution to which formalin is added as corrosion inhibitor. Cleaning takes about 5 hours. A 2–3% soda ash solution is used for cleaning the vent tubes.

* * *

Effect of vibrations on scale formation and heat exchange in tubular heat exchangers. I. M. FEDOTKIN, I. V. KOSMINSKII, V. N. GOROKH and F. T. TIMOSHENKO. *Sakhar. Prom.*, 1974, (3), 59–62.—In experiments on raw juice heater scale prevention by vibratory means, maximum heat exchange at a juice flow in the range 1·11–1·5 $m.sec^{-1}$ was obtained with amplitudes of 105 and 130 mm and frequencies of 0·335 and 0·52 Hz, respectively. After five days' operation the heat transfer coefficient was 2½ times greater than in a heat exchanger not provided with vibratory means. Energy consumption by the pulsator and pump was about the same as for a pump where no pulsator was used, and there was hardly any scale on the heating surface.

* * *

Automatic device for technical control of the settling rate of suspensions. S. M. ZAGRODZKI. *Zeitsch. Zuckerind.*, 1974, **99**, 119–121.—A device is described which comprises a vertical tube into which the test suspension is introduced through a bottom entry port and flows upwards during a period of about 3 minutes, after which the feed port is closed and settling commences. At a point towards the top of the tube is located a photo-element which normally receives light from a source on the opposite side of the tube. A recorder pen starts to draw a straight line immediately at the start of settling, being actuated by closure of the feed valve, and automatically stops only when light falls on the photo-element, which also marks the end of settling. Hence, the recorder line is a measure of settling time. Tests have demonstrated applicability of the device in the sugar industry.

* * *

Closed loop water systems at Red River Valley factory. T. E. PAXSON. *Sugar y Azúcar*, 1974, **69**, (2), 39–40. Information is given on the various water systems at this North Dakota beet sugar factory which is planned to operate without discharge of any effluent into the local river, all the process and other water being fed from a reservoir supplied with 750,000,000 gal of fresh water from the river.

* * *

Water circuits in a sugar campaign. J. HUBERLANT. *Sucr. Belge*, 1974, **93**, 103–115.—Calculation of a water balance for a beet sugar factory having a daily slicing capacity of 4000 metric tons shows that there is an excess of water amounting to 43 $m^3.hr^{-1}$, i.e. which is not recycled but which is discharged to settling and storage tanks. However, the point is made that, no matter what form of water economy is practised (even if it is used to the very limit), there will always be one source of excess water, viz. vapours produced in evaporation. Every additional cubic metre of fresh water entering the factory will produce an extra cubic metre of waste water and may have to be paid for twice, i.e. as fresh draw-off water and as waste water. Flow diagrams are presented to describe a number of water schemes for a factory slicing 4000 tons per day which does not draw-in any fresh water from outside sources and which is exemplified by the factories at Oreye and Brugelette.

* * *

Sugar manufactore with thick juice storage. III. Heat economy in thick juice storage. K. BOHN, E. MANZKE and C. NESTKE. *Die Lebensmittelind.*, 1974, **21**, 83–86. The effect of thick juice storage on the heat economy of a white sugar factory is discussed, and the steam consumption calculated for various factory capacities and for various proportions of the total output which is obtained from stored thick juice. While, in the case of a factory where all the white sugar is produced from stored thick juice, the steam consumption can be as much as 135% of the level when no thick juice is stored if no modifications are made to the evaporation system used, it is considered possible to reduce this to 110% by redistributing the evaporator heating surface so that there is an increase from effect to effect and the last effect has a large heating surface, giving a much greater temperature gradient.

* * *

Change in colour of sugar solutions during evaporation. V. V. MAIOROV and L. P. MAIOROVA. *Izv. Vuzov, Pishch. Tekh.*, 1973, (6), 79–81.—From statistical treatment of results obtained over two campaigns, formulae are presented for calculation of juice colour (optical density) as a function of time and temperature which are applicable for Brix values in the range 10–20°, juice circulation rates of 1–3 $m.sec^{-1}$, temperature in the range 126–147°C and temperature difference between heating steam and juice of 3–12°C.

* * *

Filtration of thick juices and remelt liquors. S. M. ZAGRODZKI. *Zucker*, 1974, **27**, 185–190.—See *I.S.J.*, 1974, **76**, 151.

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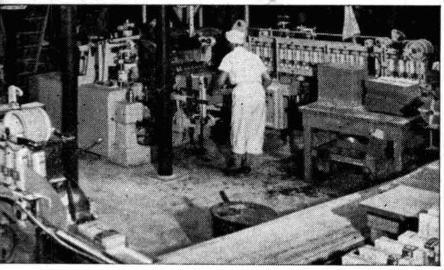


Sugar refining

Melt-phosflotation *vs.* melt carbo-sulphitation for the manufacture of refined sugar. A. C. CHATTERJEE and C. SHYAMSUNDER. *Proc. 25th Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1973, (I), M.36–M.46.—A description is given of each of the two processes for treatment of melt liquor and comparative costs calculated under Indian conditions. Capital costs for phosphate-flotation are lower and no flue gas supply is required, lime usage is only half that for carbonatation-sulphitation, and the process removes iron-polyphenol compounds which are difficult to remove by other processes. It is also easier to produce thermophile-free sugar by the phosphatation process.

* * *

Movement of non-sugars in granulated sugar refining. S. A. BRENMAN *et al. Sakhar. Prom.*, 1974, (2), 23–29. Detailed examination of the non-sugars in refinery intermediate products and molasses relative to the content in the raw sugar feed at three Soviet refineries demonstrated the marked increase when low-quality raws were being processed. The details given include reducing matter, colour and organic acids as well as nitrogen and ash (originating from both the raw sugar and water). Considerable changes in the nature of the non-sugars and recycling of the latter caused disproportionate increase in the non-sugars contents between products. All three refineries used a 3-massecuite boiling scheme and syrup decolorization with active carbon.

* * *

Desweetening and disposal of carbonatation muds using vacuum filters at Savannah sugar refinery. O. G. HOHNERLEIN. *Proc. 32nd Meeting Sugar Ind. Tech.*, 1973, 19–23.—The development and present operation of the vacuum filter system at Savannah are described with initial reference to the regulations introduced in the late 1960's with regard to river water pollution control. Modifications to the system have permitted the refinery to meet the requirements as regards reduction in total suspended solids and BOD, while sugar losses have been reduced as have operational and maintenance labour costs. The system normally handles about 150,000 gal of slurry per day, of which about 5% by weight is in solid form. The Brix of the slurry and filtrate is 10°; total suspended solids in the filtrate averages 370 $mg.litre^{-1}$. The filtrate pH is 10 and the reducing sugars content negligible. The mud, averaging 120,000 wet lb per day, contains 50% moisture and has a COD of 120 $mg.g^{-1}$. Filtrate and sweetening-off water combined total about 77% of the total water required to melt washed raw sugar, the remainder coming from e.g. the dust collecting system, so that only very occasionally do municipal water supplies have to be used.

