THE International Sugar Journal

MARCH 1974

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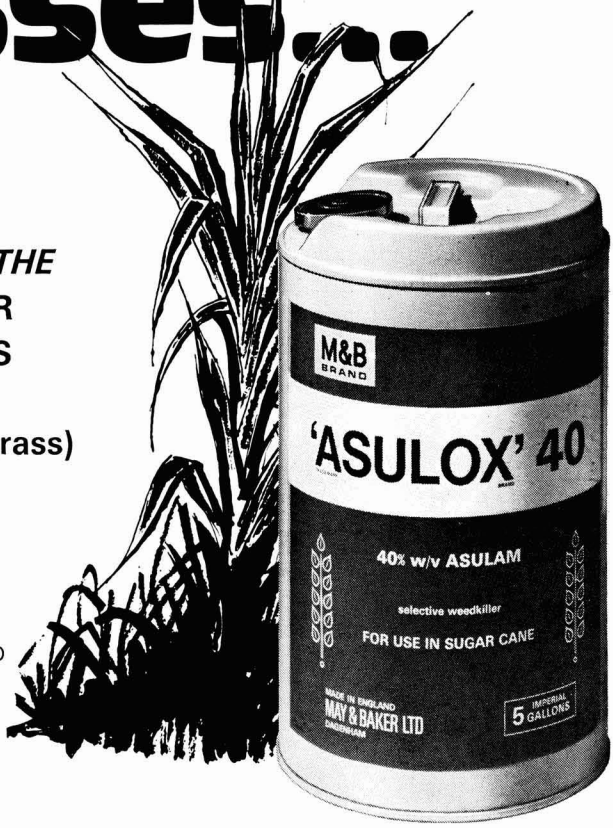

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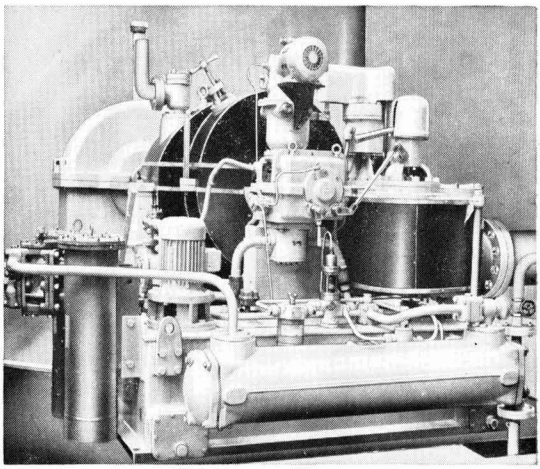

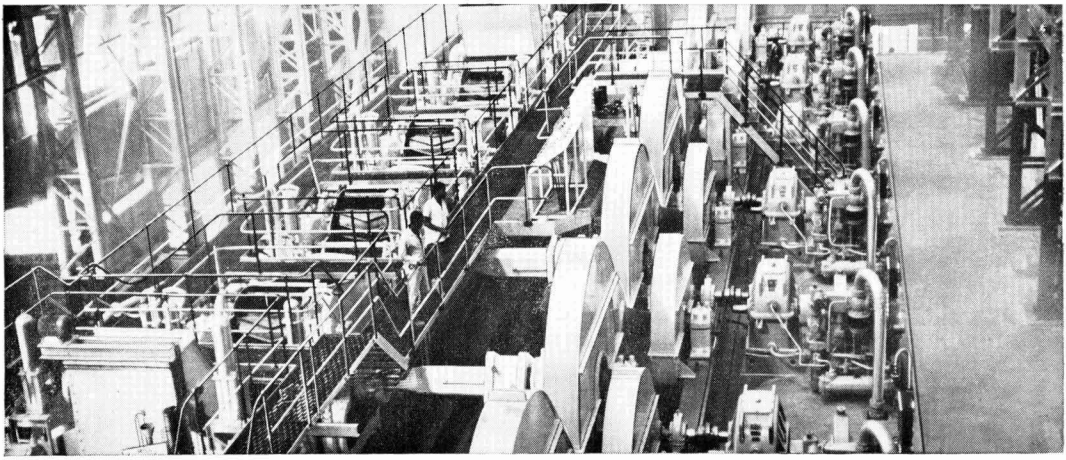

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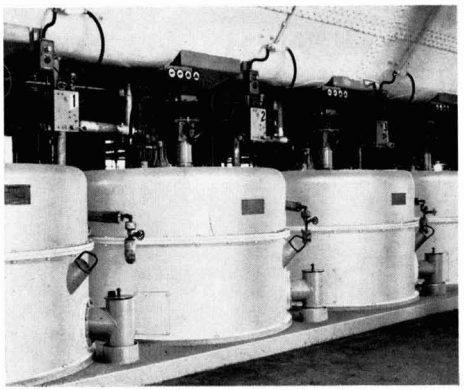

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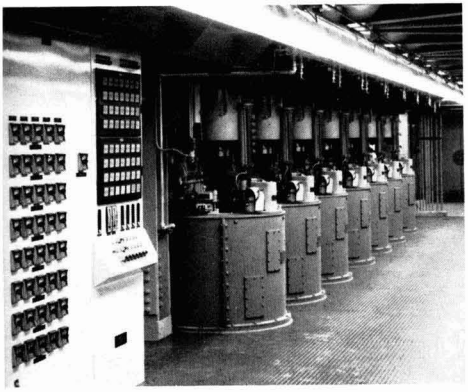

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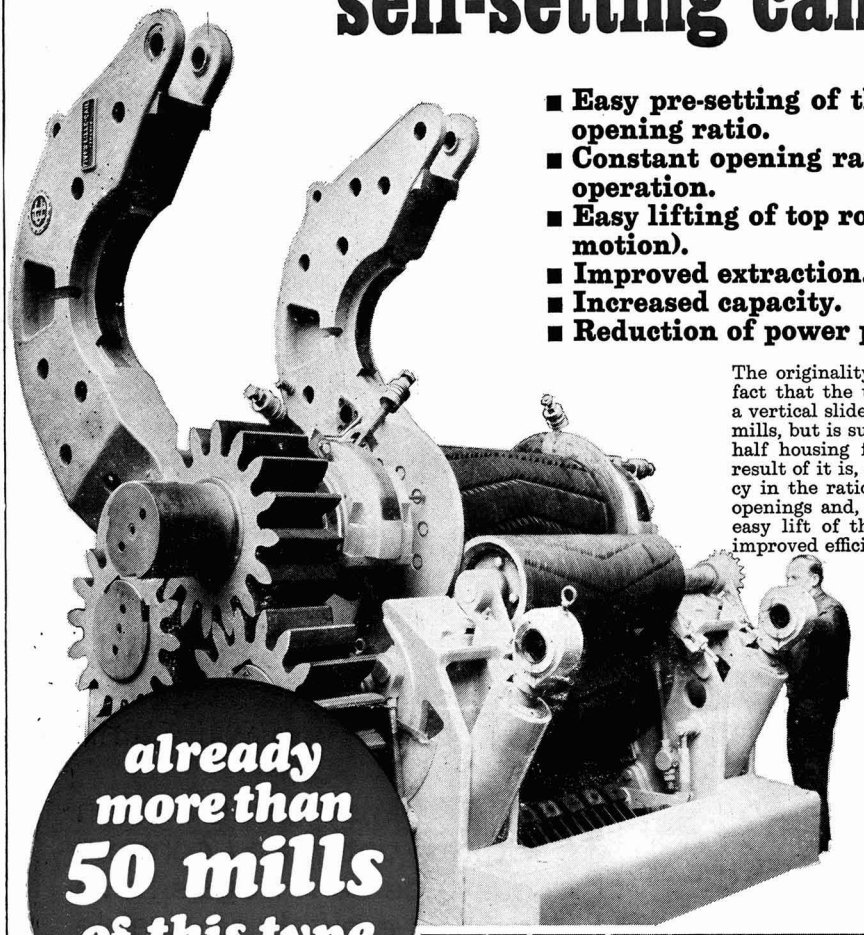

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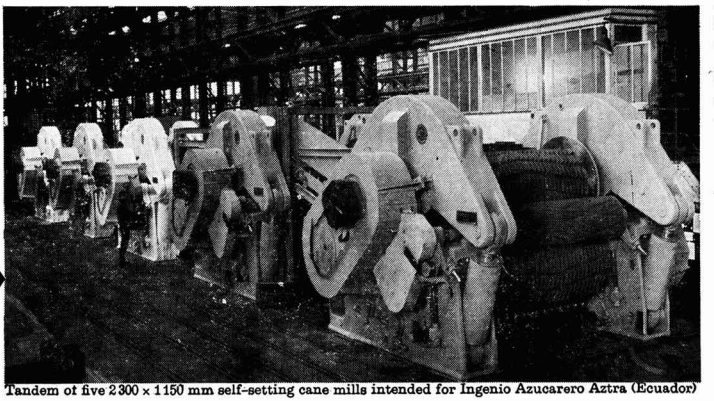

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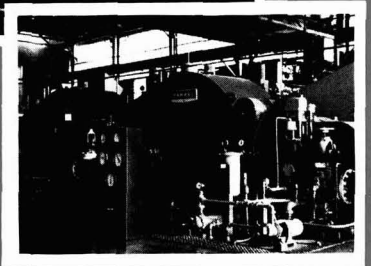

Aerial view of Gulf & Western's Okeelanta sugar factory and installation picture of Farrel drives in operation at the Central Romana factory.

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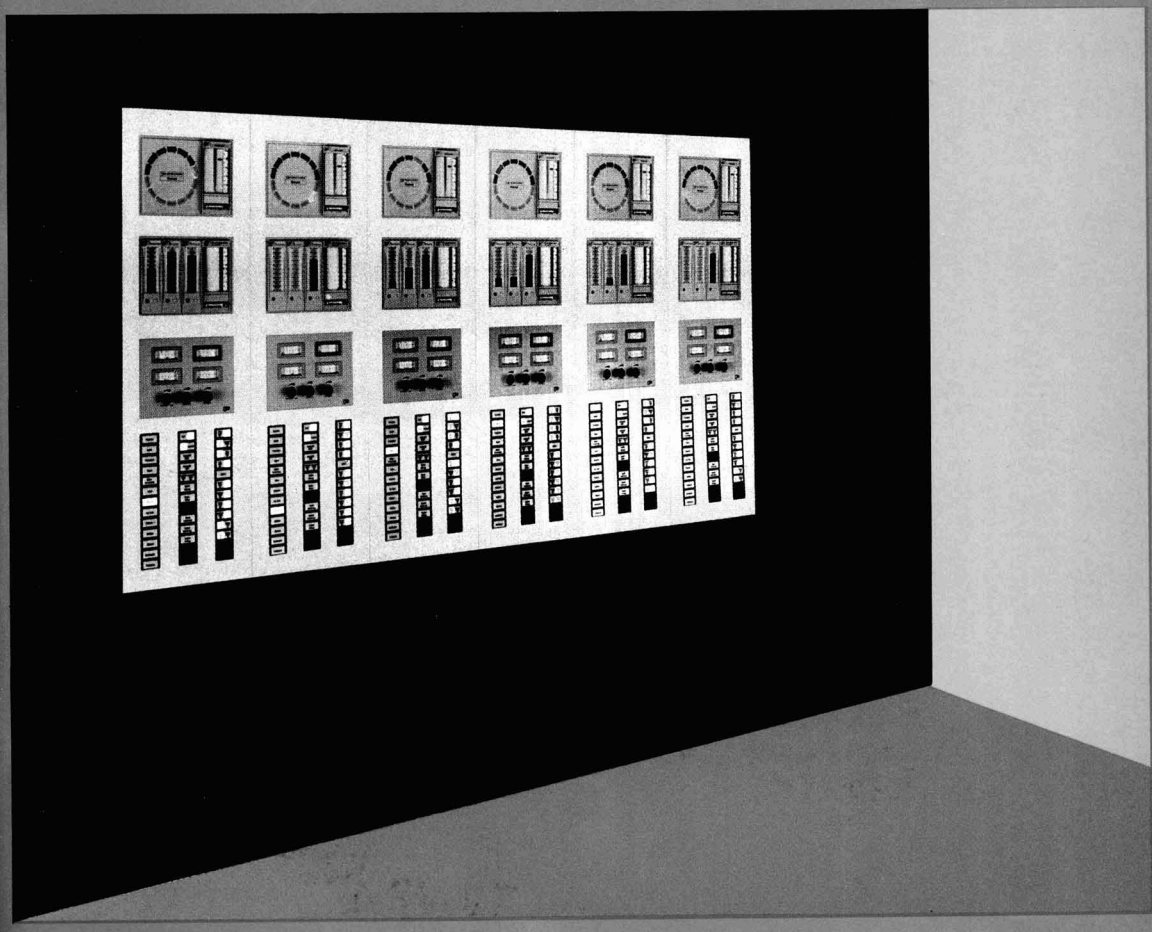

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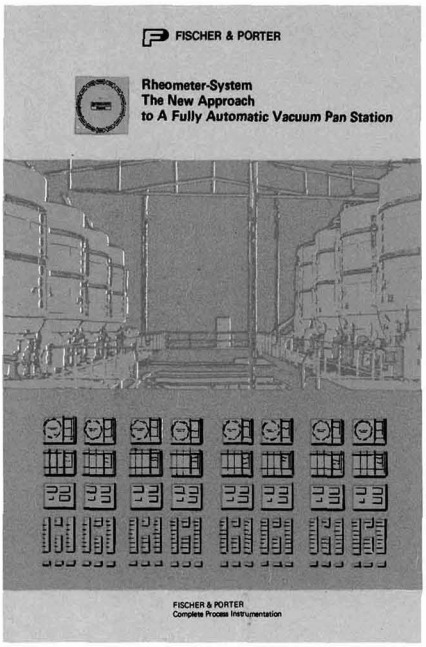

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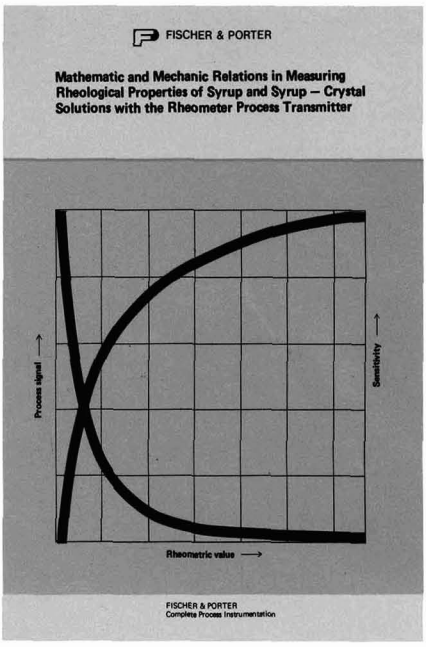

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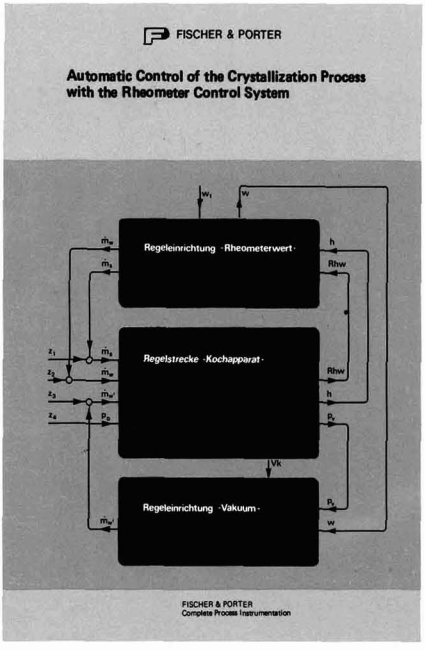
in Measuring Rheological Properties
of Syrup and Syrup-Chrystal Solutions
with the Rheometer Process Transmitter



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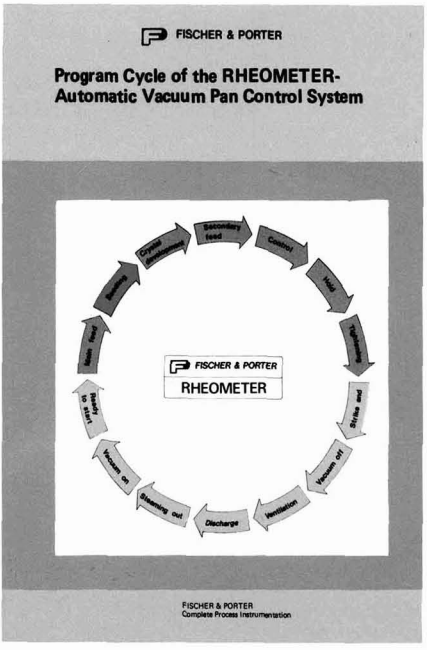

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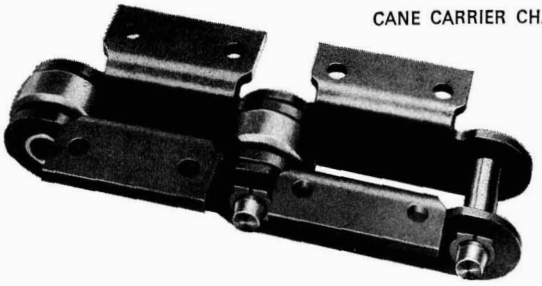

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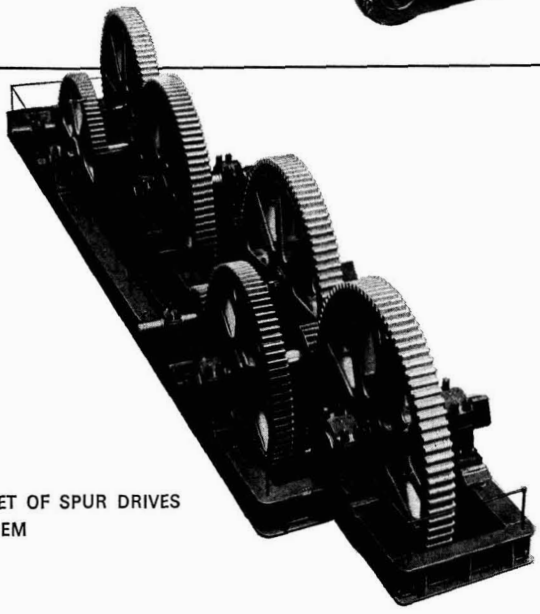