* * *

Decolorization at Tate & Lyle Refineries Ltd. Thames refinery. J. C. ABRAM and W. B. HILL. *Proc. 32nd Meeting Sugar Ind. Tech.*, 1973, 24–39.—Decolorization is carried out in two bone char cistern houses, each of about 32,000 ft^3 bone char capacity; coarse grist char is used in the older of the two houses (the so-called "ten foot" house in which the char is handled manually), while a fine grist material is used in the modern "hydraulic" house. A study of bone char utilization was made as a contribution to replacement of the older house. Tests showed that the fine grist char was below standard; column experiments indicated that, provided the char was regenerated correctly and brought back to a state of maximum activity, press liquor could be decolorized to the requisite level at the rate of 2½ hr per settled volume compared with the normal 5 hr, and the 33 cisterns in the older house could be replaced by the equivalent of eight 1000-ft^3 cisterns. Washing efficiency in the "hydraulic" house could also be improved if the char were transferred, after sweetening-off, to another vessel for washing. Hence, the eight new cisterns are washing and dewatering vessels, and non-effective cisterns in the "hydraulic" house are thereby released for decolorization, while providing more efficient acid washing. Full details and performance data are given for the new system.

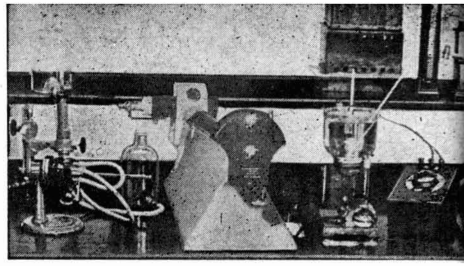
* * *

A new bone char facility at the Crockett refinery. L. A. ZEMANEK. *Proc. 32nd Meeting Sugar Ind. Tech.*, 1973, 40–57.—Details are given of the new char house at Crockett where a 25 $ton.hr^{-1}$ Herreshoff multi-hearth furnace replaces several old retort kilns. The system includes continuous counter-current de-ashing, hydraulic conveying of spent char after sweetening-off and continuous dewatering by vacuum filters. With the new system, char filter capacity has been increased by about 20%, the quality of the poorest grade of char used at the refinery has been improved and the decolorizing capacity increased. Operating costs have been substantially reduced through savings in labour. Some teething problems are discussed.

* * *

Progress report—computer control project at Flo-Sweet. H. M. WALLENSTEIN. *Proc. 32nd Meeting Sugar Ind. Tech.*, 1973, 89–101.—Details are given of the IBM 1800 process control computer system at Yonkers refinery and of its application in closed loop control of (i) the monobed ion exchange station used in liquid sugar production, which involves eight programmes, and (ii) the clarifier station, which embodies thirteen programmes. A further control project, involving the invert ion exchange station, is expected to be finished by end-1974. The author emphasizes that the computer acts as a tool for use by the operator who is thus able to stop and start programes when he wishes and introduce his own set-points. Open loop control applications (with programmes based on operator advice) are also briefly indicated, as is the use of the computer in helping to solve day-to-day scheduling problems.

Laboratory methods & Chemical reports



Sugar laboratory research and development in South Africa. ANON. *Ann. Rpt. Sugar Milling Research Inst.*, 1973.

Brix measurement: While a precision refractometer gives an accuracy of ±0·04°Bx, determination of specific gravity of a cane juice extract and a 1:5 diluted molasses solution using a conventional Mohr-Westphal balance gave lower accuracy, and only use of an analytical balance (giving readings to four decimal places) permitted the same precision to be obtained as that given by refractometric determination. Moreover, the densimetric Brix values, particularly in molasses analysis, were found to be higher than the actual dissolved solids, the difference being greater than in the case of refractometric Brix.

Milling quality of fibre: Differences in PI (Preparation Index) between cane of varieties N:Co 331 and N 53/805 led to investigations of the physical and chemical properties. These showed a difference in the cellulose, pentosan and fibre contents, while N:Co 331 appeared to have a higher fibre tensile strength, although there was considerable scatter of the results. No significant differences were found in lignin content and alcohol-benzene extractable substances.

Testing of automatic polarimeters: In tests on a Thorn-Bendix and a Kernchen "Sucromat" polarimeter, the temperature in the cell compartment of the former instrument was sufficiently stable while the speed of operation and linearity were within specified standards (Australian Standard K 157–1968). Only a slight loss of accuracy occurred at 100°S, but a drift over 24 hours exceeded the standard value. The "Sucromat" satisfied the standard specifications except in respect of speed of operation and loss of accuracy when coloured solutions were measured, although it is understood that both faults have been subsequently corrected by the manufacturer.

Inversion of sucrose: Inversion at pH 6 and 8 and 80°C was followed using radio-active sucrose as a tracer. While a straight line was obtained for % inversion *vs.* time at the lower pH, at pH 8 (with a lower inversion rate) the count was not sufficiently accurate with the ^{14}C-sucrose concentration used as standard. While a higher concentration gave good results at pH 5, the scatter was still unacceptably high at pH 8 and the method was abandoned for economic reasons.

An investigation of electrometric amd colorimetric methods for determining reducing sugars: Various visual methods of detecting the methylene blue end-point in reducing sugars determination proved unsuitable, as did an electrometric method and a colorimetric method using glucose oxidase in comparison with the Luff-Schoorl method.

Saturation temperature measurement: Two methods were compared for molasses saturation temperature measurement: (*i*) gradually increasing the temperature of a microscope stage carrying the sample and noting the temperature at which crystal faces start to change, and (*ii*) vibrating a massecuite at 50 Hz in a small copper vessel in a water bath until equilibrium is reached (after about 2 hours), when the molasses is separated from the crystals and its purity determined. The saturation temperature is then given by bath temperature — K (equilibrium purity — original purity), K normally having a value of about 4 but requiring determination for each type of massecuite by measuring the equilibrium purities at two temperatures. Method (*i*) was found to give very much greater reproducibility than did method (*ii*).

Determination of water in molasses: Comparison of gas chromatographic, Karl Fischer and vacuum oven determination of molasses moisture showed that the first two were more rapid than the last. Tabulated values show that the vacuum oven and Karl Fischer methods gave approximately the same results, while the gas chromatographic values were slightly higher.

The effect of centrifugation and filtration of leaded solution on pol of raw sugar: Comparison of raw sugar polarization measurement after lead reagent filtration and after centrifugation showed agreement between resultant values which were within experimental error. The filtered solutions always gave a higher reading (probably as a result of evaporation) and, with sugars of low pol, had higher turbidity than did the centrifuged solutions; at 546 nm the optical densities were similar in all cases. However, for routine measurements, filtration was less time-consuming. Little difference was found between the pol values of very high pol sugars, with or without high-test molasses coating, using the two techniques.

Measurement of colour in raw sugar: Comparison of raw sugar colour measurements at 420 and 560 nm showed that while more than 94% of the colour contents at 560 nm were too low for accurate measurement, more than 70% of the contents measured at 420 nm fell within the desired range of 20–60% transmission, South African raw sugar having a very light colour. However, linearity was established between the readings at both wavelengths, and adoption of 420 nm as the standard (in line with the majority of the world's refiners) is recommended.

Refining quality of raw sugar: High negative correlation between raw sugar solution starch content and laboratory carbonatation was found, on detailed analysis, to be due to the separate action of the two major components of starch, viz. amylopectin and amylose; the former is not instrumental in causing excessive filtration difficulties, whereas the latter is certainly capable of causing poor filtrability.

Gas chromatography of trisaccharides: Separation of the three kestose isomers as their trimethylsilyl derivatives has been obtained by gas chromatography, and the trisaccharide composition in final molasses, refinery return syrup, high-test molasses, affined sugar and *C*-sugar investigated.