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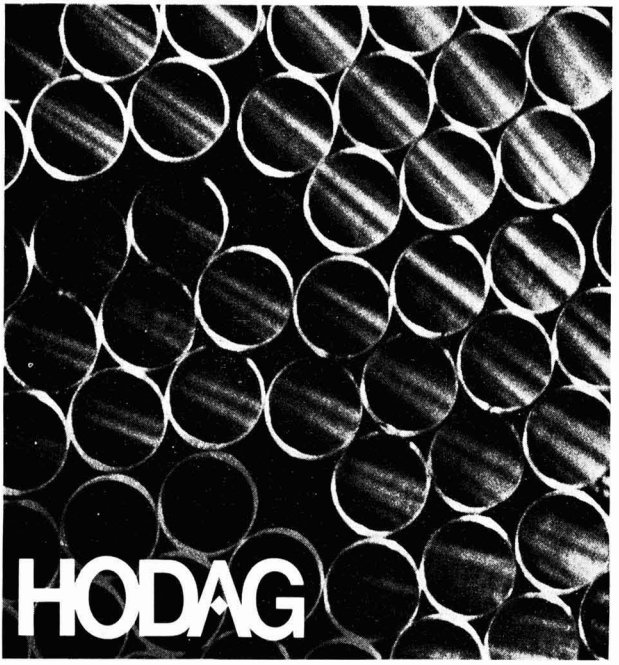

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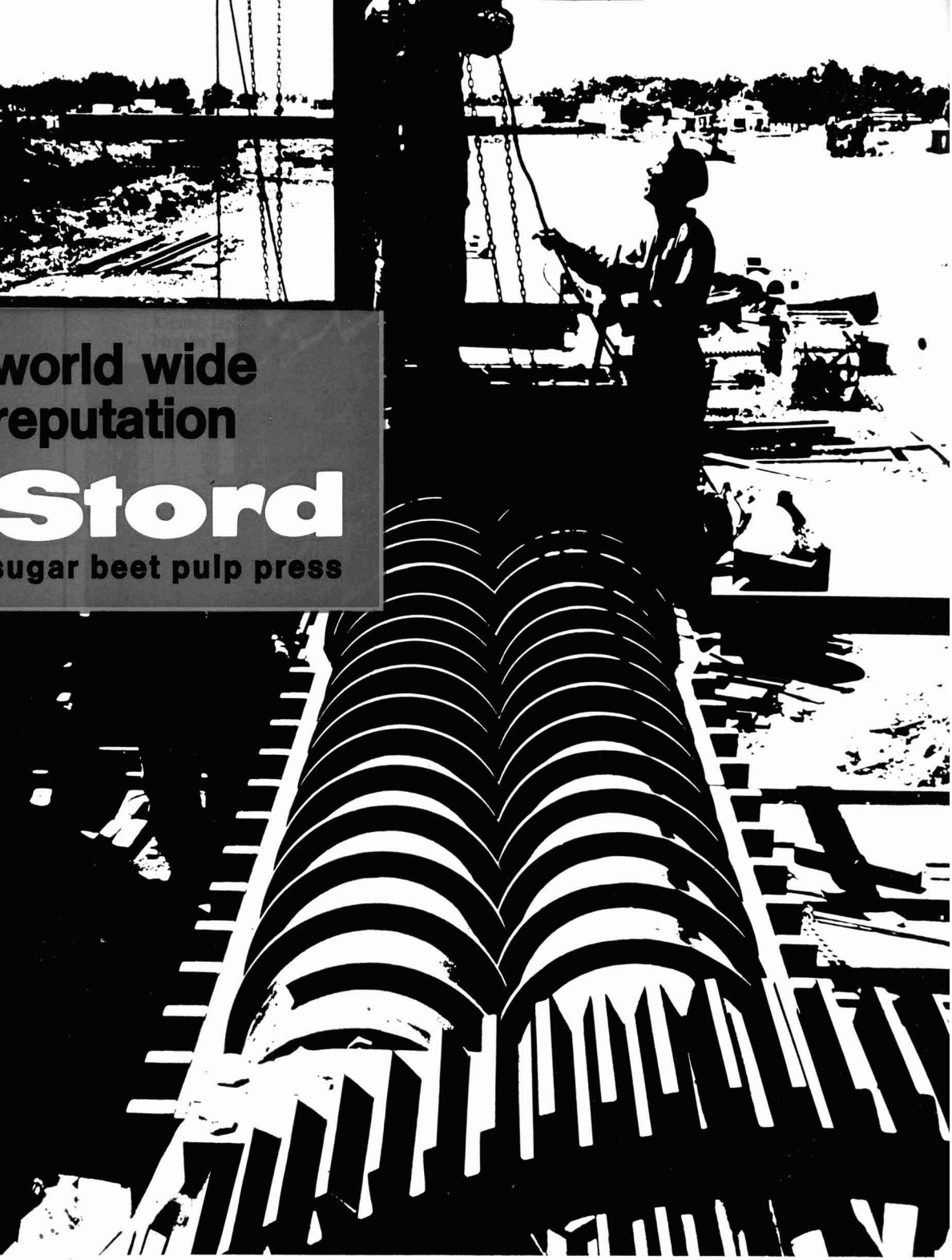

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UK ISSN 0020-8841

International Sugar Journal

March, 1974

Contents

SOMMAIRES : ZUSAMMENFASSUNGEN : SUMARIOS

Le charbon de la canne à sucre au Soudan. I. A. NASR et M. S. AHMED. *p.* 67

Les apparitions du charbon de la canne (causé par *Ustilago scitaminea*) à Guneid, au Soudan, observées pour la première fois en 1964, sont décrites et on donne des détails sur les résultats obtenus par le trempage des boutures dans une solution de "Aretan 6", l'extirpation des pieds infectés et l'abandon des repousses. On donne également des renseignements sur la maladie à Khashm-el-Girba, où l'infection n'a pas été importante et a été attribuée à des plants infectés en provenance de Guneid.

* * *

Physico-chimie de la phosphatation et de la carbonatation. 2ème Partie. M. C. BENNETT. *p.* 68–73

On établit un rapport au sujet des études concernant la phosphatation des liqueurs et les résultats sont comparés à ceux de la carbonatation; il se révèle que la phosphatation est plus efficace que la carbonatation en ce qui concerne l'élimination de l'amidon et légèrement meilleure pour l'élimination de la coloration et de la turbidité, mais moins efficace pour l'élimination du (Ca + Mg), des sulfates, des phosphates et (en général) du précipité alcoolique total. Aux niveaux de déféquant choisis, les colorations des liqueurs de la phosphatation étaient légèrement meilleures que celles de la carbonatation, contrairement à ce qu'on trouve souvent en pratique. On énumère les conditions requises pour l'obtention de la filtrabilité maximum d'une liqueur de carbonatation et certaines caractéristiques de la phosphatation usuelle sont comparées à la carbonatation du point de vue physico-chimique.

* * *

Nucléation continue du saccharose. 3ème Partie. A. D. RANDOLPH et S. A. ZIEBOLD. *p.* 73–77

Les résultats des essais (*I.S.J.*, 1974, **76**, 35–38) sont analysés et on calcule statistiquement l'effet sur le grainage de la variation de chacune de six variables indépendantes. Les résultats indiquent que pour une augmentation de la densité en germes et une réduction de la dimension de grain requise la combinaison suivante serait optimale: temps de séjour prolongé, température peu élevée, 50:50 de méthanol/iso-propanol comme solvant et concentration élévee en saccharose de l'alimentation. On effectue des essais sous des conditions optimalisées, après quoi on fait des simulations sur calculatrice d'une unité de cristallisation du saccharose en 3 jets, ce qui confirme la possibilité d'utiliser le système éthanol-saccharose-eau comme source de grainage pour un appareil à cuire en continu commercial.

Zuckerrohrbrand-Krankheit im Sudan. I. A. NASR und M. S. AHMED. *S.* 67

Die Verfasser berichten über das Ausbrechen des durch *Ustilago scitaminea* hervorgerufenen Zuckerrohrbrandes in Guneid im Sudan, das zuerst 1964 beobachtet wurde, und geben Einzelheiten darüber an, in welchem Ausmass diese Krankheit durch Eintauchen der Setzlinge in "Aretan 6"-Lösung, durch Entfernen der infizierten Schösslinge und durch Verzicht auf die Ratoonernte bekämpft werden konnte. Ferner informieren die Verfasser über die Krankheit in Khashm-el-Girba, wo der Befall nicht so stark war und auf infiziertes Pflanzenmaterial aus Guneid zurückgeführt wurde.

* * *

Physikalische Chemie der Phosphatation und der Carbonatation. Teil II. M. C. BENNETT. *S.* 68–73

Es werden Versuche zur Phosphatation von Zuckerlösungen beschrieben und die Ergebnisse mit denen der Carbonatation verglichen. Hierbei zeigte sich, dass die Phosphatation im Vergleich zur Carbonatation hinsichtlich der Entfernung von Stärke wirkungsvoller und hinsichtlich der Entfernung von Farbe und Trübung ein wenig besser ist. Im Hinblick auf die Entfernung von (Ca + Mg), Sulfat, Phosphate und (allgemein) der gesamten alkoholischen Fällung ist die Phosphatation der Carbonatation unterlegen. Bei den gewählten Mengen an Klärmitteln waren im Gegensatz zu den Beobachtungen in der Praxis die Farben der mittels Phosphatation behandelten Lösungen etwas besser als die der mittels Carbonatation behandelten. Die Voraussetzungen zur Erzielung der maximalen Filtrierbarkeit einer mittels Carbonatation behandelten Lösung werden angeführt. Schliesslich werden aus physikalisch-chemischer Sicht einige Charakteristika der konventionellen Phosphatationsmethode mit der Carbonatation verglichen.

* * *

Kontinuierliche Bildung von Saccharosekristallen. Teil III. A. D. RANDOLPH und S. A. ZIEBOLD. *S.* 73–77

Die Verfasser analysieren die Ergebnisse der durchgeführten Versuche (*I.S.J.*, 1974, **76**, 35–38) und berechnen statistisch den Einfluss der Aenderung einer jeden der sechs unabhängigen Variablen auf die Keimbildung. Die Resultate lassen darauf schliessen, dass zur Erhöhung der Kristallkeimdichte und zur Verringerung der geförderten Korngrösse folgende Kombination optimal ist: lange Verweilzeit, niedrige Temperatur, Methanol/Isopropylalkohol im Verhältnis 50:50 als Lösungsmittel, hohe Impflösungkonzentration. Unter den optimierten Bedingungen werden Versuche durchgeführt, nach welchen eine dreistufige kontinuierliche Saccharosekristallisations-Einheit im Computer simuliert wurde. Dabeit bestätigte sich die Brauchbarkeit des Systems Aethylalkohol-Saccharose-Wasser als Impfmaterial für einen technischen kontinuierlichen Kristallisator.

El carbón de caña de azúcar en el Sudán. I. A. NASR y M. S. AHMED. *Pág.* 67

Se recuerdan brotes del carbón de caña (causado por *Ustilago scitaminea*) a Guneid en el Sudán, observado inicialmente en 1964, y se presentan detalles del grado de control obtenido por sumersión de las estacas en una solución de "Aretan 6", entresaca de plantas enfermas, y abandono de cultivación de retoños. Los autores informan sobre el enfermidad a Khashm-el-Girba, donde el grado de infección estuvo menor y se ha atribuido al uso de material infectado, obtenido de Guined, para plantar.

* * *

Química física de fosfatación y carbonatación. Parte II. M. C. BENNETT. *Pág.* 68–73

Se recuerdan estudios sobre fosfatación de licores y se comparan las resultas con éllas de carbonatación, de que se demuestra que fosfatación es más eficaz que carbonatación con respecto a la eliminación de almidón y algo mejor con respecto a la eliminación de color y turbidez, pero menos eficaz en la eliminación de (Ca + Mg), sulfato, fosfato, y (generalmente) material total precipitable con álcool. A los niveles escogidos de defecantes, los colores de licores de fosfatación fueron ligeramente mejor de éllos de licor de carbonatación, en contraposición a lo que se ha logrado en el práctico. Requisitos para obtener filtrabilidad máximal de un licor de carbonatación se ponen en una lista, y varias características de fosfatación convencional se comparen con carbonatación del punto de vista químico-físico.

* * *

Nucleación contínuo de sacarosa. Parte III. A. D. RANDOLPH y S. A. ZIEBOLD. *Pág.* 73–77

Se analizan resultas de los experimentos (*I.S.J.*, 1974, **76**, 35–38) y se calcula estadisticamente el efecto sobre nucleación de un cambio en cada uno de seis variables independientes. Esto sugiere que, para un crecimiento en la concentración de núcleos y disminución en el tamaño de grano requisito, sera optimal la combinación que segue: largo tiempo de retención, bajo temperatura, 50:50 metanol/iso-propanol como disolvente, y alta concentración del solución de sacarosa de alimentación. Ensayos se hicieron sobre condiciones optimizadas y, después, se hicieron simulaciones por computador de una unidad de cristalización contínua de sacarosa de tres etapas que confirmaron la factibilidad de usar la sistema ethanol-sacarosa-agua como fuento de semilla para un cristalizador contínua comercial.

THE

INTERNATIONAL SUGAR JOURNAL

VOL. LXXVI MARCH 1974 No. 903

Notes & Comments

International Sugar Organization

The International Sugar Agreement of 1973 came provisionally into force on the 1st January 1974 and the first session of the Council under the new Agreement, held on the 22nd–25th January, was attended by 25 exporting members and 15 importing members.

The Council elected Mr. S. TAKAHASHI of Japan as its Chairman and Mr. M. RAFFAELLI of Brazil as its Vice-Chairman for 1974. Most of the items decided at this first session related to administrative matters, including the appointment of the Executive Committee and of the other principal committees.

The Council discussed the arrangements to be made in order to set on foot the preparations for a new Agreement in accordance with Article 31. For this purpose it established a Consultative Committee, consisting of all members of the Organization, which will hold its first meeting in May when the next session of the Council is due to be held.

* * *

US sugar supply quota, 1974

The price corridor for domestic sugar was raised in January to 10·61–11·27 cents/lb but the No. 10 spot price exceeded this comfortably, reaching 12·05 cents/lb, so, on the 11th January, the US Secretary of Agriculture raised the total quota by 500,000 tons to 12,500,000 short tons, raw value. Domestic cane sugar producers were allocated 86,666 tons of this while the remaining 413,334 tons were to be accepted from any foreign quota supplier other than Cuba or Rhodesia, on a first-come-first-served basis provided delivery was before the 15th March. This amount included the increase which would have been offered to Domestic Beet sugar suppliers had they been in a position to accept the additional quota. Likely suppliers mentioned include Brazil and the Philippines, although, at the time of writing, no individual allocations have been announced.

There was an initial fall in the domestic spot price but the effect of the US action in adding to the pressure on the world market supply situation in the first quarter of the year aggravated the world market price position and assisted other factors tending to raise prices. As a consequence of rising world prices, the US price also started to rise, reaching 14·18 cents/lb by the end of January and 14·50 cents/lb a week later. The action of the US authorities had clearly failed in its attempt to bring down the price of sugar within the country and after so drastic action as the very large rise in total quota, with virtually free availability of entitlement to any country able to supply promptly, it would seem that the Secretary of Agriculture has little action open to him, in respect of quotas, which would permit regaining control of the domestic sugar situation.

* * *

World sugar balance, 1973/74

F. O. Licht K.G. recently published their first estimate of the world sugar balance for the crop year September 1973–August 1974[1]. These estimates are reproduced below:

	1973/74	1972/73	1971/72
	(*metric tons, raw value*)		
Initial stocks.....	15,784,000	17,077,000	19,039,000
Production	81,845,000	77,285,000	73,852,000
Imports	24,622,000	24,216,000	24,482,000
	122,251,000	118,578,000	117,373,000
Exports	24,657,000	24,461,000	24,120,000
Consumption	81,295,000	78,333,000	76,176,000
Final stocks	16,299,000	15,784,000	17,077,000
Production increase..	4,560,000	3,433,000	1,081,000
(%)	5·90	4·65	1·49
Consumption increase	2,962,000	2,157,000	1,616,000
(%)	3·78	2·83	2·17
Final stocks % Consumption ..	20·05	20·15	22·42

It should be pointed out that Licht expects (for the first time in four years) that production will exceed consumption so that stocks will rise by an absolute amount of 500,000 tons, although this still represents a fall as a proportion of annual consumption. Also consumption is expected to rise by 3·78% in a period when prices are at record levels, whereas, with lower prices, consumption increases were restricted to less than 3% in the previous two years. It will be interesting to see if current high

[1] *International Sugar Rpt.*, 1974, **106**, (3), 1–2.

prices continue during the rest of this year, whether they have an inhibiting effect on consumption, and what modifications are made to the balance as time goes by.

* * *

Australia flood damage

Extraordinarily heavy and sustained rainfall in Australia has led to severe flooding, with thousands of square miles under water in Queensland, northern New South Wales and eastern parts of the Northern Territory. Brisbane was declared a disaster area and damage in the city is estimated at $A 200 million. Whole towns have been evacuated in parts of Queensland and the R.A.A.F. has been air-lifting trapped people and carrying food and supplies to stranded areas. Thousands of sheep and cattle have been drowned and it is remarkable that the death toll has been limited to 17 people.

The bulk of the 1973/74 crop had been completed, with only two mills in New South Wales still in operation, but it is not known whether sugar in store has been lost and how much. Before the flooding, however, it had been announced that wet weather had hindered harvesting so that 1½ million tons of cane was uncut and the crop was not as high as had been hoped; it was expected that the final figure would be about 2·6 million tons instead of the 3 million tons anticipated earlier.

The sugar market will be eager to learn, when the floods subside, the extent of the damage to the 1974 crop and the degree of recovery possible before harvesting.

* * *

World sugar price

Our last issue referred to an astonishing rise in world prices which had risen by £49.50 per ton during December. Even more astonishing is the subsequent rise in values which led to a level of £206 per ton being reached on the 6th February, a level which faltered by £2 on the 8th after which the rise continued to £274 at the time of writing. Future prices have leapt correspondingly.

A number of factors have contributed to this: the large increase in the US sugar supply quota, the floods in Queensland, weakness of currencies which have led speculators to invest in sugar, steady buying interest from both normal importers and irregular ones such as China, announcements of production difficulties and low figures from several countries including, especially, Brazil. E. D. & F. Man commented on the lack of buyer resistance to the high prices in their end-January bulletin, and "a prominent London dealer" was quoted[1] recently as confidently predicting a sugar price of £300.

It has been assumed that production will rise to meet demand as a consequence of high prices; it has been pointed out, however, that in a number of countries, farmers are reluctant to plant sugar cane without guaranteed better prices. In addition, with the world anxiety over oil supplies—and subsequent petrochemicals shortage—natural fibres have become more valuable so that the increased value of a cotton crop is greater than that of a cane crop and farmers might prefer to grow cotton rather than cane.