Chemistry of juice purification. II. V. PREY and H. HOLLE. *Zeitsch. Zuckerind.*, 1974, **99**, 113–119.—Investigations were carried out on formation of browning products from dihydroxyacetone solution under alkaline conditions, such products having been found earlier[1] to possess chemical structures similar to those of browning products in carbonatation. The effects of alkali quantity, pH and temperature on increase in colour were determined as well as the effect of added amino-acids. The relationship between molecular weight distribution of the browning products and reaction time was examined. Subsequent hydrogenation of the browning products was also studied. Details are given of the characteristic structural elements of the browning products.

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Some notes on the determination of water in molasses by the Karl Fischer method. E. C. VIGNES. *Zeitsch. Zuckerind.*, 1974, **99**, 121–123.—Tests on moisture determination in cane molasses by the KARL FISCHER method, using the special titrator manufactured by Deutsche Metrohm GmbH & Co., showed that, provided adequate precautions are taken and the right technique used, the method is sufficiently rapid and accurate for the purpose, despite its limitations.

* * *

Polarographic study of the properties of colorants in sugar manufacture. L. D. BOBROVNIK, L. P. KOTEL'NIKOVA, A. R. SAPRONOV and M. M. POLYACHENKO. *Izv. Vuzov, Pishch. Tekh.*, 1973, (6), 39–42.—Polarographic determination of the caramelan concentration in pure sucrose and molasses solutions using a mercury cathode is briefly described. Reduction of the caramelan on the cathode was found to be a diffusion process, and from the diffusion coefficient at 20°C was calculated the mean radius of the caramelan molecule. Only one caramelan electron was found to participate in the reduction process per polarizer particle. The polarograms showed that all sugar colorants reduce the wave height maximum at positive voltages. It was found that anions participate in this, and that the colorants were of an acid nature. From a graph of maximum wave height *vs.* colorant concentration, it is seen that for a 50% reduction in the wave height maximum the amount of caramelan needed is much greater than that of melanoidins which in turn is slightly greater than the concentration of reducing sugar alkaline decomposition products.

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Diffusion, light scattering and deviation from ideal conditions in aqueous sucrose solutions. M. N. DADENKOVA, L. P. ZHMYRYA and R. S. BURDUKOVA. *Izv. Vuzov, Pishch. Tekh.*, 1973, (6), 46–49.—Investigations showed that, for all the concentrations studied, aqueous sucrose solution deviated on the negative side from conditions for an ideal solution (where kinetic particles participating in diffusion do not alter in size with association or complex formation and diffusivity is a linear function of composition). The findings indicate that there is a change in mobility of the kinetic particles with change in concentration.

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Residual amounts of aluminium in beet sugar factory waste products. A. A. LIPETS, I. A. OLEINIK and O. P. RYABUSHKO. *Izv. Vuzov, Pishch. Tekh.*, 1973, (6), 164–165.—Tests showed that the aluminium ion is almost completely removed with carbonatation mud after use of aluminium sulphate as an aid in diffusion[2], and that only a negligible amount of aluminium is then to be found in molasses.

Molecular weight of beet and raw juice albumins. G. P. VOLOSHANENKO and S. S. MIROSHNICHENKO. *Izv. Vuzov, Pishch. Tekh.*, 1974, (1), 42–45.—The molecular weight of albumin in beet and raw juice, as determined by gel filtration on "Sephadex G-100" and "Sephadex G-150", was found to lie in the range 155,000–195,000. The method used was effective in separating albumin from other non-sugars and sucrose.

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Effect of glucose on sucrose crystallization parameters. A. I. BYVAL'TSEV and A. V. ZUBCHENKO. *Izv. Vuzov, Pishch. Tekh.*, 1974, (1), 152–154.—Solutions containing 11 g glucose to 200 g sucrose were subjected to crystallization, in which it was found that with rise in supersaturation, the activation energy, enthalpy and entropy fell. At constant supersaturation, rise in temperature caused a fall in enthalpy and entropy while the activation energy rose. Transfer from the kinetic to the intermediate zone in the crystallization process occurred at higher supersaturation than with pure sucrose solutions.

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Modification of Rietz "Varigrator" to reduce maintenance costs. J. T. D'ESPAIGNET. *Rev. Agric. Sucr. Maurice*, 1973, **52**, 118–119 + 2 figs.—Because of a tendency to wear of the shaft seal on the bottom drive arrangement of a Rietz "Varigrator" (used for direct cane analysis) with resultant failure of the self-lubricating bearings, modifications have been made to the bearing house and shaft arrangements to permit use of inexpensive bearings which are easily obtainable. Full details and diagrams are presented.

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Heavy metals in cane sugar products. M. A. CLARKE, N. M. MORRIS, V. W. TRIPP and F. G. CARPENTER. *Proc. 32nd Meeting Sugar Ind. Tech.*, 1973, 160–171. Atomic absorption spectroscopy was used to determine heavy metals in raw sugar, refinery liquors and refined sugar at three refineries to establish the effects of various processes. Results showed that affination and clarification were the most effective in removing Fe, Mn, Cu, Cr, Pb and Ag. Little difference was found between the effects of phosphatation and carbonatation, while bone char removed more metals than did granular carbon. The contents of each of the above metals except Fe and Ag (the latter was found in products from only one of the three refineries) and of Ni, Zn, Se, Cd and Sn in refined sugar were found to be well below those in flour and soft wheat.

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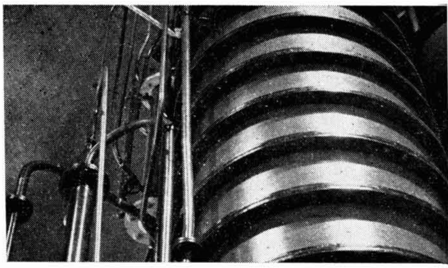
Investigation by ion exchange of the colouring compounds in viscous beet sugar products. V. A. KOLESNIKOV and D. M. LEIBOVICH. *Izv. Vuzov., Pishch. Tekh.*, 1973, (6), 50–52.—Use of AV-16 GS anion exchange resin in Cl^- and OH^- mixed form to adsorb colouring matter from thick juice and molasses was followed by elution with NaCl, HCl and NaOH solutions. The optical properties of the various fractions were then measured. Greatest colorant desorption was achieved with HCl and least with NaOH. The colorant fraction which could not be removed by resin treatment had spectral properties very similar to those of caramel. Distinct maxima and minima in the spectral curves were found only in those solutions eluted with NaCl.

[1] PREY *et al.*: *I.S.J.*, 1972, **74**, 281.
[2] LIPETS & OLEINIK: *ibid.*, 1973, **75**, 391.

By-products



Furfural and levulinic acid concomitantly from bagasse pith. C. I. Nee and W. F. Yeh. *Rpt. Taiwan Sugar Research Sta.*, 1973, (60), 77–83.—In making paper from bagasse, 30–40 parts of pith is separated from 100 parts of bagasse and disposal is a problem; the work reported establishes the technical feasibility of industrial preparation of furfural and levulinic acid from the pith.

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Pulp flow control from tower to drying. R. Oeljeschläger. *Zucker*, 1974, **27**, 17–22.—Using the juice flow control system at Uelzen sugar factory as illustration, the author indicates the prerequisites of an efficient system and then describes the flow control system applied at the same factory to the pulp following the introduction of fully-automatic drying. To smooth out the major disturbance, i.e. variation in pulp quantity, cossette feed to the tower diffuser was regulated from the speed of the diffuser drives, leading to more uniform discharge of exhausted cossettes. In the same way, distribution of the pulp in the presses was improved and hence discharge made more regular.

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Investigation of molasses yeast formation and fermentation processes. II. V. A. Marinchenko, A. D. Kovalenko, E. V. Volynets, K. K. Basilevich and T. T. Usenko. *Kharch. Prom.*, 1972, **15**, 29–33. Details are given of tests carried out with a continuous plant developed for molasses alcohol production in one- and two-stream systems.

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Trace elements in beet pulp. A. A. Lipets and E. A. Grivtseva. *Kharch. Prom.*, 1972, **15**, 41–44.—Details are given of the quantities of trace elements found in beet pulp samples from factories in three major regions of the Ukraine during 1966/67 and 1969/70.

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Current status and future potential for utilization of non-wood vegetable fibres—a world analysis. J. E. Atchison. *Amerop Noticias*, 1974, (3), 9–17.—Although non-wood sources of paper pulp are only 5% of the total raw material used, their use has been growing at the rate of 10% annually over the past 10 years while wood pulp usage has been growing at only 5½%. The current and potential use of non-wood fibres is briefly surveyed and more detailed attention given to the use of bagasse for pulp production. The outlook for bagasse utilization is considered good and it is estimated that in the next 15–20 years bagasse will provide 2–3% of the total world supply of paper pulp. With projects under way or being studied, 1974 is described as the "year of bagasse". An appendix lists 42 bagasse pulp plants and mentions a further 42+ plants, with capacities and types of product. Total capacity is set at 1,258,000 tons of air-dry material per year.

Obtaining coloured substances from final molasses and their testing as corrosion inhibitors. S. Kara-Murza, H. Shimbor, F. Pérez and S. Müller. *CubaAzúcar*, 1973, (July/Sept.), 30–37.—Coloured components were separated from final molasses by various methods including acidification and alcohol precipitation, isolation using "Sephadex A-25", precipitation with cetyl trimethyl ammonium bromide, etc. and these were added to 1N solutions of HCl and H_2SO_4 at 35°C, 1M NaCl, and saturated KCl and K_2SO_4 at 60°C to determine the effect obtained on the corrosion of mild steel. All were inhibitors to a greater or lesser degree of acid corrosion, but they accelerated corrosion in the neutral salt solutions. The inhibitory action of molasses itself was shown to be due to its content of coloured compounds formed by alkaline degradation of reducing sugars and the Maillard reaction.

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MSG production by the fermentation of cane molasses. Y. C. Chang. *Taiwan Sugar*, 1973, **20**, 180–184. Monosodium glutamate, the flavour-enhancing substance, was first identified in seaweed in 1908 and until 1956 was made by protein hydrolysis. The fermentation process, growing *Micrococcus glutamicus* on a medium containing sugar and ammonia under aerobic conditions, originally used glucose and starch hydrolysate but this has been replaced by cane molasses which provides the source for most of the world production. In Taiwan production started in 1960 and by 1972 had reached 18,956 metric tons, of which 6601 tons worth over $5,000,000 was exported. An account is given of the process used, with a flowsheet, description of the micro-organism culture, preparation of the fermentation medium, fermentation conditions, isolation of glutamic acid and crystallization of MSG.

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Torula yeast production from blackstrap molasses. C. T. Chang and W. L. Yang. *Taiwan Sugar*, 1973, **20**, 193–199.—Teast is produced in Taiwan for animal fodder and thus provides protein food. An analysis of such yeast is presented and an illustrated account given of the manufacturing process at Hsinying where 36 tons of yeast are produced per 24 hours, using cane molasses as the carbohydrate source.

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Study on feed yeast production from molasses distillery stillage. C. T. Chang and W. L. Yang. *Taiwan Sugar*, 1973, **20**, 200–205.—The manufacture of animal fodder yeast from vinasse by cultivation of *Candida utilis* NRRL-Y-900 is described, with a flowsheet and information on the fermentation characteristics.

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The use of cane molasses and dried Torula yeast in swine feed. F. K. Koh and N. L. Tai. *Taiwan Sugar*, 1973, **20**, 206–208.—Of the 240,000 metric tons of molasses produced in Taiwan, 80,000 tons is used for alcohol production, 66,000 tons for direct use in animal feed and 40,000 tons for production of Torula fodder yeast, the remainder being used for other by-products. Thus, more than 40% is used in the feeding of animals, particularly pigs which are able to utilize molasses to replace grain. Feeding trials have been carried out over many years.

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Sucrose as an industrial raw material. K. J. PARKER. *Sucr. Belge*, 1974, **93**, 15–27.—See *I.S.J.*, 1971, **73**, 26.

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Molasses as raw material for baker's yeast production. H. OLBRICH. *Branntweinwirtschaft*, 1973, **113**, (4), 53–68; through *S.I.A.*, 1974, **36**, Abs. 74–54.—The use of molasses for baker's yeast production is discussed, and comparisons are made with other raw materials. The effects of variations in molasses quality are indicated, and economic and commercial conditions are described in detail.

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Dissolving pulps from Egyptian bagasse. II. Low temperature cooking. M. A. ABOU-STATE, B. M. AWAD and M. M. EL-MORSY. *J. Appl. Chem. Biotechnol.*, 1973, **23**, 505–509; through *S.I.A.*, 1974, **36**, Abs. 74–71.—The effects of prehydrolysis and pulping temperatures and reagent concentrations on the properties of pulp produced from depithed bagasse were investigated. In the prehydrolysis stage, higher quality pulp was obtained by using 0·3% H_2SO_4 rather than 0·15% H_2SO_4, and by treatment with 0·6% H_2SO_4 at 120°C rather than treatment with 0·3% H_2SO_4 at 140°C. In the pulping stage, increasing the NaOH concentration from 17·4 to 25·2 g per 100 g of bagasse or lowering the temperature from 160°C to 140°C resulted in the production of superior pulp.

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Extraction of cane wax from press mud. Design of pilot unit. R. B. NIGAM and A. C. RAHA. *Proc. 39th Ann. Conv. Sugar Tech. Assoc. India*, 1973, G13–G19, G25–G34.—Preliminary data for optimization of cane wax extraction from press mud and for use in designing suitable equipment are presented, and an outline scheme for handling 1 ton of press mud per day is described.

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Different tests with molasses from raw sugar and the formation of scale in ethanol distillation columns. L. G. DE SOUZA and U. DE A. LIMA. *Brasil Açuc.*, 1973, **82**, 527–536.—Laboratory experiments were made in distillation of fermented worts which were derived from diluted molasses as such, molasses acidified with sulphuric, hydrochloric or phosphoric acid to pH 4·5, and molasses acidified with sulphuric acid to pH 4·5 and then brought to pH 5·6 with sodium hydroxide. The distillations were carried out in the presence of stainless steel and copper rings, and one experiment was made where the molasses was acidified to pH 4·5 with sulphuric acid and the rings connected to earth via a water pipe. In no case was scaling observed, although the ionic concentrations of Ca^{++} and SO_4^{--} exceeded the solubility coefficient. In tests for scale removal, treatment with 2% HCl followed by 2% NaOH proved faster than treatment with alkali followed by acid.