* * *

UK sugar supplies and the CSA

The upsurge in world sugar prices has prompted angry words from Mr. FORBES BURNHAM, Prime Minister of Guyana, about the price paid to suppliers under the Commonwealth Sugar Agreement. In January, with the world price around £170, he declared that the £61 negotiated price was most inadequate, and that he had given orders that supplies to Britain were to be cut back while negotiations were going on with the UK Government for an increase in price. Diversion of sugar to the US (where the price paid is higher than the CSA negotiated price) is not a breach of the Agreement.

The negotiated price was agreed in late 1971 and was to apply for the three years 1972–74; under the Agreement it was calculated to give a reasonable profit to an efficient producer and for most of the 23 years of the Agreement, this has ensured that Commonwealth sugar exporters received higher prices than the world market price prevailing. It would seem reasonable that the extraordinary rises in costs of sugar manufacture which have taken place since 1971 should permit a reassessment of a proper negotiated price; however, the present level of the world price seems as irrelevant to the CSA as it was seven years ago when the world price was £12.10s. per ton and the negotiated price £43.10s.

Sources quoted in the press[2] interpreted Guyana's move as a reply to the UK Government's negative response to West Indian requests for an increase in the price paid for their sugar under the CSA.

"It would come as no surprise if other countries decided to follow Guyana's lead. The sources believed that Jamaica, the biggest sugar producer in the West Indies, had also begun to divert shipments to the United States.

"Under the Agreement the West Indies ship over 700,000 tons to the British market. Jamaica supplies 223,000; Guyana 189,500; Trinidad, 134,600; Barbados, 133,800, and St. Kitts, 33,800 tons.

"The West Indian governments are said to be well aware of the political implications if they are forced to ship the new crop to more lucrative markets in the absence of United Kingdom concessions on price.

"Failure to fulfil their negotiated price quota would weaken their case for a guaranteed outlet in the European Economic Community and would have serious repercussions on EEC sugar policy, the United Kingdom refining industry, and the London terminal market".

[1] *The Times*, 11th February 1974.
[2] *ibid.*, 28th January 1974.

Sugar cane smut in the Sudan

By IBRAHIM A. NASR and M. S. AHMED

THE culmicolous smut of sugar cane caused by *Ustilago scitaminea* Syd. is a serious disease encountered in many sugar cane-producing countries[1]. It is one of the most economically serious diseases which infect sugar cane, reducing both yield and sugar content of the cane. The infected cane stalk becomes very thin and grassy and eventually dies. The disease is characterized by the production of a whip-like structure at the tip of the stalk carrying a great number of chlamydospores.

In the Sudan, sugar cane is at present grown at Guneid on the east side of the Blue Nile river. It is also grown at Khashm-el-Girba which is located between latitudes 15° 25′ and 15° 35′ N and longitudes 33° 25′ and 33° 35′ E. A sugar cane project at North West Sennar is being developed.

At Guneid smut was first observed[2] in November 1964 on third ratoons of the variety N:Co 310. In 1965 smut was recorded on 35 varieties out of the 46 grown in the varieties collection. Infection was high in N:Co 310 and CP 48/79, reaching a level of 30–40%[3].

The conditions at Guneid were conducive to epiphytotics owing to the occurrence of the high level of smut inoculum, ease of spore dissemination (by wind, irrigation water, and through contaminated and infected seed cane) and the raising of highly susceptible varieties. Hence, in the 1967/68 season the disease reached the following epidemic levels[4]:

1. *By type of plant*	*Degree of infection*
Plant cane	19%
First ratoon	52%
Second ratoon	55%
2. *By variety*	*Degree of infection*
N:Co 310	41%
Co 413	52%
Co 527	39%

In the 1968/69 season the recommendations of the research station were adhered to. These included dipping of seed cane in "Aretan 6" solution at a concentration of ½ lb per 20 gallons, roguing of infected stools and abandoning of first and second ratoons. Consequently, the level of infection markedly dropped to 8%, 7% and 8% on N:Co 310, Co 413 and Co 453 respectively[5].

In the 1969/70 season the following level of infection was recorded[5]:

Co 453	7·1%
Co 413	6·4%
Co 527	4·4%
N:Co 310	5·8%

In 1971/72, contrary to the research recommendations, an area of over 2000 feddans was kept as first ratoon. The infection in this crop was high[6].

N:Co 310	25%
Co 413	19·7%
Co 527	15·5%

It is evident from this short note that culmicolous smut was kept under control by adhering to the strict control measures recommended by pathologists; when these measures were ignored or inadequately implemented, the disease reached epiphytotic levels.

At Khashm-el-Girba LOCK[7] reported that infection was not high and attributed it to infected planting material obtained from Guneid.

The first proper smut survey was done in 1968[8]. The results of this survey were as follows:

1. *By type of plant*	*Degree of infection*
Plant cane	2%
First ratoon	4%
Second ratoon	10%
2. *By variety*	
N:Co 310	4%
CP 44/101	1%
Co 527	1%

No survey was done in the 1968/69 season, but a survey was made on the cane during the 1969/70 season as follows[5]:

Variety N:Co 310

Type of crop	% *infection*
Plant cane	0·3
First ratoon	6·2
Second ratoon	26·4

Variety Co 527

Type of crop	% *infection*
Plant cane	0·1
First ratoon	1·1
Second ratoon	1·8

Sugar cane smut in Girba is increasing but is still low except on the second ratoon of variety N:Co 310. Accordingly, it was recommended to discontinue raising a second ratoon crop of this variety. It was also recommended to establish a hot water unit for the control of internal infection and elimination of virus diseases.

Acknowledgement

We are grateful to the Director of the Agricultural Research Corporation for permission to publish this note.

[1] ANTOINE: "Sugar cane diseases of the world", Vol. I. (Elsevier Amsterdam). 1961, pp. 327–345.
[2] LINDEBLAD: *Pest and cane diseases file*, Guneid Sugar Factory, 1964 (unpublished).
[3] EL NUR: "A report on loose smut in Guneid Sugar Scheme" (Botany and Plant Pathology Section, Gezira Research Station), 1965.
[4] "Estimation of smut disease in sugar cane in Guneid scheme, 1967/68" (Agricultural Economics Division, Statistics Section).
[5] AHMED: *Annual Rpts. Guneid Research Substation*, 1968/69 and 1969/70.
[6] NASR: "A report on sugar cane smut at Guneid" (Guneid Research Substation), 1971.
[7] "A report on smut status in Khashm-el-Girba", 1966.
[8] "Estimation of smut disease in sugar cane in Khashm-el-Girba scheme 1967/68" (Agricultural Economics Division, Statistics Section).

Physical chemistry of phosphatation and carbonatation

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Paper presented to the 1972 Technical Session on Cane Sugar Refining Research, New Orleans, La., USA

PART II

Phosphatation

Liquor phosphatations were carried out in the following manner: 0·5 M phosphoric acid was run into the liquor at room temperature to give the required concentration and milk-of-lime added immediately, raising the pH to the required value. The liquor was heated to 85°C for 50 minutes and then transferred to centrifuge bottles for separation at 1000*g* for 90 minutes. The supernatant liquor was decanted and further treated by filtration through a kieselguhr filter cake (Dicalite "Speedflow", at 50 mg.cm^{-2}), the volume of filtrate being taken to give an equivalent filter aid use of 0·25% on solids.

Analyses were carried out on both the supernatant and filtrate liquors.

A typical phosphatation reaction is described by the results shown in Fig. 4 for Liquor C treated with phosphoric acid equivalent to 0·02% P_2O_5 on solids, limed to the pH values indicated.

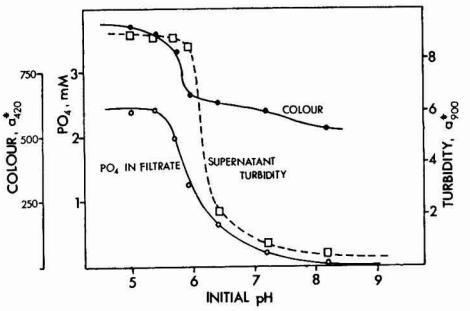


Fig. 4. Phosphatation of Liquor C

The extent of calcium phosphate precipitation is revealed by the filtrate content of phosphate and it is seen that the greatest change occurs around pH 6. The filtrate colour (measured on liquor samples adjusted always to pH 7·5) follows the precipitation around pH 6 but there is further colour removal at high pH values. The extent of flocculation is revealed by the turbidity of the supernatant liquor after centrifugal separation, it being believed that the lower the turbidity of the supernatant liquor, the higher the degree of flocculation in the original treated liquor. However, it is noticed that the flocculation reaction lags slightly behind the precipitation reaction. The result is similar to that found in the carbonatation reaction: the first precipitate to appear in the liquor apparently deals primarily with impurity removal, while later additions of precipitate deal with aggregation of the solid phase already present.

Comparison of phosphatation and carbonatation

Carbonatations were carried out by the laboratory constant condition method, which gives filtrabilities like those achieved in refinery plant. Phosphatations were carried out as described above, liming to pH 8·0.

The analyses of filtrates from Liquor A, carbonatated over the range 0–0·9% on CaO and phosphatated over the range 0–0·04% P_2O_5 are shown in Fig. 5. Although no added filter aid was used in any carbonatated liquor, the values for zero lime are taken from the chalk filtrate analyses in Table I. All phosphatated liquors were polish-filtered through a filter cake of Dicalite "Speedflow" kieselguhr used at the

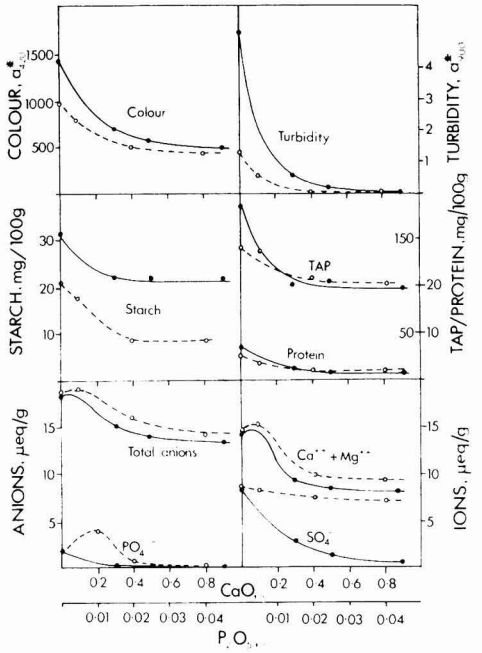


Fig. 5. Comparison of defecation by carbonatation (solid lines) and phosphatation (broken lines) in Liquor A

Table III. Comparison of carbonatation at 0·6% CaO with phosphatation at 0·03% P_2O_5 in Liquors A and B

	Liquor A			*Liquor B*			
Constituent	*Original*	*Carb.*	*Phos.*	*Original*	*Carb.*	*Phos.*	*Membrane*
Colour (a^*_{420})	2170	560	480	1120	440	420	600
Turbidity (a^*_{900})	179	1	0	70	1	0	1
TAP (mg/100 g)	200	98	105	151	14	58	67
Starch (,,)	38	22	8	4	2·0	0·7	1·2
Protein (,,)	11	2	2	7	2	2	3
Total anions (μeq/g)	19·4	13·6	14·6	16·6	13·0	14·4	15·9
SO_4^{--} ,,	8·6	1·2	6·2	7·8	1·5	7·4	7·6
PO_4^{---} ,,	2·5	0	0·3	0·8	0	0	0·4
$(Ca^{++} + Mg^{++})$,,	14·2	6·8	9·3	9·8	6·0	8·6	9·2

rate of 0·25% on solids and the values for zero phosphate addition are taken from the kieselguhr filtrate analyses shown in Table I. The results shown in Fig. 5 are presented using the same set of axes for both phosphatation and carbonatation. The scale has been chosen so that 0·03% P_2O_5, approximately the normal level for plant scale phosphatation, is equivalent to 0·6% CaO, approximately the normal level for refinery plant carbonatation. The solid lines show the carbonatation results, the broken lines, phosphatation results.

The important features of the analyses shown in Fig. 5 may be listed as follows:

(i) In starch removal, phosphatation is much more effective than carbonatation.

(ii) In $(Ca^{++} + Mg^{++})$ and sulphate removal, the reverse is true.

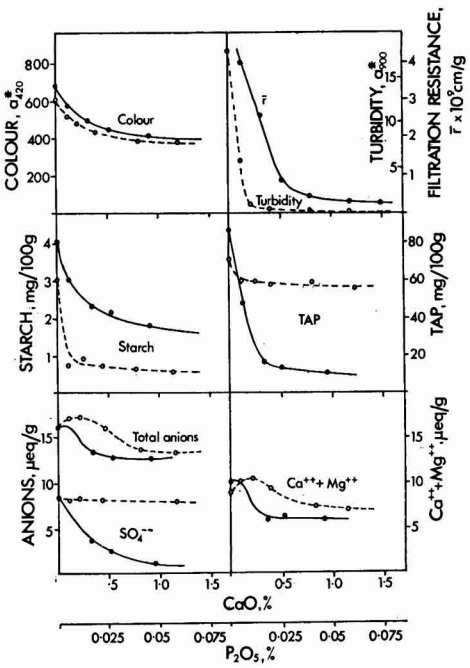


Fig. 6. Comparison of defecation by carbonatation (solid lines) and phosphatation (broken lines) in Liquor B

(iii) The removal of TAP by the two processes in this Liquor A is seen to be similar, but this is not always the case. Generally, carbonatation is found to be considerably more effective than phosphatation.

(iv) In the removal of colour and turbidity, phosphatation shows a slight advantage, particularly at the lower defecant levels. This will be discussed in greater detail below.

(v) The gain in $(Ca^{++} + Mg^{++})$ and phosphate content at very low % P_2O_5 levels is probably due to the presence of very finely-divided calcium phosphate which escapes both the centrifugal separation and the polish filtration.

The results for Liquor B shown in Fig. 6 are consistent with those for Liquor A in Fig. 5, though the level of organic impurity is much lower. The difference between carbonatation and phosphatation shows clearly in the curves for starch, TAP, $(Ca^{++} + Mg^{++})$ and sulphate. The gain in $(Ca^{++} + Mg^{++})$ and total anion content of the phosphatated liquor filtrates at low % P_2O_5 levels can probably be explained, as before, by leakage of calcium phosphate precipitate through the kieselguhr filtration. Colour is removed to an almost equal extent in both processes.

For the sake of completeness, Fig. 6 (top right) also shows the carbonatated liquor specific filtration resistance ($\bar{r}$) and the phosphatated liquor turbidity before polish filtration. These are the factors which affect operation of the two processes in practice and which will be discussed in a later section.

In Table III above, the findings on Liquors A and B have been summarized by comparing the results of carbonatation at 0·6% CaO with those of phosphatation at 0·03% P_2O_5. The original (unfiltered) washed raw liquor analysis is given in each case.

The important features of this comparison are listed as follows:

(i) The percentage colour removal shown by phosphatation and carbonatation are similar and in the range of 70–80%. These percentage figures are considerably higher than those generally quoted for the defecation process because they are based on unfiltered washed raw liquor colours.

Generally, washed raw colour is determined after filtration through kieselguhr or millipore membranes and the colour recorded is, of course, much lower.

On this basis phosphatation and carbonatation are generally found to achieve decolorization levels below 50%.

(ii) At the chosen defecant levels, the phosphatation liquor colours are slightly better than the carbonatation liquor colours, in contrast to what is often found in practice. From a survey of refining operations[8], it has been reported that phosphatation refineries obtain 25–40% decolorization, while carbonatation refineries obtain 30–50% decolorization.

The data presented in this report were obtained under the more tightly controlled conditions of the laboratory and might be taken to indicate that, although phosphatation is capable of yielding a small colour advantage, this is seldom achieved in refinery practice. It should also be noted that the phosphatation reaction pH used here (pH 8·0) is probably higher than that commonly used in refinery practice, and gives slightly superior decolorization results, as shown in Fig. 4.

(iii) Both processes achieve almost complete removal of turbidity and this must be highlighted as one of the major features of the chemical defecation treatments. In fact, phosphatation at 0·03% P_2O_5 was found here to achieve 100% removal, while carbonatation at 0·6% CaO achieved a slightly lower removal. Again, it is doubtful whether the slight advantage offered by phosphatation can be realized in practice by the conventional phosphatation processes.

(iv) While the phosphatation results show a very considerable advantage over carbonatation in starch removal, the TAP results (which include all "colloidal" material) show the reverse effect.

(v) As is already well known, carbonatation shows a spectacular removal of sulphate, (Ca^{++} + Mg^{++}) and phosphate. It is believed that this effect of carbonatation concerns the removal of any anion which forms a sparingly soluble calcium salt. Calcium sulphate and calcium phosphate are removed by inclusion within the precipitated chalk particles, and there seems no reason to doubt that the calcium salts of certain organic acids, including acidic polysaccharides and some colour, behave in the same way.

Approximately 30 times more calcium ion is precipitated in carbonatation than in phosphatation and the possibility of inorganic ash inclusion by this mechanism in phosphatation can, therefore, be neglected.

(vi) The last column of data for Liquor B shows an analysis of the filtrate through a 0·22 μm pore diameter Millipore membrane. The results are taken from Table I above and they are seen to be similar to those of the phosphatation treatment. This comparison might be taken to indicate that the defecation action of phosphatation is primarily an aggregation of impurity (generally termed "flocculation") and that the maximum capability of phosphatation with respect to most impurities could be defined by filtration through a pore diameter of approximately 0·1 μm.

The removal of colour would apparently lie outside this broad generalization and it is likely that in this case, some specific adsorption occurs as with the hydroxyapatite component of bone charcoal.

Separation of Impurities in Carbonatation and Phosphatation

Operation of the carbonatation and phosphatation processes in refinery practice is dominated by the requirements of the separation treatments, filtration in the case of carbonatation and flotation followed by filtration in the case of phosphatation.

Carbonatation

It has already been shown that the defecation achieved by carbonatation is not particularly sensitive to the way in which the carbonatation reaction is carried out. It is considerably more dependent on the quantity of chalk precipitated in the liquor. The defecation stage consists primarily of impurity inclusion within precipitated chalk particles and the ease of removal of this impurity from refinery process liquor, therefore, depends critically upon the filtrability of the precipitated chalk.

Several of the factors which affect carbonatated liquor filtrability have been discussed individually in previous publications[6,7,9]. For maximum filtrability in a given liquor the following factors are important:

(i) *Percentage CaO.* For every liquor there is a particular lime dose at which the filtrability will be greatest. This optimum lime dose varies from below 0·4% CaO on solids in some liquors to over 1·2% CaO in others.