Utilization of beet pulp for L-mannose preparation. V. BÍLIK and F. JANEČEK. *Listy Cukr.*, 1974, **90**, 35–37. A brief description is given of a process for production of L-mannose from beet pulp which has been tested on a laboratory scale. After hydrolysis of the pulp with 0·25N sulphuric acid and heating for 5 hours at 80°C, the cellulose component is filtered off and the filtrate concentrated before extraction with 96% ethanol. Pectin is then removed by filtration and the filtrate neutralized with barium or calcium carbonate. The precipitated sulphates are removed and the filtrate concentrated to a syrup. Methanol is added, the solution heated to boiling point, cooled and filtered; nitromethane is added to the filtrate and, after 1 hour, sodium methanolate. The mixture is then stood for 20 hr at room temperature, and the resultant precipitated sodium salt of 1-desoxy-1-nitro-alditole filtered off, washed with methanol and dissolved in water. Sodium molybdate is added to the solution followed by hydrogen peroxide after 1 hr. After 20 hours' standing at room temperature, palatinized carbon is added to decompose excess hydrogen peroxide and the solution stood for a further 60 hours. The mixture is filtered, and phenyl hydrazine in methanol added. After 20 hours, mannose phenyl hydrazone is precipitated and the L-mannose liberated with benzaldehyde to give 80% crystalline mannose of specific rotation $\alpha_D^{24} = -14°$.

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Results of tests on a E8-PGA press for briquetting pulp with amido-mineral additives. A. I. KVYATOVSKII and L. E. DOLGORUCHENKO. *Sakhar. Prom.*, 1974, (2), 31–32.—Mention is made of a Soviet beet pulp briquetting press which handles a maximum of 4·6 metric $tons.hr^{-1}$ at an optimum moisture content of 15–17%. The mix is composed of 74–77% dried pulp, 9·5–10% molasses, 6–6·7% urea, 6–6·3% defluorinated phosphate and 1·5–3% sodium sulphate.

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Urge recycling. ANON. *Sugar News* (Philippines), 1973, **49**, 365.—The question of pollution of waterways by vinasse is discussed and possible means of reducing it considered. Recycling processes, which may merely be a means of solving the disposal problem or may also involve recovery of valuable by-products, are briefly outlined. Addition of sulphates in the yeast manufacturing process has been discouraged because of the objectionable odours and serious corrosion of concrete drain pipes caused by anaerobic reduction to sulphide.

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Methods of preparing an invert sugar solution. S. Z. IVANOV and V. A. GOLYBIN. *Izv. Vuzov. Pishch. Tekh.*, 1973, (6), 138–140.—Of six methods examined for invert preparation by acid hydrolysis of sucrose at high temperature, two were found to give minimum hydroxymethyl furfural and other inversion side-products. They are the method of PALASH [treatment with HCl (0·96 g.eq per litre) at 58–60°C for 10 minutes] and of VUKOV [treatment with H_2SO_4 (0·01 g.eq per litre) for 7 minutes at above 100 °C].

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Thermodynamic characteristics of mass transfer in wet beet pulp. M. G. PARFENOPULO. *Izv. Vuzov, Pishch. Tekh.*, 1973, (6), 145–148.—Experiments are reported on determination of the specific isothermal bulk volume of beet pulp at different temperatures, and empirical formulae presented for calculation of the bonding energy of moisture to beet pulp as a function of mass transfer potential. The investigations are aimed at determining the total heat requirement for pulp drying.

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Dependence of the speed of vibro-transporting of dried beet pulp on amplitude and frequency of vibrations. M. G. PARFENOPULO and N. E. KARAULOV. *Izv. Vuzov, Pishch. Tekh.*, 1974, (1), 100–103.—An empirical formula derived from tests aimed at working out basic design parameters for vibratory conveyors used to transfer beet pulp is valid for calculation of speed in terms of amplitude and angle of slope for frequencies of 50 Hz and height of pulp layer in the range 20–130 mm.

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Influence of pantothenate on the growth and chemical composition of *Candida utilis* yeast. J. S. OLIVEIRA. *Ind. Alim. Agric.*, 1974, **91**, 93–98.—The influence of 400 μg of calcium pantothenate per litre added to a substrate made of cane molasses to which nitrogen (in the form of urea, glutamic acid, sulphate of ammonia and ammonia) and mineral substances had been added was investigated in *Candida utilis* var. *major* culture. It was found that the pantothenate reduced the latent phase period without affecting growth but had a significant effect on the amino-acid, riboflavin and nicotinic acid contents.

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An inexpensive molasses stockfeed mixer. E. LIM FAT. *Rev. Agric. Sucr. Maurice*, 1973, **52**, 131–132 + 1 fig. A description is given of a cheap and simple molasses feed mixer which can be made by farmers or small manufacturers in tropical countries where lack of capital and transport problems involved in distribution prevent the production of molasses feed in factories.

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Performance tests on pigs fed maize or high-test molasses as the energy source. I. Interrelationships among growth traits. F. J. DIÉGUEZ and M. MENCHACA. *Cuban J. Agric. Sci.*, 1973, **7**, 277–283. Correlations have been established for a number of growth factors, showing similarity between the levels for both diets with the exception of the correlation between feed consumption and conversion.

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***In vivo* gas production and VFA (volatile fatty acids) pattern of sheep given molasses.** R. J. MARTY, D. I. DEMEYER, C. J. VAN NEVEL and H. K. HENDERICKX. *Cuban J. Agric. Sci.*, 1973, **7**, 313–321.—A method for gas collection and molasses infusion is described which was used to determine the amount of methane produced by sheep given molasses of varying quantities. Results suggest an inverse relationship between methane production and molar proportions of propionate in the rumen fluid.

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Protein levels in molasses-based diets for fattening pigs. M. VELÁZQUEZ and T. R. PRESTON. *Cuban J. Agric. Sci.*, 1973, **7**, 323–329.—Results of tests showed that there were no significant differences in growth rate, feed intake or dry matter conversion with protein level, but there was a significant linear relationship between protein level and protein conversion rate. Six protein levels were involved.

Bagasse storage research in South Africa. ANON. *Ann. Rpt. Sugar Milling Research Inst.*, 1973.—Wide variation in the bacterial populations and organic acid contents was found in bagasse stored by three different methods. Organic acids found included acetic, propionic, butyric and valeric acids (all resulting from bacterial fermentation of residual sugar), but no lactic acid was found. Micro-organisms found included: *Clostridium botulinum*, *C. fallax* (responsible for butyric and acetic acids), *Bacillus subtilis*, *B. stearothermophilus*, *B. licheniformis* and *B. coagulans* (causing acetic acid formation). Results indicated that the storage process is governed by reduction in pH caused by the volatile acids, while the nature of the liquid used for wetting the bagasse appears to be of secondary importance.

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Fermentation of cane sugar molasses. K. P. GOPALRATHNAM. *Chem. Eng. World*, 1971, **6**, (4), 41–43; through *S.I.A.*, 1974, **36**, Abs. 74–344.—The production of alcohol from cane molasses by fermentation with *Saccharomyces cerevisiae* is outlined. The optimum conditions are: pH 4·0–4·5; temperature about 30°C; sugars % molasses, 10–12. Typical industrial processes are briefly described.

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Manufacture of alcohol from molasses by continuous fermentation. I. KARAKI. *Hakko Kyokaishi*, 1972, **30**, 422–433; through *S.I.A.*, 1974, **36**, Abs. 74–345. Factory-scale experiments on the continuous fermentation of molasses were conducted over periods of 20–28 days. The variables considered included the design of the plant, the residence time (7–24 hours) and the sugars content of the wort (22 or 44%). Particular factors studied included the alcohol content and the yeast and bacterial counts of the wort; the results are presented in graphs.