(ii) *Retention time.* A few carbonatation plants operate with a single continuous-flow saturator but most plants operate with two saturators in sequence and some have three saturators in sequence. Retention time is vitally important only in the first saturator of the sequence, where most of the $CaCO_3$ precipitation occurs. For maximum filtrability, retention time in this first stage of carbonatation should be not less than 45 minutes.

(iii) *pH.* For maximum filtrability the pH of the first saturator should be as low as possible, and never above pH 10. Ideally, the whole reaction should be carried out at the final pH required, for example, pH 8·0–8·5, in a single saturator. However, gas absorption efficiencies are found to be uneconomically low and a compromise must be found. In a 2-saturator system, maximum filtrability is generally achieved with a first saturator pH around 9·5. Filtrability is only slightly sensitive to the pH at which the second saturator is operated, the latter serving mainly to adjust the pH to suit later process requirements and to achieve minimum calcium ash content. The

[8] "Symposium on auxiliary decolorants and de-ashing techniques". *Proc. Sugar Ind. Tech. 28th Ann. Meeting.*, 1969, 219.

[2] Bennett: *I.S.J.*, 1967, **69**, 101–104.

relation between pH and calcium ash content in a particular liquor is, of course, determined by the bicarbonate-carbonate equilibrium conditions for that liquor. In practice it is seldom possible to achieve carbonatated liquor pH values below 8·0 and most processes run around pH 8·2–8·5.

(iv) *Temperature.* Temperature affects not only viscosity, with its consequent effect on observed filtration rate, but also the quality of precipitated $CaCO_3$ particles. The degree of conglomeration increases with temperature up to about 82°C and filtrability increases independently of the improvement observed in filtration rates due to reduced viscosity.

Two other variables must be mentioned: Brix and lime quality. Like temperature, Brix affects both filtrate viscosity and particle structure in the $CaCO_3$ precipitate, a reduction in Brix giving an increase in filtrability independently of the reduced viscosity. The effects of temperature and Brix on viscosity have an important bearing on the mass transfer rate of CO_3 from the gas phase into solution and thence to the ionic carbonate forms in which it is capable of taking part in the carbonatation reaction. These two variables must also be expected to have some influence on the nucleation and crystallization rate of calcium carbonate.

Lime quality is a factor appreciated by most carbonatation technologists, but understood by few physical chemists. If the amount of available $Ca(OH)_2$ is kept constant in a comparative experiment, slaked lime from limestone is generally found to give significantly higher filtrabilities than slaked lime from chalk. Freshly slaked quicklime is considerably inferior to the same milk-of-lime which has been allowed to stand for a few hours.

The most striking effect is produced when the components of slaked lime, Ca^{++} and OH^-, are added (in the laboratory) from independent sources, for example using $CaCl_2$ and KOH. The measured carbonatated liquor filtrabilities can be up to 10 times greater than those found using conventional milk-of-lime, as described elsewhere[6]. The effect is little understood but, there is some evidence that it concerns the nucleation of calcium carbonate by solid phase particles of $Ca(OH)_2$. When the undissolved solid phase $Ca(OH)_2$ is eliminated by the separate addition of $CaCl_2$ and KOH, or removed from a conventional lime sucrate solution by membrane filtration, unwanted nucleation is reduced with a concomitant increase in the size of the carbonatation precipitate particles.

The carbonatation precipitate reaction is essentially a crystallization process, like sucrose crystallization in pan boiling, with the important difference that the level of supersaturation is maintained by chemical reaction between the two added reactants, calcium and carbonate ions. Excessive nucleation must be avoided in both the saturator and the vacuum pan and similar principles must be followed. Sudden changes in liquor flow rate, reactant flow rate, temperature, Brix and pH all produce an immediate decrease in filtrability and in most cases the change can be detected by particle size analysis of the carbonatation precipitate.

An important difference between sucrose crystallization and carbonatation concerns conglomeration of the product crystal. In nearly every liquor studied in these laboratories, acceptable carbonatated liquor filtrability depends on the establishment of the highest possible degree of conglomeration of precipitated $CaCO_3$ crystallites. Certain impurities which occur in particular liquors have the effect of preventing conglomeration and low filtrabilities result. These impurities are effective in low concentration and have not been identified in the type of gross analysis reported earlier in this paper.

When the factors discussed here are taken into account in both the design and operation of a refinery carbonatation station, the process offers an exceptional degree of reliability. The use of a lime dose considerably in excess of that required to achieve defecation ensures relative insensitivity to minor variations in either liquor quality or operating conditions.

Phosphatation

The particle size of the phosphatation precipitate is extremely small and the specific filtration resistance of the phosphatation floc is about 1000 times greater than that of carbonatation precipitates. A relatively large proportion of high quality filter aid must, therefore, be added to achieve acceptable liquor filtration rates. In order to reduce the quantity of phosphate floc presented to the filters, a flotation clarification is generally carried out prior to filtration. In the conventional flotation clarifier, the phosphate floc removal is found in practice to lie between 50% and 95%, the remaining floc being carried over in the so-called clarified liquor to the filter station.

When the flotation clarifiers are operated with high efficiency, polish filtration of the clarified liquor seldom presents any difficulty and is sometimes omitted altogether. With low-efficiency flotation-clarification, the load on the filter station is reflected by the relatively large amount of filter aid required. In this case, the phosphoric acid addition is sometimes reduced to levels where a large part of the defecation effect is lost.

At the normal phosphoric acid dose of 0·02–0·03% P_2O_5, the composition of carry-over floc is identical with that of the floated scum material and its presence in clarified liquor is merely an expression of inadequate flocculation or incomplete flotation within the retention time available. Since the removal of such material by filtration must involve some compromise between the porosity of the filter aid and an acceptable liquor filtration rate, a part of the carryover material will generally pass through the filters. It is this aspect of the conventional phosphatation process which probably accounts for the observations in refinery practice that phosphatation gives somewhat lower colour removal than carbonatation.

The technology of the phosphatation-flotation process has been the subject of an excellent recent review[10]. From the physico-chemical point of view, certain features of the conventional phosphatation process warrant comparison and contrast with carbonatation.

(1) An adequate phosphoric acid dose is necessary to induce flocculation of suspended impurity. From data presented above, this is generally around 0·03% P_2O_5 on solids and further additions above this level serve only to increase the total quantity of floc.

(2) There is little evidence to suggest that the separation of the phosphate floc is sensitive to the way in which the lime and phosphoric acid reactants are mixed. Because phosphatation is essentially a flocculation process, the smaller the calcium phosphate crystallite size, the greater is the defecation effect. Rapid and complete mixing of the two reactants is, therefore, a desirable feature of the phosphatation process and it is common practice to use in-line power mixers where the retention time is less than 1 sec. However rapid the initial precipitation, the reaction mixture takes an appreciable time to reach chemical equilibrium. A decrease in pH can be measured several minutes after initial mixing of reactants and the residual phosphate content also decreases during this period.

(3) Because of the simplicity of mixing the two reagents, phosphatation is often used in batch operations. In this case, careful control of pH is essential, since minor fluctuations from batch to batch can lead to further reaction at the mixing boundary between two consecutive batches.

In continuous flow operations, the importance of steady state conditions in the liquor flow, reactant feed rate and pH of the reaction mixture has been recognised for many years.

(4) Where clarifiers are used for the primary separation, adequate aeration is essential for satisfactory flotation of the floc. In the conventional phosphatation process, air bubbles are trapped mechanically in the phosphate floc and a variety of systems have been developed for this purpose. In most cases it is essential to heat the liquor in the clarifier so that conditions of minimum air solubility in liquor and continued bubble growth are maintained during the period of flotation. Clarifier temperatures as high as 97°C are commonly found in practice.

With the notable exception of one or two refineries, conventional phosphatation-flotation is found in practice to be a sensitive process. Relatively minor changes in reaction conditions or in the liquor type can have a catastrophic effect on flotation characteristics, leading to the appearance of heavy carry-over in the clarified liquor. In nearly every case the change can be attributed either to a decrease in the level of air bubble retention within the floc or to a decrease in floc size.

During the last two years, work in these laboratories has led to the development of chemicals which have a profound influence on the aeration and flocculation of phosphatation precipitates. Firstly, the use of "Talofloc" as a colour-precipitant leads to the inclusion of the surface active dialkyl quaternary molecule within the phosphate floc. This material reduces interfacial tension at the air/liquor interface, so that in the presence of air bubbles, the hydrocarbon chains are orientated at the bubble surface. In effect, in the presence of "Talofloc", air bubbles adhere to the floc so that special devices or systems are no longer required to achieve proper aeration. Of course, the air must be presented in a state of subdivision in which a close approach is possible and this requires a bubble diameter in the range of 10–100 μm. This can be readily achieved by passage of the liquor through a centrifugal pump fitted with a cruciform impeller, operating at speeds around 3000 r.p.m., with an air bleed on the suction side. In the presence of "Talofloc", aeration of the floc is spontaneous.

The second factor mentioned above concerns floc size. Investigation of the relationship between molecular structure and activity in acrylic acid-acrylamide copolymers has allowed the development of a flotation aid called "Taloflote", which effectively controls flotation rate. Over the dose range of 1–10 p.p.m. "Taloflote" on solids, the increase in floc size is followed by an increase in flotation rate and a decrease in carry-over.

It will be seen that the two speciality chemicals mentioned here have quite different and unrelated effects on the phosphatation floc. They impart physico-chemical properties to the floc which can never be matched by those arising naturally during the course of normal processing. In this way, the use of the speciality chemicals overrides many of the inherent properties of phosphatation floc and eliminates the more extreme sensitivity of the system.

Concluding Observations

(1) "Turbidity" is the only component of washed raw liquor which can be completely removed by the chemical defecation process. Since turbidity can also be removed completely by membrane filters of pore diameter approximately 0·1 μm, it is inferred that the appearance of turbidity in liquors is due to the presence of a suspension of particles of diameter greater than approximately 0·1 μm. Chemical analyses show that the composition of such particles covers a wide range of organic and inorganic material, and includes the so-called "colloidal" impurities like starch, gums and protein.

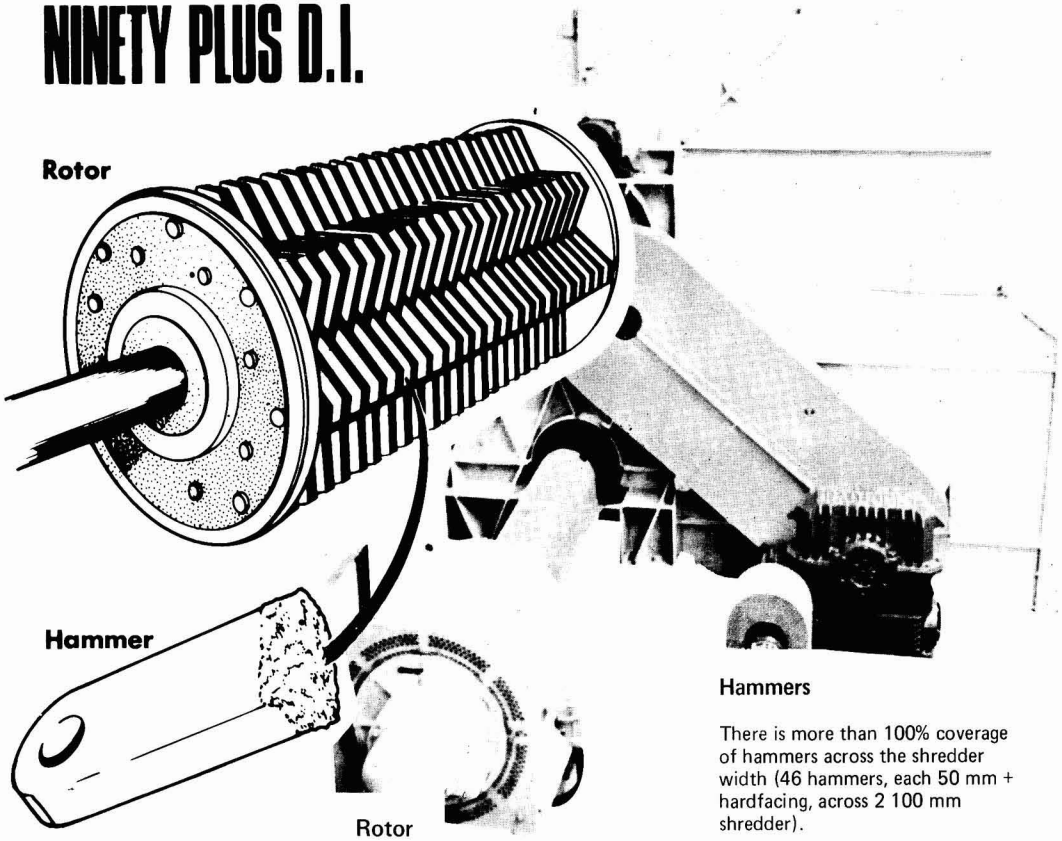
(2) Phosphatation acts primarily by flocculation of impurity particles and, with the exception of colour, the maximum possible removal of impurity by this process can be determined by filtration through a membrane of pore diameter 0·1 μm. Colour removal is better than that indicated by such a membrane filtration, presumably because of adsorption onto the precipitated calcium phosphate.

[10] Saranin: *Sugar Tech. Rev.*, 1972, **2**, (1).

The Tongaat 5 Shredder

The HEART of the matter Continued.....

NINETY PLUS D.I.



Rotor

Extremely rigid construction, with 350 mm shaft (on 1 500 mm shredder) and no spacer discs.

Rotor elements (discs) are flogged up solid with large through-bolts, then locked together with 'Ringfeeder' double-taper clamps, giving a solid assembly.

The mass of construction renders a flywheel unnecessary. The inertia of the 1 500 mm shredder rotor with hammers is a 2 060 kg m^2.

Hammers

There is more than 100% coverage of hammers across the shredder width (46 hammers, each 50 mm + hardfacing, across 2 100 mm shredder).

Hammers are of simple rectangular construction no 'club heads' required for width coverage.

Hammers need no bushes—very little wear on bore (approximately 1·25 mm in direction of loading in hammers used for 800 000 tons cane).

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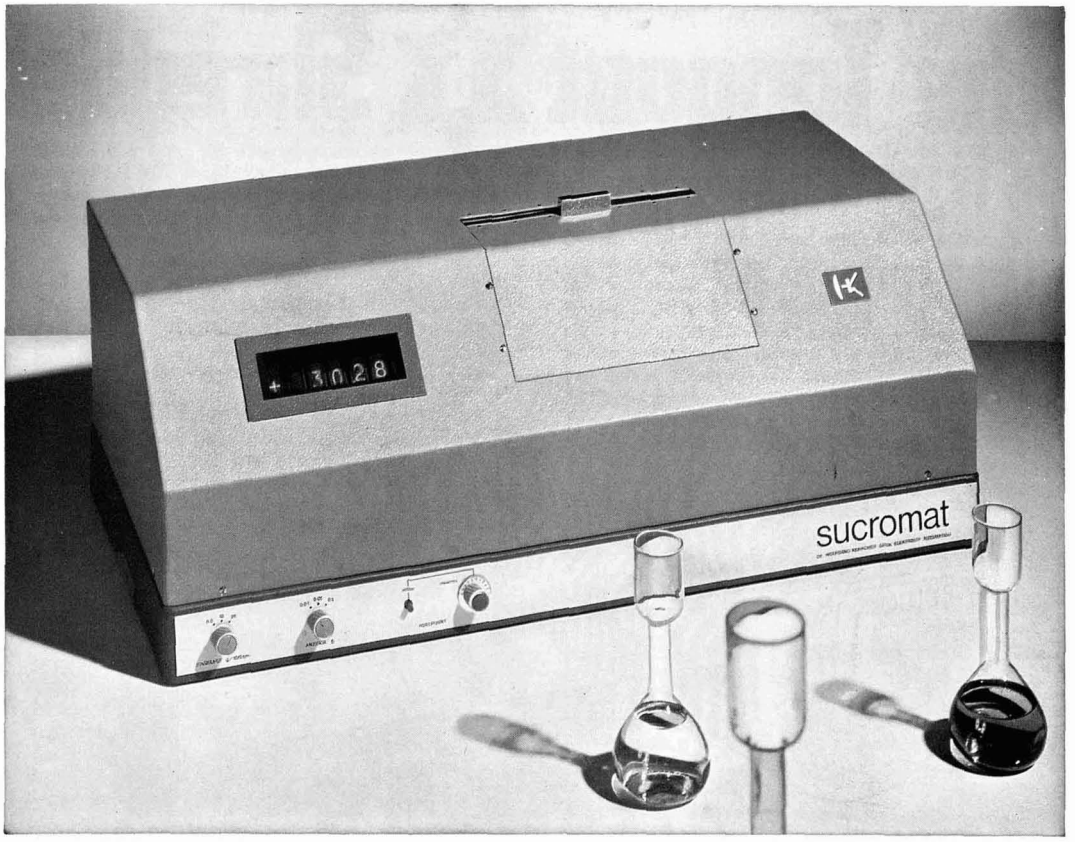

The automatic sugar polarimeter **sucromat** *has built-in reliability*

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2. Servo-driven quartz wedge compensator.
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(3) Carbonatation acts primarily by impurity inclusion within relatively large masses of precipitated calcium carbonate conglomerates. Approximately 30 times more lime is precipitated as carbonate during carbonatation than as phosphate during phosphatation. Carbonatation, therefore, shows a remarkable specificity in the removal of any impurity capable of forming a sparingly soluble calcium salt. This accounts for the outstanding feature of the process in removing sulphate and phosphate, together with certain organic anionic material which may include some colour and acidic polysaccharides. For those impurities which are not capable of taking part in such a specific chemical interaction, for example starch, carbonatation shows a lower removal than phosphatation.

(4) The separation of impurity from phosphatation liquor in refinery practice depends ultimately upon the porosity of the filter aid employed. Where a preliminary clarification is carried out by flotation, the separation depends on satisfactory aeration and flocculation of the phosphate precipitate. In the conventional process this is highly sensitive to minor variations in both the liquor and the process conditions. However, newly developed chemical additives are capable of overriding the natural variations and can eliminate the sensitivity of the flotation system.

(5) The ease of separation of impurity from carbonatated liquors in refinery practice is determined by the filtrability of the precipitated $CaCO_3$. Provided the design and operating conditions of the saturators follow the well-known principles of crystallization processes, the carbonatation system is relatively insensitive to minor variations.

Continuous sucrose nucleation

Observations of secondary particle breeding in sucrose/water/organic systems as related to a continuous sugar pan

By ALAN D. RANDOLPH and STEVEN A. ZIEBOLD

(Chemical Engineering Department, University of Arizona, Tucson, Arizona, 85721 USA)

NOMENCLATURE

B°	nucleation rate, number per cm³ per min.
CV	coefficient of variation; standard deviation divided by mean, based on mass-weighted particle size.
G	linear crystal growth rate, microns/min.
i	exponent of growth rate in nucleation kinetics expression
j	exponent of solids concentration in nucleation kinetics expression
k_n	coefficient in nucleation kinetics expression
k_v	crystal volume shape factor, (volume)(length)$^{-3}$
L	crystal size, microns
M_t	solids concentration, g.cm^{-3}
$n(L)$	population distribution function, number per cm³-micron
n°	nucleus population density, B°/G, number per cm³-micron
S	coefficient of supersaturation, C/C_s
T	temperature, °K
ρ	crystal density, g.cm^{-3}
τ	crystallizer retention time, V/Q, hr.

PART III

ANALYSIS OF RESULTS

Statistical results

The B-series experiments were run to find the effects of the independent variables (from Table II) on the system kinetics, i.e. the nucleation rate and the population-weighted characteristic size, using a Plackett-Burman statistical analysis[18]. This analysis uses a one-level statistical t-test, i.e. no interactions are assumed between the real independent variables. Thus, it can not be used to estimate two-factor interactions.

Six variables were studied in eight experiments; one variable was assumed to be a dummy variable for estimation of the standard error.

The design matrix for the eight experimental runs is shown in Table IV. The +'s and —'s indicate the particular high and low settings for the independent variables (designated by columns) for a given experimental run (designated by rows). The independent variables are numbered as follows:

(1) Crystallizer temperature,
(2) Holding time,
(3) Concentration of sucrose feed,
(4) Methylamine hydrochloride (surfactant),

(5) "Fluorocarbon FC 96" (surfactant),
(6) Solvent type, and
(7) Dummy variable.

After completion of the experiments, the effect was calculated of a change in each independent variable from the low level to the high level. The original reference[18] should be consulted for the detailed mechanics of this statistical test.

Table IV. Design matrix for series B runs

	Independent variable						
Run	1	2	3	4	5	6	7
1	+	+	+	—	+	—	—
2	+	+	—	+	—	—	+
3	+	—	+	—	—	+	+
4	—	+	—	—	+	+	+
5	+	—	—	+	+	+	—
6	—	—	+	+	+	—	+
7	—	+	+	+	—	+	—
8	—	—	—	—	—	—	—

The standard errors of both $G\tau$ and $\ln n^\circ$ were high owing to a high effect value of the dummy variable. One dummy variable (one degree of freedom) cannot be considered a good estimate of the standard error. The analysis would be improved if two or three dummy variables (two or three degrees of freedom) were chosen in order to lower the standard error, since this would result in a more accurate t-test. Another statistical t-test was carried out, therefore, using an alternative method of evaluating the standard error. As pointed out before, Runs 1-C, 2-C and 3-C are equivalent to Runs 3-B, 5-B and 8-B, respectively. The differences of the system responses in these duplicate sets of runs were used to calculate a new standard error. This method known as the combination of variances was presented by DAVIES[25]. Using this technique alternate standard errors for $\ln n^\circ$ and $G\tau$ were calculated to be 0·294 and 1·43, respectively. The results of the t-test using these calculated standard errors are shown in Tables V and VI.

Table V. System response = $G\tau$ (Characteristic Length)

Variable number	*Variable name*	*Effect — to +*	*t-Value*	*Significance, %*
1	Crystallizer temperature	0·585	0·409	28·3
2	Holding time	—1·860	1·300	71·3
3	Sucrose feed concentration	0·0075	0·0053	$\simeq 0$
4	Methylamine HCl	0·170	0·119	<10%
5	"Fluorocarbon FC 96"	1·410	0·985	60·3
6	Solvent type	—1·007	0·703	46·6

Note: Standard Error = 1·43
Degrees of Freedom = 3

In Table V, the highest significance level was holding time (71·3%). The next highest significance level was that of the fluorocarbon surfactant (60·3%) which appears to increase particle size, i.e. inhibit nucleation. Other significance effects are below 50%.

Table VI indicates that the highest significance level is holding time (83·8%); longer holding times increase $\ln n^\circ$. The next highest level is that for

Table VI. System response = $\ln n^\circ$

Variable number	*Variable name*	*Effect — to +*	*t-Value*	*Significance, %*
1	Crystallizer temperature	—0·5075	1·73	81·3
2	Holding time	0·5625	1·91	83·8
3	Sucrose feed concentration	0·3225	1·10	64·5
4	Methylamine HCl	—0·0975	0·332	23·7
5	"Fluorocarbon FC 96"	—0·3630	1·24	69·6
6	Solvent type	0·5425	1·85	83·0

Note: Standard Error = 0·294
Degrees of Freedom = 3

solvent type (83·0%). Thus it may be advantageous to use 50:50 methanol/*iso*-propanol rather than "Vanzol A-1" solvent systems. A decrease in crystallizer temperature causes an increase in the nuclei density with a significance of 81·3%. "Fluorocarbon FC96" was found to decrease the nuclei density (69·6%) as indicated above. Finally, sucrose feed concentration increases $\ln n^\circ$ (at the 64·5% confidence level). Certainly high feed concentration increases the solids concentration in the crystallizer which would increase the total number of seed and thus a high sucrose feed concentration should be used.

This statistical study suggests that to increase nuclei density and decrease $G\tau$, the combination of long holding time, low temperature, 50:50 methanol/*iso*-propanol solvent type, and high sucrose feed concentration should be used.

Crystal habit

Run 1-D was carried out with conditions which corresponded to the optimized levels of the operating variables, except that the holding time was decreased to 2·0 hours, the solvent mass ratio was changed to 3·0, and sodium hydroxide was added to the sucrose feed solution to change the pH to approximately 10. (All other runs had a natural syrup pH of 6.) In

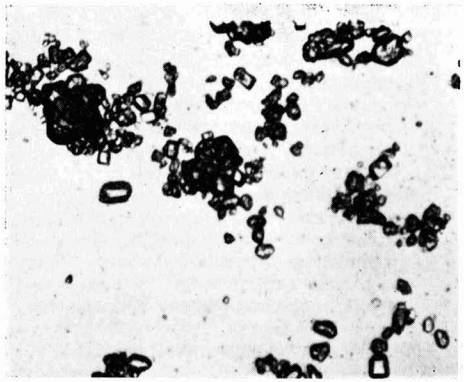

Fig. 3a. Photomicrograph of Run 1-D agglomerates

[25] "Statistical Methods in Research and Production" (Hafner Publishing Company, New York), 1961.

Run 1-D extreme multi-crystal growth occurred above 30 microns. Figs. 3a and 3b shows photomicrographs of crystals which exhibit unfavourable multi-crystal habit from this run at a solvent:water ratio of 3·0.

Run 2-D was similar to Run 6-B except that the solvent:water ratio R was changed to 2·5. In comparing the two runs, an increase in R seems to have increased the nuclei density and decreased the characteristic size. However, Run 2-D exhibited considerable multi-crystal agglomerative-type growth and again verified an upper limit of solvent:water ratio of approximately 2·0 in order to obtain acceptable single crystal habit.

Thus high solvent:water ratios appear to produce high nuclei densities at the cost of multi-crystal agglomerated habit. If a surfactant could be found which would suppress multi-crystal growth, higher solvent:water ratios could be used with a concomitant increase in nucleus production. Therefore there is considerable incentive to find such habit modifiers in experimental studies.

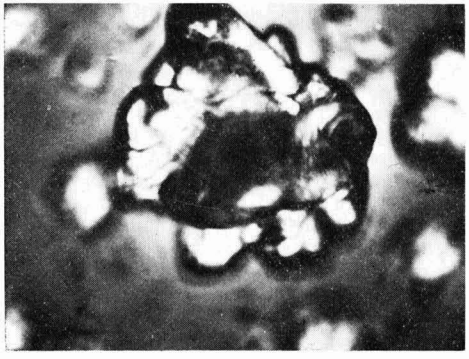

Fig. 3b. Close-up of individual Run 1-D agglomerate

Run 3-D was carried out with the optimum conditions for nucleation which were determined from the B-series runs. The holding time was decreased from the B-series runs. The holding time was decreased from 3·00 to 2·5 hours in an attempt to shorten the required run duration in order to assure steady state operating conditions. Acceptable product with a high nuclei density and small particle size was produced.

Photomicrographs of crystal samples for runs 6-B and 8-B in *iso*-propanol counting solution are shown in Figs. 4a and 4b. These samples were prepared by first filtering the slurried crystals, treating them in the ultrasonic bath, and then suspending them in the electrolytic solution used in the counting procedure. The majority of these crystals are of single crystal habit; the largest crystals in the photograph are approximately 100–150 microns in size.

A sample of the crystallizer product from run 3-D was suspended in a 75°Brix sucrose solution and allowed to ripen for approximately 15 minutes.

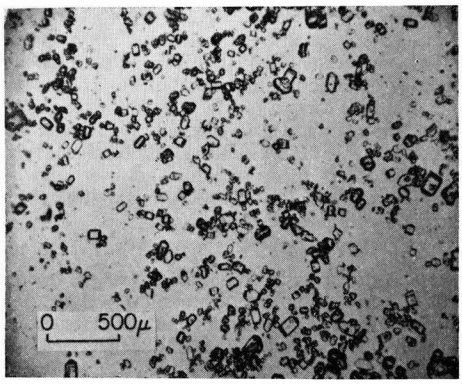

Fig. 4a. Photomicrograph of run 6-B product

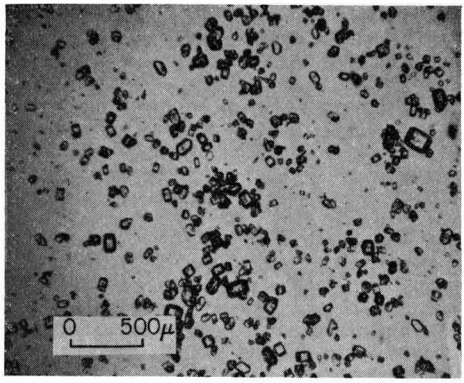

Fig. 4b. Photomicrograph of run 8-B product

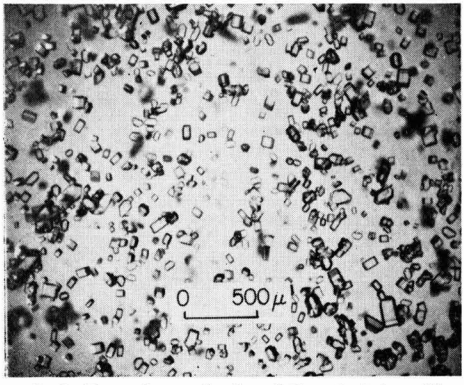

Fig. 5. Photomicrograph of run 3-D product ripened in feed syrup

Fig. 5 is a photomicrograph of these crystals in which there are few agglomerates visible. This simple test indicates that these solvent-grown crystals will survive as seed source when properly mixed in a supersaturated syrup.

Nucleation kinetics correlation

Nucleation rates were calculated from nuclei densities by means of equation (4) and correlated to operating conditions using equation (6). Data were taken from the 8 experimental runs not involving the fluorocarbon surfactant to eliminate the adverse and unknown effects of this additive. Both solvent types were included in the correlation, however, and the following equation was obtained using multiple linear regression computer analysis:

$$B^\circ = 0{\cdot}622 \exp (4322/T)\, G^{0{\cdot}543} M_t^{1{\cdot}212} \quad \ldots\ldots\ldots (8)$$

Here, B° is the nucleation rate per cm³ per minute, T is the crystallizer temperature in °Kelvin, G is the crystal growth rate in microns per minute, and M_t is the solids concentration (g.cm⁻³) measured directly from the crystallizer slurry.

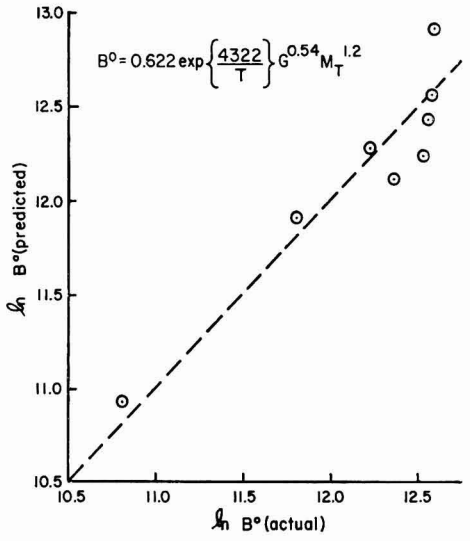

Fig. 6. Correlation plot of predicted *vs.* actual nucleation rates

Values obtained using the above equation corresponded well with actual nucleation rates, as shown in the correlation plot, Fig. 6. All the coefficients in this equation were calculated with a t-test to be at least 95% significant. An F-test established the overall regression analysis to be statistically significant above the 97·5% level. Equation (8) is a statement of the system kinetics and reinforces the statistical observations made previously.

Process Calculations

Computer simulations of a three-stage continuous sucrose crystallization unit were made using the reported nucleation kinetics. The steady state Mark I-A CSD simulator written by Nuttall[19] was used in these calculations. In a typical simulation, the production and flow rates along with seeding, classification and growth rate dependency (if any) are read in as data and the programme then calculates the level of the driving forces that are required in order to produce the specified production.

Nucleator/Ripener/F.C. Crystallizer

The first stage of the continuous sugar crystallizer was assumed to be a 30-gallon MSMPR nucleator which operated at conditions similar to run 7-B but without any surfactants and with a pure ethanol feed. A holding time of 3 hours and a solids concentration of 0·42 g.cm⁻³ were assumed with a production in the stage of 0·33 tons per day. Nuclei density was assumed to be $5{\cdot}0 \times 10^6$ per cm³-micron. The growth rate was determined by the calculations to be 0·063 microns per minute. The CSD for this stage is shown in Fig. 7. The average size (population weighted) for this distribution was calculated to be 11·4 microns. On a weight basis, the average size was 46 microns and the coefficient of variation was 0·5, the theoretical value for the MSMPR crystallizer.

The second stage was assumed to be a crystal ripener of 20 gallons capacity operating at 38°C with pressure of 0·24 atmospheres. The feed streams to this stage were the product stream from the nucleator (0·132 gallons/minute) and a 1·0 gallon/minute (160°F, 75°Brix) sucrose syrup stream. The purpose of the ripener was to promote better mixing of the seed slurry produced by the nucleator. This would ensure a better chance of seed survival when injected into the FC crystallizer (stage 3). Another purpose of this stage was to provide a means for solvent recovery. The ripener operated at a holding time of 20 minutes and the nuclei density was assumed to be small (i.e. 10 nuclei per cm³-micron). Fig. 7 shows the second stage CSD at two different production rates. When the production was assumed to be 0·634 tons/day the crystals had a growth rate of 0·318 microns/minute and the supersaturation was calculated from Equation (7) to be 1·22. The average size on a weight

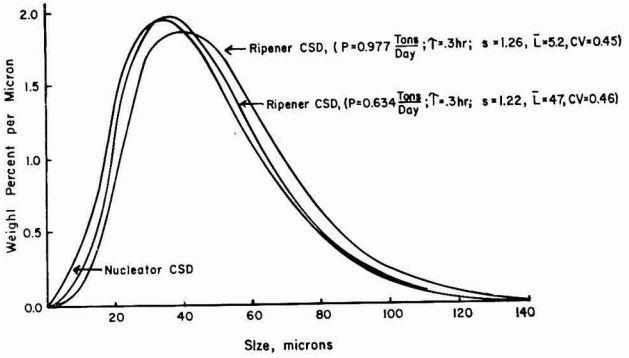

Fig. 7. Nucleator CSD and ripener CSD for two production rates

basis was 47 microns with a CV of 0·46 (weight basis). When production was increased to 0·977 tons/day, the supersaturation level was required to increase to 1·26 with a corresponding increased growth rate of 0·511 microns/minute. On a weight basis, the average size was 52 microns with a CV of 0·45. One can see from Fig. 7 that as the production increases in the ripener stage, the required supersaturation level increases (and hence the growth rate).

Footing Crystallizer CSD

Stage 3 was assumed to be a forced circulation crystallizer with 240 gallons capacity. This crystallizer was assumed to have a solids concentration in the product slurry of 0·4 g.cm^{-3}. Fig. 8 shows the CSD for the FC crystallizer at two different retention times and thus at two different production rates for the continuous footing crystallizer shown in Fig. 9. One can see that, as the holding time decreases, the required supersaturation and thus growth rate levels increase. Production also increases from 3·2 to 9·6 tons/day (assuming M_t remains constant). The average weight size of the CSD increases from 70 to 107 microns with a CV of 0·42 in both cases. In both cases, the FC crystallizer is fed from the ripener with an assumed production of 0·634 tons/day. No particle classification in the FC unit was assumed.

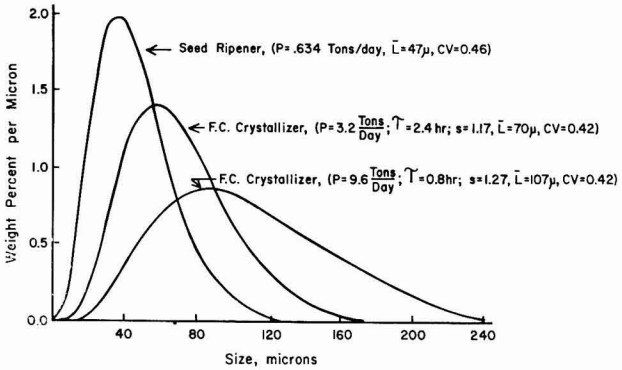

Fig. 8. Ripener CSD and FC crystallizer CSD for two production rates

Solvent Recovery

Material and energy balances were carried out on the ripener stage assuming the operating conditions that were previously mentioned. The sugar/water/ethanol system was assumed to behave similarly to that of a salt/water/methanol system in order to obtain an estimate of the relative volatility of ethanol. It was estimated that approximately 63% of the solvent could be recovered when the ripener operated at the assumed conditions. This was equivalent to a 7% volume change in the ripener as the ethanol and water were flash-evaporated.

Summary

Continuous crystallization machines of the mixed magma type probably cannot achieve the narrowness of CSD obtained in current batch sugar pans unless a breakthrough is achieved in the size-separation of particles in a viscous massecuite and/or excessive vessel staging is used. Most continuous processes must be seeded rather than relying on false grain as a seed source.

The kinetics of secondary sucrose nucleation in a sucrose/water/organic system were exploited to develop a continuous seed source for a continuous sugar pan. Conditions were found in the study which would result in a seed fondant having a nuclei population density of 5×10^6 per cm^3-micron and a population-weighted mean size of 10 microns.