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Evaluation of molasses as raw material for the alcohol and yeast industries in 1966-1972. L. HROBONI and I. KOLODZIEJCZAK. *Przem. Ferment. Rolny*, 1973, **17**, (1), 11–15; through *S.I.A.*, 1974, **36**, Abs. 74–346. Results of standard quality control analyses on beet molasses are tabulated as campaign averages for Poland and its individual factories; the corresponding yields of yeast and alcohol are tabulated and classified as good, average or poor. Deterioration of molasses processing quality between 1966 and 1972 is ascribed to newer techniques in agriculture and sugar manufacture.

New factories for India[1].—Preliminary steps, including selection of sites and placing of orders for equipment, etc., have been taken by the U.P. State Sugar Corporation for setting up four sugar factories in the State, at Nandganj (Ghazipur), Chhata (Mathura), Chandpur (Bijnor) and Daryapur (Rae Bareli). A licence is awaited for a fifth factory at Lakhimpur-Kheri. Each factory, expected to cost about 50 million rupees, will have a crushing capacity of about 1250 t.c.d.

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Japanese investment in Honduras sugar industry[2].—Mitsubishi Corporation plans to produce 75,000 metric tons of sugar yearly in Honduras jointly with local concerns and starting 1976. Part of the output will be consumed locally and the rest exported to Japan. A Mitsubishi subsidiary company has been established in Honduras for this purpose.

[1] *N.S.I. News*, 1974, **10**, (1), 5.
[2] *Public Ledger*, 12th September 1974.

Brazil sugar statistics[1]

	1973	1972	1971
	metric tons, tel quel		
Initial stocks......	2,409,212	2,929,387	2,669,530
Production	6,612,930	5,866,474	5,030,619
	9,022,142	8,795,851	7,700,149
Exports*	2,940,881	2,608,647	1,230,475
Consumption ..	4,050,939	3,777,992	3,540,297
Final stocks......	2,030,322	2,409,212	2,929,377

* Exports in metric tons,raw value, were tabulated in a previous issue of this *Journal* (1974, **76**, 160).

* * *

UK refined sugar price.—A prize equalization scheme for sugar, to be operated by the Sugar Board, came into operation in the UK on the 4th November, in order to remove the differential between the price of white beet sugar and that of refined sugar produced from the CSA raws imported at a cost of £140 per ton. The statutory 28 days' notice required for notice of price changes under UK legislation has been waived so that the retail price of sugar rose immediately to about £190 per ton.

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New sugar complex for Zaire[2].—The Government of Zaire has authorized the erection of a new sugar complex at Mushie-pentane in the Bandundu District, to be financed by Government and British financial interests in a proportion of 65:35. The project will cost $8,650,000 and will produce about 54,000 tons of sugar per year.

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Trinidad sugar production[3].—Sugar production in the 1974 season in Trinidad was 186,298 metric tons, raw value, compared with 184,073 tons in 1973. The 1974 crop was higher than originally anticipated, mainly because of favourable weather conditions.

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Distillery for Brazil[4].—A plant to produce 18 million litres a year of anhydrous alcohol from sugar cane, to mix with motor spirit, is to be installed at També, near Recife, for operations to begin in 1976.

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St. Kitts sugar production, 1974[5].—Sugar production from the 1974 season in St. Kitts reached 25,470 long tons, compared with 23,222 tons in 1973. It is feared that drought conditions during June have affected the young plants and that many newly planted fields have been lost through lack of rainfall. Young canes have also suffered, thus affecting the estimate of 25,000 tons for the 1975 crop.

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Tanzania sugar factory plans[6].—The World Bank has announced that Tanzania is to receive $18,000,000 for help in constructing a $55 million factory capable of producing 45,000 metric tons of refined sugar.

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Egyptian sugar industry expansion programme[7].—Official sources in Cairo have announced that it is intended to increase sugar production in Egypt by about 25% within the next three years with the erection of two new sugar factories and the modernization of an existing factory. Sugar production in Egypt in 1974/75 is estimated at 623,000 tons, raw value.

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Polish sugar industry expansion[8].—The Lapy sugar factory has gone into operation although it is not expected to attain its rated capacity of 5280 tons/day in its first campaign. The country's 78th factory is to start operation in October 1976 at Krasnystaw; while in the next few years at least ten more factories must be erected to reduce the cost and losses entailed in the transport of beets from the east to the west of Poland.

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Chad sugar refinery[9].—A sugar refinery is to be erected in Chad, with an annual capacity of 20,000–25,000 tons of sugar.

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Cuban sugar industry investment[10].—A massive investment in the Cuban sugar industry was announced by President DORTICOS, amounting to between $720 and $840 million during the five year plan period 1976–1980. Meanwhile the current sugar crop, which started in November, may be seriously affected by droughts suffered by the island during the last few years. The 1973/74 crop was 7% higher than that of 1972/73 and 25% higher than that of 1971/72, the President said, but he gave no figures.

Brevities

US sugar factory sale to Panama[11].—It is reported that the Frisco sugar factory in Louisiana which did not operate during the 1974 crop[12] has been sold to a company controlled by the Government of Panama and is being dismantled for shipment and re-erection in Panama, starting January 1975.

* * *

Sugar refinery in Algeria[13].—A refinery has been put into operation by the Société de Gestion et de Développement des Industries du Sucre (SOGEDIS) and will have a capacity to convert raw sugar to 30,000 tons/year of cube sugar, 30,000 tons/year of sugar loaves and 30,000 tons/year of granulated refined sugar.

* * *

Levulose manufacture in the US[14].—California & Hawaiian Sugar Co. and the Finnish Sugar Company Ltd. have agreed to set up a joint company, Finn-Cal Fruit Sugar Company, to be based in San Francisco and to construct a production facility in the Bay Area for levulose manufacture according to the process patented by the Finnish Sugar Co. Ltd. The new company will market levulose in crystalline and liquid form and also in a special pharmaceutical grade throughout the USA, Canada and Mexico.

* * *

New Peruvian sugar factory[15].—A new mill, capable of processing 200,000 tons of sugar cane a year, is to be installed in the Santa valley, in the Department of Ancash.

* * *

Philippines sugar production 1973/74[16].—Sugar production in the 1973/74 season totalled 2,694,952 short tons, tel quel, according to the Philippine Sugar Association. This compares with 2,474,530 tons produced in 1972/73.

* * *

Thailand sugar production increase[17].—Thailand will be able to produce 1,500,000 metric tons of cane sugar annually within the next two years, according to a USDA field report from Bangkok. It estimated raw sugar production in 1974/75 at 1,025,000 tons and in 1975/76 at 1,130,000 tons. The 1973/74 revised production was 930,000 tons. The report said there will be 39 sugar mills operating in Thailand in 1975. Sugar exports in 1973/74 were 274,959 tons and are estimated to reach 600,000 tons in 1974/75 and 1975/76. Sugar smuggling became a serious problem in 1974, owing to high world prices; it is unofficially estimated that 100,000 tons of white sugar were smuggled into Cambodia, South Vietnam, Laos, Hong Kong and Singapore in 1974.

* * *

International Sugar Research Foundation Inc.—The Annual Meeting of the Foundation was held in Durban, South Africa, during the 8th–13th September 1974. During a meeting of the Directors, M. PAUL WAHL of Belgium was elected Chairman for a second term. The papers presented were exclusively concerned with nutritional and medical aspects of dietary sugar, although the $81,000 allocations made during the meeting were in the fields of sucrochemistry, and sucrose derivatives in pesticides and animal feeds as well as medical and dietary topics.