Rigorous calculations confirm the feasibility of using the ethanol/sucrose/water nucleator system as a seed source in a commercial continuous sugar crystallizer. The required equipment, reproducibility and costs of this process could be readily assessed from this research work. A possible product quality improvement from the use of such well-formed seed could only be determined from extensive pilot tests using industrial syrups.

Acknowledgements

The authors sincerely appreciate the help of Messrs. Mike Arnold and Steve Metchis for some preliminary investigations of this project and to Dr. Richard Mead for advice on equipment fabrication. Thanks are given to the Battelle Development Corporation and to the CIBA-Geigy Corporation for grants to the Chemical Engineering Department which made this work possible.

Beet weed control conference.—The 3rd International meeting on selective weed control in sugar beet crops will take place in Paris, in the UNESCO Building, on the 27th and 28th February 1975, under the auspices of the Institut International de Recherches Betteravières (IIRB), the Comité Français de lutte contre les mauvaises herbes (COLUMA) and the European Weed Research Council (EWRC). There will be simultaneous translations in German, English and French during the meeting and the themes chosen include: present state of selective weed control in sugar beet crops; physical and chemical aspects of soil-herbicide interactions; interaction of pesticide—herbicide treatments in sugar beet crops; herbicide residues and cropping; late germinating weeds and resistant species; new kinds of formulation; developments in herbicide application equipment; various places where herbicides act on plant physiology, particularly in beet; new herbicides; evolution of the weed flora; weed control and environment. Readers interested in attending or contributing to the meeting should write for further details and a registration application form to: M. L.-A. Durgeat, Institut Technique Français de la Betterave Industrielle, 45 rue de Naples, 75008 Paris, France.

* * *

Ghana sugar factory plans[1].—A sugar factory is planned at Agogo in the Ashanti Region of Ghana.

[1] *Barclays International Review*, November 1973, 18.

Sugar cane agriculture

Comparative performance of cane varieties at Daurala. A. K. GARG, S. V. SINGH and T. R. SHARMA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, 11–16. Co 1148 has been found superior by comparison with other recently-released varieties in respect of germination, tillering, yield, juice quality and pest and disease resistance.

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Intercropping of various crops with sugar cane. S. C. SHARMA and R. B. PRASAD. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, 53–62.—An account is given of intercropping trials with coriander, mustard, potato, wheat, maize and moong, the last two with spring-planted cane and the rest with autumn-planted cane. Maize reduced the cane yield while moong when ploughed-in increased yield. Wheat reduced the cane yield somewhat and a dwarf variety must be chosen as intercrop. Cane quality was not affected by the other intercrops and mustard did not affect cane yields while coriander slightly raised it (by reduced borer attack) and potato raised yield by at least 50%.

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Sugar cane research in Mauritius. R. ANTOINE. *Mauritius Sugar Industry Research Institute Ann. Rpt.*, 1971, 35–89.—A total of 1203 crosses were made and the M71 series transplanted in February 1972, involving a total of 39,495 seedlings. Selection from earlier series continued and two varieties were released for estate use, viz. M 124/59, a late variety, and M 438/59, an erect cane adapted to dry conditions. Studies have been made on the behaviour of potassium in Mauritius soils, the mineralization of nitrogen, soil acidity and liming and soil silicon. Irrigation and infiltration capacity studies were made, as well as work on foliar diagnosis analytical techniques and the influence of variety and $(NH_4)_2SO_4$ application on leaf nutrient levels. N-P-K levels in cane stalks are recorded as a function of N applied and studies continued on the rôle of Si in cane nutrition. *Physcus seminotus* was successfully bred and introduced as a parasite for biological control of the scale insect, *Aulacaspis tegalensis*, a pest to which the variety S17 showed itself very highly susceptible. This variety also appears susceptible to the spotted borer (*Chilo sacchariphagus*), while another pest, *Mythimna tincta*, was recorded on cane for the first time since 1912. Dry weather at the end of 1970 and early in 1971 reduced gumming disease but increased leaf scald. Smut incidence has not deteriorated but a new virus disease resembling streak was observed; the diseased plot was uprooted and burnt. Weed control trials showed that chemical spraying proved more economical than manual weeding. Tests were made of ranges of chemicals and excellent results given with R.P. 17623 which is, however, too expensive for large-scale use. "Atrazine" and DCMU remain the standard residual herbicides. Experiments showed TCA + "Dalapon" and TCA + sodium chlorate to be the best treatments for control of *Cynodon dactylon*. Studies are being made on the physiology of flowering in cane and on its growth to find the reasons for differing yields of the same variety in different environments and of different varieties in the same environment. Ripening of cane is also being investigated, with trials of a chemical ripener (CP 41845). A survey of irrigated lands in December 1970 showed that surface irrigation was slowly decreasing while overhead irrigation was increasing to a greater extent. Economic studies on four estates showed a fixed system to be preferable to a semi-portable one.

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Characterization of Strain E of sugar cane mosaic virus infecting St. Augustine grass. J. L. SALADINI and F. W. ZETTLER. *Plant Disease Reporter*, 1972, **56**, 885–889.—A manually transmissable virus isolated from St. Augustine grass in Florida was identified as Strain E of sugar cane mosaic virus. The host range of the virus is limited to the Gramineae and it is transmitted by aphids.

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Mechanical harvesting and its effect on cane quality (Cuba 1964-68). A. F. BETANCOURT. *Bol. Azuc. Mex.*, 1972, (265), 15–22.—Details are included on the history and progress of mechanical harvesting in Cuba.

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Cyperus rotundus—**the world's worst weed.** A. DEUTSCH. *World Farming*, 1963, **15**, (3), 12–13. Growth characteristics of purple nutgrass or nutsedge (*Cyperus rotundus*) and the damage it can and does cause to various crops are briefly described and possibilities of controlling it discussed, including the use of two new herbicides which are still in their final testing stages, viz. MBR 8251 ("Destun") pre-emergence and "Glyphosate" post-emergence herbicides. For partial control of nutgrass in cane fields 5–6·25 kg "Atrazine" per ha or 15–19·75 kg "Lasso" per ha immediately after or within 3 days of planting is recommended. It is mentioned that nutgrass is vulnerable to the effects of desiccation on the tubers, to shade and to one or two insect predators.

Hot air therapy against red rot of sugar cane. K. SINGH. *Plant Disease Reporter*, 1973, **57**, 220–222. Tests in which red rot-infected cane pieces were treated with hot air at 54°C for 8 hr showed that the treatment was successful in eliminating the fungus, compared with the untreated controls. The heat treatment did not damage the buds, 65% of which germinated compared with only 23% in the case of the controls.

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The Dominican Republic prepares for sugar cane mechanization. G. SAMUELS. *Sugar y Azúcar*, 1973, **69**, (2), 27–28.—Approaches being made by the Consejo Estatal del Azúcar (State Sugar Council) in preparing the Dominican Republic for cane mechanization by investigation and education are described and information given on the broad programme being carried out at the Experiment Station established by CEA in 1965, covering fertilizer requirement determination, varietal experiments, and study of the prevalence of cane diseases and white grub infestation.

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Cane harvesters and the 1972 season. L. G. VALLANCE. *Australian Sugar J.*, 1973, **64**, 537–541.—Information is given on the types and numbers of chopper harvesters (totalling nearly 1600) used to cut almost all the cane in Queensland during the 1972 season.

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Trash mulch and sugar cane yields in Barbados. B. W. EAVIS and K. CHASE. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 8 pp.—Since most of the cane in Barbados is now burnt before harvesting in contrast to the former practice of harvesting green cane, experiments were carried out to examine the effects of trash mulching in unburnt cane fields in areas of low, medium and high rainfall. Mulching increased the tiller elongation rate and number as well as cane yield, compared with the absence of mulching, while soil (coralline clay) moisture content was unaffected. Effects of trash removal were greater in areas of low growth rate than in high growth rate areas, while the beneficial effect of mulching on growth was maximum in good growing weather after a period of slower growth. Mulching was not found to help drought resistance or water conservation. The greater size or growth rate of the root system could account for the effects of mulching observed.

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A case study of the effect of varying the length of the cropping season on the economics of cane and sugar production. T. CHINLOY. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 7 pp.—Cane is harvested at Frome (Jamaica) during December-June, its age ranging from 9 to 15 months. The productivity of each of 600 fields in the 1962–71 period was calculated for B 4362, representing 82% of the cane harvested in 1962. From results it was calculated that maximum sugar would be produced from cane harvested during January-April, followed by cane harvested in December-April, December-May and December-June. Lowest sugar content occurred in December cane, followed by June, January, May, February, March and April. However, the economics of reducing crop length by increasing the crushing rate are briefly examined, showing a net return for a January-April season of only 0·5% on capital.

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The Caribbean sugar industry. Planning for future success. F. THOMLINSON. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 20 pp.—Future prospects for the Caribbean sugar industries are discussed, particular attention being focused on markets, sugar and cane prices, land selection for cane growing, crop length, agricultural equipment requirements and availability, factory capacities and long-term planning within sugar companies.

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Three years of mechanical harvesting study in Jamaica. C. O. LEE and J. C. VAN GROENIGEN. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 23 pp.—Details are given of investigations conducted on three different cane harvesters imported into Jamaica for trials, viz. a Massey-Ferguson M-F 201 chopper harvester, a Cameco "Cost Cutter" whole-stalk harvester and a Don Mizzi 740 chopper harvester. While the whole-stalk harvester proved unsuitable under Jamaican conditions, the chopper harvesters gave better results, although poor infield conditions caused considerable damage to the M-F 201; performance improved with implementation of a land forming programme. Results, concerning harvesting rate, time and cane losses, trash content and costs, are given in tables. (See also *I.S.J.*, 1973, **75**, 6–10, 112.)

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The development of a mechanical cane system in Trinidad 1962-1972. L. P. DONAWA. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 12 pp.—Information is given on the developments in cane mechanization on the 52,000 acres of land belonging to Caroni Ltd., including details of the harvesters and the modified Bell self-loading trailer (used in hilly areas) as well as descriptions of the methods used in land reforming, ridge recultivation for optimum ratooning, varietal selection and row spacing.

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A locally developed container for transporting chopper-harvested cane in St. Kitts. A. C. COLE. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 4 pp. A metal wire cane container with bottom-opening door having a capacity of 2 tons of cane is described which was designed to be lifted by crane into standardized road carts at transfer stations. Experiments revealed the need for minor modifications; no problem was found in cane discharge, but the filling speed was low, and a 4-ton capacity would have been more acceptable. (The limit was imposed by the crane lifting and cart carrying capacities.)

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Compaction characteristics of four soils. C. L. PAUL. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 6 pp.—The effects of compaction on bulk density, moisture content and resistance to penetration

of four major soil types from the Guyana sugar belt were investigated in laboratory experiments. The results are given in the form of graphs, and it is suggested that these plus field penetrometer readings could be used to estimate density levels as an aid to compaction control, the compaction forces used in the tests being representative of those used in field operations such as drain filling during conversion of cambered beds to ridges and furrows.

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Twenty years after—the present situation of weed control in the northern areas of Caroni. L. C. GOBERDHAN. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 12 pp.—The species of weeds found in cane fields of Caroni Ltd. in Trinidad are listed and details given of the herbicides and techniques used to combat them. While some weed species have been eliminated, particularly herbaceous broadleaves, fourteen new species have appeared during the last twenty years, of which six are grasses. Annual grasses are now the principal weeds.

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Insects associated with sugar cane on Abaco Island, the Bahamas. M. N. BEG and F. D. BENNETT. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 13 pp.—Details are given of cane pests encountered in the Bahamas during the period 1967–1970, after which the sugar industry ceased operations. Information is also given on parasites and predators of the pests.

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Pre-emergence herbicides for use in the growing of bud chips in bags. L. C. GOBERDHAN. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 2 pp.—Of three pre-emergence herbicides applied to bags in which plants are grown from bud chips (one-eye seed pieces), "Atrazine 80W" proved the most suitable and permitted 87·5% germination 21 days after planting of the seed pieces while giving excellent weed control.

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Fertilizer experiments in Guyana. F. C. MCLEAN and N. E. JACKSON. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 11 pp.—Trials with N, P and K fertilizer application to soils in cane fields owned by Bookers Sugar Estates Ltd. in Guyana during an 8-year period are reported. Both small- and large-plot trials are recorded.

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A method of assorting foliar data to determine optimal levels of N, P and K for different varieties of sugar cane. F. C. MCLEAN. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 9 pp.—Results of foliar analysis for N, P and K in ratoon cane from the four major commercial varieties in Guyana showed that in one variety (D141/46) the N levels were consistently significantly lower than in B 41227, the variety mainly used for determining critical levels, whereas no significant differences were found between the four varieties in the case of P and K.

An estimation of the effect of flowering on yield and quality of sugar cane in Barbados. P. S. RAO. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 5 pp. Determination of cane weight, fibre and total sugars as well as juice Brix indicated losses due to flowering which were greater in one variety tested (B 52107) than in another (B 57150) at the same flowering intensity. Reasons for the varietal differences are discussed.

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Comparison of the efficiency of three months of selection in a mixed seedling population. V. M. YOUNG-KONG. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 4 pp.—Of three selection methods applied to a seedling population of 500 obtained from five commercial cane crosses, that based on refractometric Brix and visual stool characters of 20% of the best phenotypes (an independent selection of the best phenotypes was also made by four experienced selectors) proved the most efficient guide to performance, as shown by their yields as plant, 1st and 2nd ratoon canes. Determination of Brix in 20% of the best phenotypes was the next best method, followed by random selection.

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Chemical ripening of sugar cane in Jamaica. D. EASTWOOD. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 11 pp.—Field tests of a number of ripeners in small plots at two stages of the crop period in two different environments are reported. In general, the effects of the chemicals on ripening were rather small. Best results were given by "Polaris" (formerly CP.41845, a Monsanto chemical), which performed consistently well in all tests. Under low rainfall conditions requiring irrigation 3·8 lb/acre was more effective than 1·9 lb/acre, whereas there was little difference where the rainfall was high. Optimum response was obtained 4 weeks after spraying, although even after 6 weeks the chemical still had an appreciable effect. Results for the other chemicals tested are discussed. (See also YATES: *I.S.J.*, 1972, **74**, 198–203.)

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Preliminary investigations on the sugar cane insects of the Dominican Republic. L. F. MARTORELL, J. A. BURGOS and F. MEJÍA B. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 35 pp.—About 40 cane insect pests of the Dominican Republic are listed by orders, genera and species and biological and chemical methods of controlling the more important ones are mentioned. Sixty references are given to the literature.

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The *Calisto* (Lepidoptera:Satyridae) problem in sugar cane in the Dominican Republic. J. A. BURGOS and L. F. MARTORELL. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 7 pp.—Of the 11 species of *Calisto* butterflies found in the Dominican Republic, only one (*C. pulchella* Lathy) is known to attack sugar cane, causing considerable losses in cane through defoliation on 26,000 acres in 1972. The history, taxonomy and biology of the pest are described and

details given of chemical control, the most effective means against adults and larvae being aerial spraying of "Endrin" at the rate of one-third gal of a 19·2% concentrate per acre. Biological control investigations are also briefly mentioned.

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Notes on the sugar cane soil insect pests in the Dominican Republic. F. MEJÍA B. and L. F. MARTORELL. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 6 pp.—Determination of infestation by soil-inhabiting insects (grubs) on state-owned cane plantations in the Dominican Republic is reported and the details tabulated. The insects most commonly found are described and their biological and chemical control discussed. Recommended treatment is 2–3 lb "Heptachlor" (10% granular) a.i. per acre applied in a 12–18 inch band on the furrow together with fertilizer at planting time before the cane setts are covered with soil. This should be done once the infestation rate exceeds 5000 grubs per acre. It is mentioned that this treatment need only be done once in an interval of many years.

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The relationship between sugar cane yields and accumulated moisture deficits and excesses in Guyana. F. C. MCLEAN. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 7 pp.—Evapotranspiration and rainfall data for the 11-year period 1959–69 were integrated for 8 Bookers estates and used to calculate, by computer, accumulated weekly moisture deficits and accumulated weekly rainfall excesses with the aim of establishing relationships between these and cane yields and hence determining irrigation requirements. Allowance was made for a given moisture-holding capacity of the soil. The results indicated a substantial effect of moisture deficit on yield, with differences in the pattern between estates and between seasons on the same estate.

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The irrigation of sugar cane with particular reference to Jamaican conditions. E. A. C. HUIE. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 14 pp. A survey of surface and overhead irrigation in Jamaica is presented with mention of the five major schemes and calculation of irrigation economics and efficiency. Recommendations for increasing efficiency are listed.

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Fire, water and sugar production in Barbados. J. C. HUDSON. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 10 pp.—An empirical method for estimating the cane sugar yield per acre and total sugar production as a function of rainfall is described which is based on actual data for 1951–65. Comparison of crop yields since 1967 with predicted values show a progressive fall in the actual values away from the expected figures; this is mainly attributed to pre-harvest burning of cane, which has been found by other authors to account for a drop of $\frac{1}{2}$–$\frac{3}{4}$ tons of sugar per acre.

Cane quality control in St. Kitts. A. C. G. COLE. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 2 pp.—The cane contract which came into force in 1971 in St. Kitts provided, amongst other things, for penalties for excessive trash (i.e. over 5% of cane weight) and immature cane. The system applied in determining the trash penalty, based on the so-called "trash index", is described. It has been found that the trash content has fallen since introduction of the penalty system, but that mechanical harvesting gives higher contents than does manual cutting.

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Mechanical harvesting in Queensland—1972 season. L. G. VALLANCE. *Australian Sugar J.*, 1973, **64**, 595–599.—A summary of mechanical cane harvesting is presented, showing that there was a slight increase in the number of chopper-harvesters and a slight reduction in that of whole-stalk harvesters. Difficulties in obtaining clean cane when the crop is wet and has a large amount of unburnt green leaf are discussed; it is considered impossible to provide very clean cane without the use of ground crews and a drastic reduction in harvesting rate. Improvements in billet length were obtained by modifying or adjusting the extra knives fitted to many machines; where high harvesting rates were maintained, the Massey-Ferguson multiple-knife system gave a better billet than did other systems. The individual harvesters are described as well as a number of developments in cane transport.

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The cane grub problem at Mackay. B. E. HITCHCOCK. *Cane Growers' Quarterly Bull.*, 1973, **36**, 112–114. The main white grub pests of cane in the Mackay area of Queensland are *Dermolepida albohirtum* (greyback), *Lepidiota frenchi*, *L. mungomeryi*, *L. squamulata* and *L. grata*. The incidences of individual types, estimated losses caused by them and means of controlling them (where possible) are reported.

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The Annual Block Performance Report takes the guesswork out of farm management. R. J. HAMPSON. *Cane Growers' Quarterly Bull.*, 1973, **36**, 117–119. Information is given on the Annual Block Performance Report, which is a part of the BSES (Bureau of Sugar Experiment Stations) system of farm management accounting[1] and permits the cane farmer to make decisions based on the results of computerized processing of the data as logged in a Daily Work Record.

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Poor ratoons. Why? C. R. NALDER. *Cane Growers' Quarterly Bull.*, 1973, **36**, 120–121.—Reasons for poor ratoon crops are discussed, including varietal differences, harvesting speed and basecutter blade condition as well as stool compaction by harvesters, diseases (particularly ratoon stunting) and pests, and climatic conditions—very wet or dry conditions during the ratooning period will cause losses, while poor ratoons also occur as a result of harvesting under wet conditions.

[1] *I.S.J.*, 1974, **76**, 45.

Sugar beet agriculture

Relation of sugar beet germination to maturity and fruit moisture at harvest. F. W. SNYDER. *J. Amer. Soc. Sugar Beet Tech.*, 1971, **16**, 541–551.—Beet fruits were harvested 3–4 times at 5- or 6-day intervals from the same field-grown plants, whereby it was found that seed harvested 5–11 days before commercial maturity did not germinate as well as seed harvested at maturity, which was based on fruit colour. With the aim of relating germination performance to stage of maturity, commercial maturity, fruit moisture content at harvest and physiological maturity (90% germination of adequately developed seeds in 10 days), greenhouse-grown seed was harvested repeatedly and differences found between seed from individual plants for a given variety which were greater than the average differences between varieties. Poor correlation was found between commercial maturity and physiological maturity, which occurred at fruit moisture contents of 29–76% on a wet basis, and at intervals of 26 days before to 10 days after commercial maturity. Neither fruit colour nor fruit moisture content alone can be used to predict physiological maturity precisely.

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Morphological changes in roots of sugar beet and tomato infected with *Heterodera schachtii* Schmidt 1871. A. E. STEELE. *J. Amer. Soc. Sugar Beet Tech.*, 1971, **16**, 561–567.—Surfaces of roots of pot-grown sugar beet and tomato plants infected with this nematode showed extensive sloughing of the epidermis and cortical parenchyma as well as rift formation (found also in non-infected roots). Examination of strained root sections showed that after invasion of the root, larvae usually became oriented parallel to the root axis, but occasionally perpendicular to it. Syncytia (giant cells) initially developed from cells of the pericycles, protophloem and interfascicular parenchyma, and their formation within the vascular cylinder was accompanied by enlargement of the stele, resulting in localized swelling of the roots at invasion sites both at root tips and in maturing roots far removed from the meristematic areas. In young beets the development of a tough periderm, lack of sufficient cortical parenchyma and the presence of the stele (and hence syncytia) near the root surface possibly make the roots less susceptible to penetration and development of late-emerging larvae. Variation in the number or size of syncytia plus observed differences in the feeding requirements of male and female larvae may influence the adult sex ratio and permit a greater number of males to develop at or near the root surfaces, thus establishing an equilibrium which may tend to create an infection threshold in a given parasite community.

Performance of multigerm triploid sugar beet hybrids when space planted. J. S. MCFARLANE, I. O. SKOYEN and R. T. LEWELLEN. *J. Amer. Soc. Sugar Beet Tech.*, 1971, **16**, 577–584.—Experiments to compare the field performance of monogerm and multigerm diploid and triploid hybrids sown as decorticated seed showed that the latter exhibited poorer germination than that of the equivalent diploids when space planted. Emergence of multigerm diploids was also greater in terms of the number of hills (containing 1–5 plants), but the percentage of single plants was higher for the multigerm triploids, and there was no significant difference between the equivalent diploids and triploids when space planting was followed by hand thinning to a plant or hill spacing of 8–10 inches, giving a field population of 79% single plants with the remaining hills mainly of two plants. Advantages of triploid hybrids as regards breeding are briefly discussed, and it is suggested that multigerm triploids can be used pending the development of satisfactory monogerm triploids.

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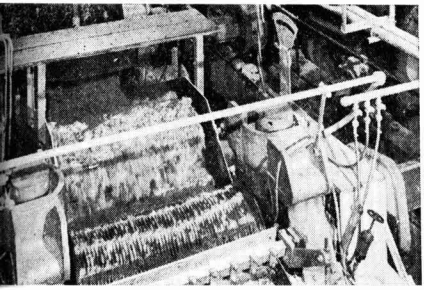
Sugar beet as influenced by row width, nitrogen fertilization and planting date. M. A. DILLON and W. R. SCHMEHL. *J. Amer. Soc. Sugar Beet Tech.*, 1971, **16**, 585–594.—In beet rows spaced alternately 11 and 22, 13 and 22, 18 and 22, 11 and 33 inches apart, as well as all 22 inches apart, the narrower spacings had only small effect on early season growth but did increase the leaf area in August/September. However, final root yield and sucrose content were not increased when the rows were less than 22 inches apart, while a 11 + 33-inch spacing resulted in a root yield and sucrose content reduction. All beets were spaced 10 inches apart within the rows. Nitrogen fertilizer application did not affect early beet growth, but did increase the leaf area index in August/September. However, it did reduce the final root quality, while having little effect on final recoverable sucrose yield. The only factor having any substantial influence on early season leaf area and final recoverable sucrose was the planting date. April planting gave a closed leaf canopy earlier in the season, and the increase in early top growth was accompanied by increased root yield, about 80% of the advantage in final root yield resulting from early planting being accrued by the end of July. Early planting increased light interception and probably efficiency of sunlight utilization, since leaf area increased at a time when the leaf area index was relatively low and solar radiation high.



Cane sugar manufacture

Abnormal behaviour of Palia cane juices with special reference to the melanoidin formation in clarified juice and syrups and clarification difficulties. S. K. D. AGARWAL, P. C. JOHARY and K. K. MATHUR. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M29–M52.—Difficulties have been experienced with processing of juice from cane grown in the Palia area of Uttar Pradesh and juice samples were examined to investigate the cause. Juices were found to be low in phosphate and high in ash and reducing sugars so that for good clarification additional phosphate and high lime dosage were necessary. Amino-acids were also high and gave abnormal melanoidin formation which required extra sulphur usage in white sugar manufacture. In addition there was unusually high caramel formation during evaporation.

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On the rôle of filtration efficiency of Oliver Campbell vacuum filters. R. C. SINGH, M. N. SINGH and J. J. BHAGAT. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M65–M72.—Retention of solids by a rotary vacuum filter was improved by increasing the proportion of bagacillo in the feed; this also raised the filtration rate, and a proportion of about 10 kg/t.c.h. is considered desirable. As drum speed was raised filtration rate rose but filtration efficiency fell; a suitable speed must be chosen which is the lowest able to cope with factory throughput. The lime dose in clarification was found to be of greatest importance in providing a clear juice and low-volume mud which filtered easily.

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Suggestions for expansion of sugar factories. K. S. MARAYANA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G9–G12.—Suggestions for increasing sugar production in India are made; they include: ensuring that existing factories operate to full capacity and extend their season by crushing early-maturing cane before their usual season start, installation of additional cane preparation equipment and/or extensions to the milling tandem to raise cane crushing capacity, and installation of a diffuser.

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Cleaning of filter press plates. S. C. SETHI and Y. P. GUPTA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G27–G29.—A comparison was made between the cost of cleaning filter presses with a 1:5 diluted hydrochloric acid solution and manually using discarded rotary tube-descaling equipment. Under the conditions applying at the author's factory the manual method was preferable.

Formalin as a chemical agent-cum-acid inhibitor in evaporator cleaning. S. K. CHATTOPADHYAY. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G31–G34.—Addition of formalin to HCl used for evaporator scale removal assisted the action of the acid and was a suitable corrosion inhibitor, protecting brass and mild steel.

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A narration of troubles in sugar factories. H. P. S. BHATIA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G41–G43.—A number of expensive accidents which have happened in sugar factories are reported; these were mainly due to negligence and the author believes that if such incidents were recorded it might help to prevent a recurrence.

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Soft coke as a substitute for lime kiln. V. S. CHOPRA and A. SINGH. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G45–G47.—No adverse effects were observed when soft coke was substituted in part or wholly for hard coke which was in short supply for use in the Belgian lime kilns at the authors' factory.

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Maintenance management. S. P. NARAIN. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G53–G56. Aspects of preventive maintenance are briefly discussed.

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Chemical cleaning of press plates and frames. S. C. ARORA and M. S. MATHUR. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G75–G77.—Cleaning of plates and frames from a carbonatation mud press, by treatment with 5% HCl solution followed by manual brushing, was more satisfactory and quicker than by manual cleaning with scrapers.

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Chemical descaling and the importance of correct acid inhibition. E. PRASAD and N. V. PANCHANATHAN. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G79–G89.—It is asserted that the key to success in chemical removal of scale from heating surfaces is the acid inhibitor which prevents attack on metal by the acids used. Suitable "Rodine" inhibitors have been developed by the authors' company for use with HCl and sulphamic acid, and an account is given of cleaning techniques.

Clarification. I. Mud concentration. E. P. DÍAZ G., O. TAMAYO B., A. NUÑEZ G. and I. CALA Q. *ATAC*, 1973, **32**, 22–34.—An account is given of the modification of "Pearson" clarifiers in order to improve their efficiency and mud concentration.

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Clarification. II. Juice feeding. O. TAMAYO B., E. P. DÍAZ G., A. NUÑEZ G. and I. CALA Q. *ATAC*, 1973, **32**, 35–42.—Modifications to the juice feeding arrangements of "Pearson" clarifiers at a number of sugar factories are described and discussed.

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Clarification. III. Experimental Equipment No. 600. A. NUÑEZ G., O. TAMAYO B., E. P. DÍAZ G. and I. CALA Q. *ATAC*, 1973, **32**, 43–50.—A description is given of the Type 600 clarifier which embodies the results obtained from studies intended to improve the operation of existing unsatisfactory units in Cuban sugar factories.

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The preparation and application of flocculant solutions. J. MCFARLANE. *Globetrotter* (Fabcon Inc.), 1973, (Spring).—Most commercial flocculants for use in the sugar industry are dry powders adsorbing water readily to give sticky masses. They dissolve slowly in water and give highly viscous solution even in low concentrations. They are best used as additions of required amounts of 0·25–0·50% solutions to give the desired final concentration (2–5 ppm), and this intermediate stage may be prepared by addition of the powder or a slurry in methylated spirit into the vortex created by a high-speed mixer in water at not over 120°F. Stirring should not exceed 20 min and when the solution is added to the juice mixing should be gentle to avoid mechanical damage to the floc.

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***Corrosion fatigue—its effect on sugar cane chain* conveyors.** J. H. SHULER. *Sugar J.*, 1973, **35**, (10), 29–30.—The adverse effects of stress corrosion and pitting on the chain pins of conveyors used as feed tables, cane carriers and for bagasse and trash transfer are discussed with the aid of illustrations. The use of alloy steel coated with "electroless nickel" (containing 90–98% nickel and 2–10% phosphorus) is described; sample pins removed from conveyors at two factories at the end of the 1968, 1969, 1970 and 1971 seasons indicated 100% protection from corrosion fatigue.

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Sugar cane research projects at Audubon Sugar School. J. J. SEIP and F. L. GAYLE. *Sugar J.*, 1973, **35**, (10), 43–45.—Cane sampling using a vertical corer developed at Louisiana State University proved difficult in tests, which indicated that under Louisiana conditions a simple horizontal or vertical corer cannot easily obtain a representative sample of whole-stalk cane with a high volume of immature top sections. The cane wash water recycling system at Alma sugar factory, which includes a sedimentation canal, a sedimentation pond and a clear water pond, was studied and wash water and mill juice samples analysed. No incipient juice infection was found, and the only problem was one of odour on warm days. The total impounding area is about 8 acres. Analysis of juice from four cane varieties showed that at high purity there was no difference between sucrose and pol, but the sucrose value exceeded the pol value with decrease in purity. The phenomenon is attributed to differences in cane maturity rather than to varietal differences. Investigations of leaf filter performance in the handling of clarifier mud showed that high filtration rates were associated with rise in temperature, suggesting the advantage of adding heating elements to the mud-bagacillo mixing tank or the mud tank before the bagacillo mixing trough. The amount of bagacillo used as filter aid was also found to be highly significant with dilute mud treatment. pH and the possible need to add lime to maintain its value in the filter station are discussed, as is the use of flocculants in mud filtration.

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An approach to vapour bleeding in quadruple-effect evaporators. A. JOSEPH and W. A. MELLOWES. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 12 pp.—A mathematical model is used in an analysis of evaporator operation with the aim of utilizing known parameters to obtain an optimum bleed rate for given values of juice and steam inputs. It takes into account juice and condensate flashing as well as changes in latent and specific heat from effect to effect, and can be adapted to include vent losses. The effect of excessive vapour bleeding is calculated as is the optimum steam flow rate to give a thick juice of 60°Bx from the last effect in a quadruple-effect evaporator. Results indicate a sharp reduction in Brix with excessive bleeding at constant steam rate. A method of controlling vapour bleed by means of condensate flow monitoring is proposed.

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De-ashing travelling grates used on bagasse-fired boilers in Guyana. A. M. WAITH. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 4 pp.—The advantages of continuous de-ashing of bagasse-fired furnaces are discussed and a Babcock & Wilcox travelling chain grate developed for bagasse some years ago and used at two sugar factories in Guyana is described.

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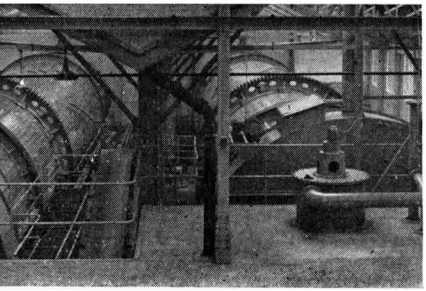
The drying of sugar in an experimental pneumatic dryer. L. A. SHAH and D. R. MCGAW. *Paper presented at* 1973 *Meeting W. Indies Sugar Tech.*, 11 pp.—Investigations of the performance of a small-scale pneumatic dryer, comprising a 17-ft vertical glass pipe of 1 inch i.d., are described. Results indicated a reduction in the white sugar moisture from a maximum of 0·6% to 0·027% at a sugar flow rate of 22·9 lb/hr. The air was heated by a 3 kW heater. Some particle fracture occurred, presumably in the feed section to the cyclone used to separate the sugar and air streams at the top of the pipe as well as in the cyclone itself.



Beet sugar manufacture

A shaft lime kiln with oil-firing in the sugar industry. H. SCHNEIDT. *Zeitsch. Zuckerind.*, 1973, **98**, 139–140. An oil-fired lime kiln producing 95 tons of lime per day with a CaO content of about 95% and a waste gas CO_2 content of 29–30% is briefly described. Installed at Mosul sugar factory (Iraq), it burns 120 litres of oil per ton of lime and has operated for two campaigns. It was constructed by West's (Manchester) Ltd. in association with their licencees, Maschinenfabrik H. Eberhardt.

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Eppeville sugar factory is fifty years old. ANON. *Sucr. Franç.*, 1973, **114**, 166–169.—A brief illustrated account is given of this French sugar factory which in 1972 had a daily slice of 10,000 tons of beet compared with 3,500 tons in 1923. It has a distillery which produces 17% of the total amount of molasses alcohol produced in France and 2·5% of the French beet alcohol production.

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The molasses sugar extraction plant of Sucrerie et Distillerie d'Origny-Sainte-Benoîte. P. DUPONT. *Sucr. Franç.*, 1973, **114**, 184–188.—Details are given of the equipment and of the RT continuous cold lime process used at this French beet sugar factory to recover sugar from a rated 130 tons of molasses daily.

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Packeting sugar for consumers. J. BUREŠ, M. FRIML and P. URBÁNEK. *Listy Cukr.*, 1973, **89**, 59–68. Tests on filling 1-kg packets with sugar showed that next to hand weighing and packeting, the most accurate filling of 1-kg packets (to within $\pm$ 10 g) was obtained with a Hesser automatic system, provided it was maintained in regular working order. Otherwise precision suffers, particularly under the effect of bulk weight of sugar. Other weighers used were an unnamed Czechoslovakian system and an automatic ICA.

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Use of pure carbon dioxide in the sugar industry. A. Z. GET'KALO and E. V. LITVINOV. *Sakhar. Prom.*, 1973, (3), 23–25.—The possibility of using high purity CO_2 for carbonatation, and thus eliminating problems associated with low CO_2 content and the presence of CO in the gas, is discussed and a scheme briefly outlined for production of pure CO_2 from kiln gas by contacting with monoethanolamine. Carrying out carbonatation with pure CO_2 at a pressure above atmospheric has been shown by laboratory tests to reduce the process time considerably, while reduction in the amount of gas used permits the size of the carbonatation vessels to be decreased.

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Examination of geometrical parameters of the baskets of continuous centrifugals. V. G. ANDREEV and V. F. KOLOMIETS. *Sakhar. Prom.*, 1973, (3), 25–28.—Details are given of tests conducted with an experimental continuous centrifugal having an exchangeable conical basket to determine the effect of the angle of slope of the basket on throughput and sugar moisture over a given range of massecuite viscosities. Increase in the angle of the basket towards the vertical increased massecuite throughput, at a given viscosity, up to a maximum slope (also the optimum), after which throughput fell. The higher the viscosity within the range tested, the greater could be the optimum angle of slope. On the other hand, sugar moisture increased linearly with angle of slope and with massecuite throughput.

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Determination of suspended matter in sugar factory waste waters. A. P. PARKHOMETS and A. I. SOROKIN. *Sakhar. Prom.*, 1973, (3), 28–30.—Determination of waste water suspended matter is described, involving use of a laboratory centrifuge followed by drying and weighing of the separated mud.

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Increasing the coefficient of utilization of CO_2. I. F. POPOV, A. F. POPOV and A. G. RESHETNIKOVA. *Sakhar. Prom.*, 1973, (3), 48–50.—A method of calculating the optimum flow rate of CO_2 into a carbonatation vessel and required nozzle diameter at which maximum CO_2 utilization takes place is described. Application of the method to redesigning the gas feed system at the authors' factories has given positive results.

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Removal of incondensable gases from evaporators. Z. D. ZHURAVLEVA and K. P. GONCHAROVA. *Sakhar. Prom.*, 1973, (3), 50–51.—The question of suitable means of removing incondensable gases from evaporator effects without excessive vapour loss is briefly discussed.