1 C. Czarnikow Ltd., *Sugar Review*, 1974, (1188), 124.
2 *Zeitsch. Zuckerind.*, 1974, **99**, 561.
3 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (28), 9.
4 *Bank of London & S. America Review*, 1974, **8**, 607.
5 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (28), 10.
6 *Amerop Noticias*, 1974, (11), 9.
7 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (28), 10.
8 *Zeitsch. Zuckerind.*, 1974, **99**, 560.
9 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (28), 10.
10 *The Times*, 15th October 1974.
11 *Sugar Bull.*, 1974, **52**, (24), 15.
12 *I.S.J.*, 1974, **76**, 383.
13 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (28), 10.
14 *Willett & Gray*, 1974, **98**, 396.
15 *Bank of London & S. America Review*, 1974, **8**, 675.
16 *Willett & Gray*, 1974, **98**, 465–466.
17 *Reuters Rpt.*, 17th October 1974.

Brevities

UK sugar factory closure cancelled.—The British Sugar Corporation Ltd. announced on the 11th November that its factory at Selby, Yorkshire, which had been due for closure after the current campaign, will now stay open indefinitely. As a result of the urgent need to increase sugar processing capacity it had been decided to keep the factory open and to install new equipment there as part of the Corporation's capacity expansion programme. Selby produces some 25,000 tons of sugar per year.

* * *

Evaporator contract.—The A.P.V. Company Ltd. of Crawley, Sussex, has been awarded a contract in excess of £200,000 for the supply of a large quadruple-effect evaporator for the Albion Sugar Co. Ltd. The evaporator will comprise a triple-effect climbing and falling film plate evaporator, followed by a forced-circulation tubular evaporator as a fourth effect.

* * *

Bolivian factory and distillery contract for Tate & Lyle Enterprises Ltd.—A £10 million contract has been secured by Tate & Lyle Enterprises Ltd. for the supply of a turnkey sugar factory and distillery project at Santa Cruz in Bolivia. The contract is being carried out for the Unión Agroindustrial de Cañeros S.A. (Unagro), a company formed by the Federación de Cañeros de Santa Cruz. The new factory, which is to be sited near the village of Mineros, 80 km to the north of Santa Cruz, between the rivers Piray and Grande, will process over 4000 tons of cane per day and employ more than 300 people. A. & W. Smith & Co. Ltd. will be supplying part of the equipment, in particular the 12-roller 84-inch milling tandem, while the distillery is to be supplied by the French firm SPEICHIM.

* * *

FAO/UNIDO meeting on promoting food processing industries in developing countries.—Nearly 200 industrialists, financiers, consultants and government officials from 46 countries took part in a 5-day series of meetings in Amsterdam during which they explored ways in which external technical, financial and managerial resources could participate in selected food processing industries in 28 developing countries. The 78 projects put forward as requiring some form of partnership ranged from a $320,000 mushroom canning factory to a $96 million sugar mill complex. The meeting was organized by the United Nations Industrial Development Organization and the Food and Agriculture Organization of the UN, in cooperation with the Council of the Netherlands Industrial Federation and the Netherlands Industrial Board for Agriculture.

* * *

Cane leaf protein production[1].—Two factories are to be set up, at Shahada and Sanjivani sugar factories, Kopargaon, for the manufacture of protein from sugar cane leaves. An investment of 80 million rupees will be involved.

* * *

New Philippines sugar factories[2].—The first sugar factory in the Bicol region of the Philippines was to start operations in Camarines Sur before the end of 1974. It will have a capacity between 4000 and 6000 metric tons of cane per day and will be owned by the Bicol Sugar Development Corporation. The mill lies in a 110-hectare site in Himaao, Pili, and will initially receive cane from 5000 hectares of cane lands in the neighbourhood. A new corporation, Bukidnon Sugar Milling Company, is negotiating with Marubeni Corporation of Japan for establishment of a 4000–6000 t.c.d. raw sugar factory in Bukidnon.

* * *

Indian sugar factory plans[3].—The Government of Kerala State has applied to the Central Government for a licence to erect two sugar factories in the Cannanore and Idikki regions. These will be the first of a group of five, each of which is to have a crushing capacity of 1250 metric tons of cane per day and giving a total sugar production of 112,500 tons per year. The three existing factories in Kerala produce only one-twelfth of the State's requirements. Three new cooperative sugar factories have been sanctioned in Maharashtra, bringing the total number of such units in the state to 73; the new factories are the Bhima Cooperative Sugar Factory at Patas, Sholapur District; the Yawal River Taluka Cooperative Sugar Factory in Jawgaon District; and the Jain Bhawani Cooperative Sugar Factory at Gevrai in Bihar District.

European beet sugar production 1974/75[4]

	1974/75		1973/74
	2nd Estimate	*1st Estimate*	
	(metric tons, raw value)		
Belgium	620,000	666,000	797,000
Denmark	428,000	430,000	375,556
France	3,100,000	3,300,000	3,241,000
Germany, West	2,517,000	2,475,000	2,507,351
Holland	755,000	770,000	850,589
Ireland	156,000	156,000	196,557
Italy	967,000	945,000	1,155,556
UK	695,000	870,000	1,070,278
Total EEC	9,238,000	9,612,000	10,193,887
Austria	393,000	354,000	371,000
Finland	80,000	78,000	82,789
Greece	177,000	172,000	161,927
Spain	620,000	620,000	805,556
Sweden	311,000	317,000	270,000
Switzerland	70,000	75,000	79,531
Turkey	878,000	955,000	752,330
Yugoslavia	600,000	600,000	468,751
Total West Europe	12,367,000	12,783,000	13,185,771
Albania	16,000	16,000	19,000
Bulgaria	200,000	200,000	240,000
Czechoslovakia	775,000	765,000	730,000
Germany, East	510,000	520,000	560,000
Hungary	310,000	340,000	326,022
Poland	1,755,000	1,717,000	1,817,114
Rumania	550,000	600,000	580,000
USSR	9,600,000	9,500,000	9,680,000
Total East Europe	13,716,000	13,661,000	13,952,136
TOTAL EUROPE	26,083,000	26,444,000	27,137,907

* * *

Uruguay move to self-sufficiency in sugar[5].—Sugar production in Uruguay in 1974/75 is forecast at a record 104,000 metric tons, up 41% from the previous year's total of 74,000 tons, according to a USDA report. The increased production reflects a 59% increase in the area planted to sugar beets, with a large number of small farmers shifting acreage previously planted to wheat, as a response to the Government's more favourable pricing policy. If the production estimate for 1974/75 proves correct, for the first time Uruguay will not need to import any sugar for domestic needs; raw sugar imports in the first three quarters of 1974 totalled 16,043 tons.

* * *

Panama sugar expansion plans[6].—Estimated sugar production in Panama in 1973/74 is 115,000 tons, an increase of 24% over that of the previous season. Exports during 1974 are expected to have reached 70,000 tons, compared with 50,000 tons in 1973. The existing mills are expanding production and there are proposals for three additional mills. (The closed-down Frisco mill in Louisiana has been sold to Panama for re-erection there[7].) As a consequence, 1974/75 production is forecast at 140,000 tons, of which 85–90,000 tons will be for export.

* * *

Fiji sugar production fall[8].—The Fiji Minister of Agriculture has announced that sugar production in 1974 would only reach 270,000 tons or about 130,000 tons below the target figure, as a consequence of poor weather and a sugar workers' strike. Supply commitments would not be met as a result, although Fiji expects to be very close to meeting in full its commitment of 140,000 tons to Britain under the Commonwealth Sugar Agreement.

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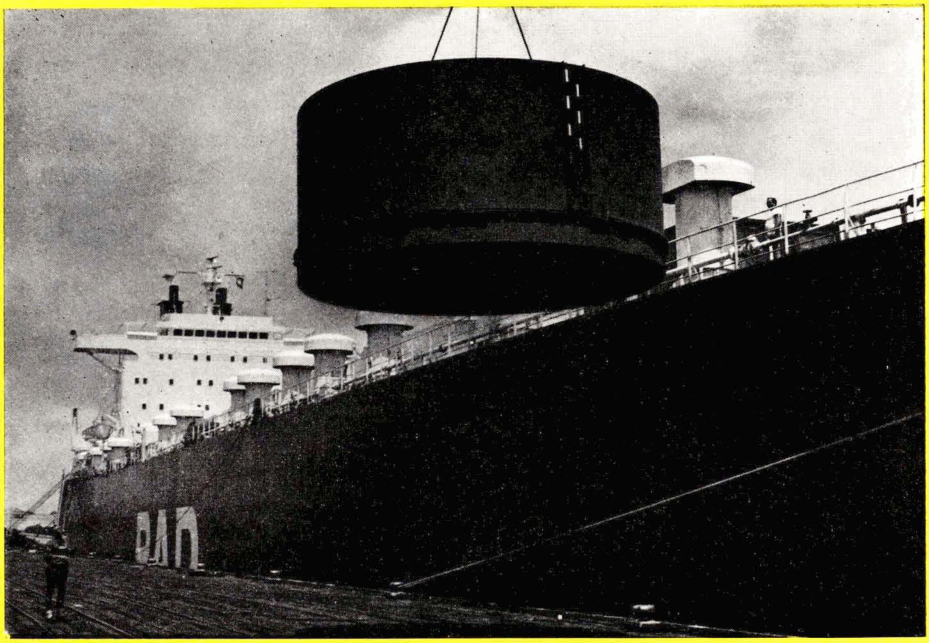
1 *Indian Sugar*, 1974, **24**, 153.
2 *Sugar News* (Philippines), 1974, **50**, 267, 271.
3 *Indian Sugar*, 1974, **24**, 152–153.
4 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (30), 1–2.
5 *Reuters Rpt.*, 25th October 1974.
6 *Public Ledger*, 19th October 1974.
7 *I.S.J.*, 1975, **77**, 31.
8 F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (33), 12.

EXPORT, EXPORT, EXPORT.



Part of a vacuum pan being loaded at Brisbane en route to the island of Hawaii.

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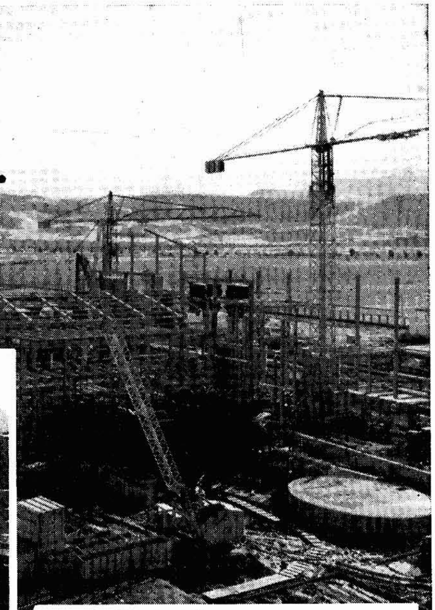
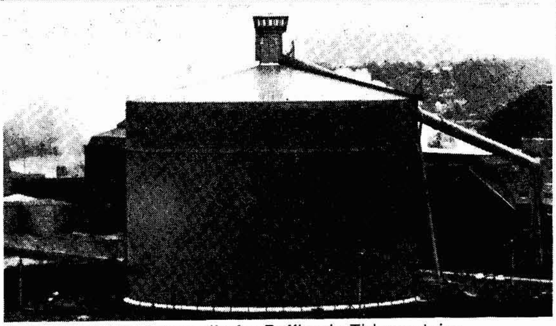
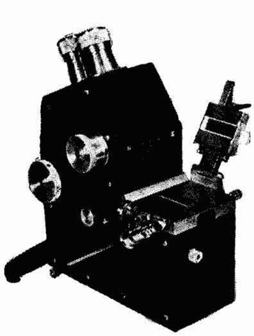




White sugar silo for Raffinerie Tirlemontoise, Division of Wanze factory. Capacity : 60.000 tons.



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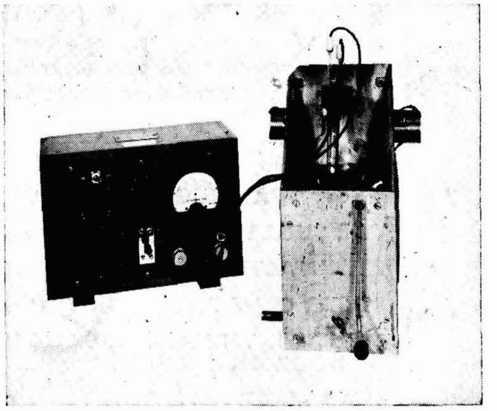
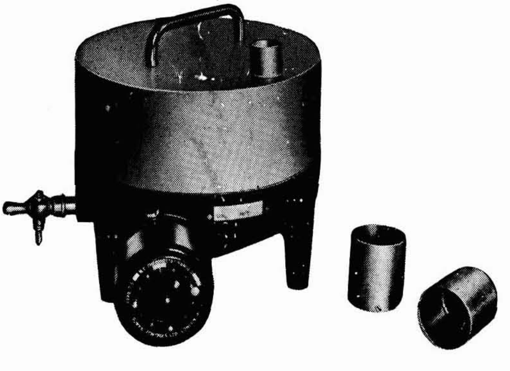
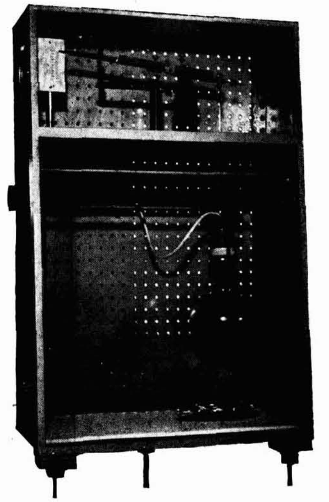


SUGAR MOISTURE MEASUREMENT



For the rapid estimation of moisture in sugars, the oven (left) is fitted with a thermostat which gives a temperature control of ± 0.25°C over a range of 60°C from a central adjusted temperature. Results can be obtained in about 15 minutes. This type of oven must be used in conjunction with a vacuum pump or factory vacuum line for drawing the air over the heating element, through the sample and into the vacuum line or pump trap. A timing device can be supplied as an extra.

The sensitive infra-red balance (right) is designed for direct indication of moisture in refined sugars containing up to 0.25% water. A 20-g sample is dried by means of a 150W i.r. lamp and the loss in weight indicated continuously by the pointer on a 50-division scale where each division is equivalent to 1 mg. Reproducibility is to within half a division.



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