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Automatic blow-through of the screen in a KDA-25-59 tower diffuser when beet quality is reduced. S. F. BLEKHER and YU. G. ZVEGINTSEV. *Sakhar. Prom.*, 1973, (3), 51–52.—Information is given on an automatic scheme for blowing air through the bottom screen of a tower diffuser when, as a result of low

beet quality, it becomes blocked with pulp and causes an excessive pressure drop, which is used as the prime actuating variable.

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Thin juice decolorization. H. ZAORSKA. *Zucker*, 1973, **26**, 189–191.—See *I.S.J.*, 1972, **74**, 117.

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Filter fabrics in the field of thick juice and liquor filtration. H. BURGHARDT. *Zucker*, 1973, **26**, 192–194. Results are briefly reported of thick juice filtration using a Schenk self-discharging filter provided with a synthetic fibre cloth (of monofil/multifil or felt weave) instead of a metal gauze. Advantages of the use of synthetic fibre are indicated.

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Investigation of boiling house performance at sugar factories using different 2nd carbonatation conditions. T. P. KHVALKOVSKII, A. L. SHOIKHET and A. YA. LIMANSKAYA. *Sakhar. Prom.*, 1973, (4), 27–31. Results are compared for two factories storing thick juice for post-campaign processing. These showed that 2nd carbonatation to an alkalinity higher than optimum as regards lime salts content gave lower boiling house losses and molasses sugar content than did 2nd carbonatation at optimum alkalinity. The recommended alkalinity (0·025–0·050%) is that corresponding to a molasses pH at 20°C no lower than 7·0, and preferably somewhat higher.

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Control of fresh water consumption and waste water quantity at a beet sugar factory. A. P. PARKOHMETS. *Sakhar. Prom.*, 1973, (4), 33–35.—The coordination and maintenance of a general scheme for control of fresh water usage and effluent quantities are outlined.

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Refractometric control in the sugar industry. A. K. FROLOV and B. A. EREMENKO. *Sakhar. Prom.*, 1973, (4), 50–53.—Details are given of a refractometer, based on measurement of the threshold angle in reflected light, which has been incorporated in an automatic system for Brix control. Preliminary results with thick juice showed that the measuring prism needs periodical cleaning with HCl. A 24-hour chart is reproduced to indicate the performance of the system.

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Progressive planning and construction of sugar factories. G. BRUHNS. *Zeitsch. Zuckerind.*, 1973, **98**, 188–193.—Work conducted by Braunschweigische Maschinenbauanstalt in planning, constructing and equipping modern sugar factories and modernizing and expanding existing factories is described as an example of the way in which a large sugar machinery manufacturer operates.

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Model analysis for determination of optimum campaign length in sugar factories. C. STRUBE and W. BRANDES. *Zeitsch. Zuckerind.*, 1973, **98**, 199–206.—Starting from beet sugar content during September-December and sugar yield, the authors analyse operation of a model factory for which certain processes are assumed as well as a number of features on the agricultural side. Cost factors are then considered, and conclusions drawn on optimum campaign length and starting date. A 100-day campaign from 11th September is considered optimum from the factory viewpoint, while a period of 50–60 days is shown to yield maximum profit for the grower.

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Use of the Enviro-Clear rapid settler at the Peterborough sugar factory during the 1971-72 campaign. D. E. ASH. *Sugar y Azúcar*, 1973, **69**, (2), 17–19. See *I.S.J.*, 1973, **75**, 170–172.

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Sugar evaporators. J. ZIEGLER. *Sugar J.*, 1973, **35**, (10), 47–53.—The fundamentals of multiple-effect evaporator operation are discussed under the headings of: heat transfer, economy and capacity, temperature gradient, vapour withdrawal, juice level, incondensable gases, condensate removal, juice flashing, superheat and vacuum, colour formation, juice Brix, evaporation rate and entrainment, including much advice on how to obtain optimum results.

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Planning and construction of Offenau sugar factory of Süddeutsche Zucker-AG. H. HAESELER. *Sucr. Belge*, 1973, **92**, 135–156.—See *I.S.J.*, 1973, **75**, 321.

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Possibility of measuring the rheological properties of massecuites. J. ZÁRUBA, Z. TOŠOVSKÝ and V. JOZEFY. *Listy Cukr.*, 1973, **89**, 82–90.—Laboratory and factory experiments involving the use of a rotary element to determine massecuite dynamic viscosity in a vacuum pan are described and details given of an automatic control system incorporating the device for control of massecuite level in a vacuum pan, which has proved satisfactory in trials. Other applications tested include control of molasses concentration after massecuite curing in centrifugals, and of liquor Brix, as well as massecuite cooling control.

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Optimization of the technological conditions in beet slicer operation. V. N. SHCHEGOLEV and N. V. POGORELOVA. *Sakhar. Prom.*, 1973, (5), 35–40. Optimum beet slicing conditions, i.e. under which cossette quality is highest at maximum practical throughput, are discussed for basic slicer types with the aid of mathematical formulae for calculation of optimum slicing rate.

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Quality of raw juice obtained in extraction using aluminium sulphate. A. A. LIPETS and I. A. OLEINIK. *Sakhar. Prom.*, 1973, (5), 40–43.—Laboratory experiments on the use of aluminium sulphate in diffusion showed that addition of 0·05–0·08% on weight of beet together with the feedwater gave a lower juice colloid, pectin and total N content (as well as albumin- and amino-N) than without aluminium sulphate addition, although the ash content was somewhat higher. Reducing matter content was the same in

both cases. Factory test data showed higher raw and 2nd carbonatation juice purities and lower colour contents; 2nd carbonatation juice lime salts were also lower.

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Hydropneumometric liquid density meter with differential pressure compensation. I. P. GLYBIN and N. P. BAIDAKOV. *Sakhar. Prom.*, 1973, (5), 56–58.—The density meter described comprises two vertical open-ended tubes of different lengths immersed in the liquid and connected at their upper ends by air line to a differential manometer and indicator. The tubes are constantly filled with water, and the difference between the two levels is a function of density. Factory tests on thick juice density measurement are reported.

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Disc filter mud sweetening-off with raw juice. L. P. SOFRONYUK. *Sakhar. Prom.*, 1973, (5), 65–66.—The use of heated raw juice instead of carbonatation juice to sweeten-off disc filter mud at the author's sugar factory is reported. After sweetening-off, the juice is pumped via a mixing tank to preliming.

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Air purifying unit with self-cleaning filter element. V. A. SERYAK. *Sakhar. Prom.*, 1973, (5), 66–67.—A brief description is given of the unit which has been used for three campaigns to purify compressed air fed to pneumatic devices and controls at a Soviet sugar factory without the need for replacement of the filter element.

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Increasing the capacity of a lime kiln. YU. K. GORSKII and V. P. SHEVCHENKO. *Sakhar. Prom.*, 1973, (5), 67.—How a lime kiln at a Soviet sugar factory was heightened by 2 m to give a 13·2 m³ increase in capacity is described.

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Study of lagooning of sugar factory waste waters. J. P. LESCURE. *Sucr. Franç.*, 1973, **114**, 241–247. Lagooning tests spanning 2 years showed that an effective basin depth of up to 3 m was preferable to one of 1 m, since the amount of effluent involved was greater while the purification rate was about the same for both depths, and that the initial COD load could be the highest possible, as COD does not affect the purification rate. It is recommended to allow for a rather long residence time and each year to discharge at least some of the effluent from the preceding beet campaign. A number of basins is advocated instead of only one, with provisions for filling and emptying them independently. The question of odour was not investigated, and the risk of generalizing on the basis of short-term trials is admitted.

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Planning and building in the sugar industry. P. BERGER. *Zucker*, 1973, **26**, 231–238.—The basic principles in planning complete sugar factories as well as invidivual sections are examined and causes of planning and construction faults discussed. It is considered essential that each part plan should be subordinated to an overall plan, which should be as forward-looking as possible (in time). Much blame is attached to stipulation of insufficient building time and inadequate allowances in costing. A number of West German sugar factories are used as examples.

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Semi-factory scale tests for electrodialysis demineralization of juice after the second evaporator effect. F. PERSCHAK. *Zucker*, 1973, **26**, 239–245.—At a throughput of 210·5 litres/hr, middle juice from the 2nd effect of the evaporator at Bruck sugar factory had its colour content reduced by 78·74% (from an average of 12·23°St) by Lewatit MP 500 A decolorizing resin, while subsequent treatment by an electrodialyser comprising 50 pairs of cells (made up of alternate anion and cation exchange membranes) reduced the ash content by 59·67% (from 45·45 to 18·33 meq/litre). In boiling experiments, the combined treatment led to increased sugar and reduced molasses yield. Sugar losses were 0·093% of the initial sugar content (0·016% on beet), while electricity consumption was 56·55 Wh per equivalent of ash removed by dialysis. The results, covering 350 hr, are used to calculate the quantities and dimensions for a plant handling the juice from 1000 tons of beet/day. Application of the process is regarded as somewhat limited at present owing to the lack of membranes of suitable quality.

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Automatic control of evaporation crystallization with the "Rheomat" system. H. KEMTER. *Zeitsch. Zuckerind.*, 1973, **98**, 249–259.—The "Rheomat" automatic boiling control system is discussed with the aid of mathematical expressions and signal flow charts[1].

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The effect of the structure of macroporous anion exchangers on decolorization of technical sugar solutions. E. BORTEL and A. WYROBA. *Zeitsch. Zuckerind.*, 1973, **98**, 260–263.—The effects of porosity, specific surface and pore size on molasses solution decolorization by laboratory-prepared macroporous strongly basic anion exchange resins were investigated. Decolorization was shown to be a combination of three major factors: absorption in the resin phase, ion exchange and surface adsorption (the last two predominating in the case of macroporous resins). Although the exchange capacity of the resins fell with increase in cross-linkage while specific surface, macroporosity and relative porosity rose, it was the dominant factor only with resins having a specific surface lower than 100 m², whereas above 100 m² surface adsorption was more dominant than ion exchange and led to a higher decolorizing capacity. Hence, only resins with well-developed surfaces should be used as adsorption resins. The best of the resins studied had a decolorizing capacity as high as a number of commercial resins such as "Amberlite IRA-401s".

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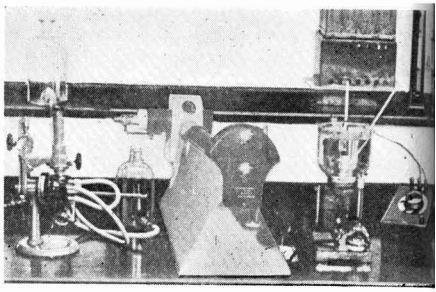
Liquid sugar production in four European countries. H. STOTTER. *Zeitsch. Zuckerind.*, 1973, **98**, 264–266. Information is given on liquid sugar products and processes at Porkkala (Finland), Arlöv (Sweden), Tirlemont (Belgium) and Dinteloord (Holland).

[1] *See also I.S.J.*, 1974, **76**, 26.

Laboratory methods & Chemical reports



Determination of the juice cells ruptured during cane preparation. P. N. R. RAO and S. S. THAKUR. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, E9–E12.—Prepared cane samples were analysed for sucrose using a wet disintegrator; the pol in juice leached with cold water from another sample was determined and this gave a measure of the percentage of ruptured cells. A further sample was compressed at 7·5 p.s.i. for 20 seconds and its bulk density measured. Linear relationships were found between density and percentage of ruptured cells, the slopes depending on the fibre content, and these relationships could be used to assess the percentage of ruptured cells, i.e. the degree of preparation, from the bulk density.

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Purity of a loss and purity of a material in process. T. T. OOMMEN and B. S. GURUMURTHY. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M1–M3. When Brix, pol and non-sugar balances are drawn up, the corresponding figures for undetermined loss can be calculated as indicating a loss purity of over 100. While this would be meaningless for a real loss, as in molasses or filter cake, in the case of undetermined loss it is the result of inversion.

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Purity drop from primary juice to mixed juice in cane sugar mills. P. K. AREN. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M13–M17.—The fall in purity between primary and mixed juice, which ranged from 1·89 to 3·04 units during the six seasons from 1966/67 to 1971/72, is attributed to fermentation along the tandem by yeasts introduced from the maceration water and bacteria introduced with the cane. Tests on disinfection with bleaching powder, formalin, ammonium bifluoride and procain-penicillin have proved ineffective.

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Change in buffering capacity and organic acid content of juices during diffusion of sugar cane bagasse in the DDS process. S. K. D. AGARWAL, B. K. GUPTA and R. P. SHUKLA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M53–M64.—Organic acids were measured conductimetrically in primary, diffuser, mixed, and clear juices at three DDS installations and a rise of up to 100% (e.g. 157 to 263 meq/litre) noted between primary and diffuser juice. The mixed juice content was somewhat lower than that of diffuser juice and an appreciable reduction occurred in clarification. The rise during diffusion is attributed to thermal destruction of reducing sugars. The buffering capacities of the juices were measured by determining the quantity of reagents needed to change the pH from 2·5 to 10·5; they were higher for diffusion juices than had been observed with other juices.

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A new method for evaluating the buffering capacity of sugar cane juices. S. K. D. AGARWAL and K. K. MATHUR. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, M73–M85.—The method used in the preceding abstract is described; samples of juice are titrated with N/10 HCl to pH 2 and with N/10 NaOH to pH 11 and the changes of pH for each increment of reagent recorded on a graph paper. The total of acid and alkali between pH 2·5 and pH 10·5 is taken as a measure of the buffering capacity of the juice resulting from its content of calcium salts of organic acids.

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Spectrophotometric characteristics of caramels and melanoidins in relation to the nature of the colouring matter present in commercial sugars. S. K. D. AGARWAL and D. S. MISRA. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G13–G25.—Caramels produced by heating sugars alone showed characteristic absorption peaks at 282 nm while caramels prepared in the presence of alkali had peaks at 270 nm; Beer's law was observed at these wavelengths. Other peaks were observed between 420 and 460 nm for caramel, while melanoidins showed peaks at 310 nm in some cases while others were without any peak.

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Viscosity of cane molasses. N. H. NGUYEN. *Cukoripar*, 1973, **26**, 58–60.—Studies of molasses samples from North Vietnam, India and Cuba showed that they are Newtonian fluids and that concentration and temperature affect their viscosity just as with beet molasses.

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Rapid method for gas chromatographic determination of lactic acid in molasses. E. REINEFELD, K. M. BLIESENER, L. REXILIUS and A. REINEFELD. *Zucker*, 1973, **26**, 186–188.—Details are given of a gas chromatographic method in which the only preliminary treatment of the molasses sample is its silylation with an excess of N,O-bis-(trimethylsilyl) trifluoracetamide (BSTFA), whereby the water present is bound. The lactic acid content is found from its trimethylsilyl derivative by reference to a calibration curve. The values found by this means, which is accurate to within $\pm$ 4·5%, were found to agree with values

obtained by enzymic determination within the limits of experimental error.

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Effect of colloids on sucrose crystallization. S. E. KHARIN, V. M. KHARIN and V. A. TONKIKH. *Sakhar. Prom.*, 1973, (4), 31–32.—Laboratory experiments showed that addition of controlled quantities of pectin to aqueous sugar solution caused a drop in the crystallization rate, so that the final number of crystals was greater and their size smaller than in the absence of pectin.

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The effect of cane preparation on pol extraction. S. H. NAQVI and Z. M. KONASIEWICZ. *Paper presented at 1973 Meeting W. Indies Sugar Tech.*, 5 pp.—A high correlation was established between cane preparation (expressed as percentage of broken cells in cane samples after treatment with knife sets and calculated in terms of pol % cane, pol % press juice and fibre % cane) and extraction in a hydraulic press used instead of a mill to eliminate such variables as feed, mill speed and mill setting. A regression equation derived from the results gives whole reduced extraction as $100 - (30{\cdot}53 - 0{\cdot}2 \times \%$ broken cells). It was found that a one-third increase in % broken cells led to almost 5% increase in extraction.

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Determination of the dependence of the saturation coefficient on non-sugars concentration using the "Saturoskop". P. KADLEC, R. BRETSCHNEIDER and J. ČEPELÁK. *Listy Cukr.*, 1973, **89**, 76–81.—Determination of the saturation coefficient as a function of non-sugars concentration with a "Saturoskop"[1] was found to give measurements of use in determining standard molasses composition, with a mean relative deviation from true polarization of —1·1%. Advantages of the method include rapidity.

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Determination of optimum proportion of ion exchange resins for beet sugar solution demineralization. K. P. ZAKHAROV, V. N. EREMENKO, A. I. POGORELAYA and S. M. KALABALINA. *Sakhar. Prom.*, 1973, (5), 49–50. A laboratory method, described as simple, rapid and accurate, is reported for determining the optimum proportion of a given anion and cation exchange resin for demineralization of a sugar solution. A worked example, using formulae developed for the method, is presented.

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Coefficients of viscosity and diffusion in beet factory thick juices. L. P. ZHMYRYA, M. N. DADENKOVA and R. S. BURDUKOVA. *Izv. Vuzov, Pishch. Tekh.*, 1973, (1), 114–115.—Calculations of dynamic viscosity from determined values of kinetic vicosity and density for thick juice in the concentration range 40–70% and temperature range 25–80°C at about 90 purity showed that a simple exponential equation described the temperature-dynamic viscosity relationship, but the Stokes-Einstein law could not be applied to the relationship between dynamic viscosity and sucrose diffusion coefficient which altered considerably with change in sugar concentration. Impurities in the thick juices reduced the mean energy of interaction between the molecules in the sucrose-water system.

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Formation of colouring matter during melanoidin formation. I. F. BUGAENKO and M. MUKHAMED. *Izv. Vuzov, Pishch. Tekh.*, 1973, (1), 162–163.—Spectrophotometric and gel filtration studies of glucose-glycine solutions buffered with phosphate and heated under reflux on a hot water bath for varying times showed that alkaline degradation products of the glucose played an important part by reacting with the glycine (representing amino-acids) to form melanoidins. A colorant solution obtained by heating glucose without glycine was used as control.

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Determination of conditions for sugar crystal fluidization in a supersaturated sucrose solution. E. E. SHUMSKAYA, V. D. POPOV and S. I. SIRENKO. *Izv. Vuzov, Pishch. Tekh.*, 1973, (1), 166–167.—Tests are reported on increasing the nucleation rate by allowing a sugar solution in a sealed circuit to come into contact with a bed of crystals subjected to fluidization as used for sugar drying. The experiments were carried out with mixtures of a narrow range of sieve sizes, whereas it is admitted that difficulties would arise with polydisperse systems covering a wide range of sieve sizes.

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Sample control room—Racecourse mill. L. K. KIRBY. *Cane Growers' Quarterly Bull.*, 1973, **36**, 122.—The system for sampling farmers' 1st expressed juice and cane for fibre at Racecourse is described and an illustration given of the equipment used in the main sample control room which is located above the cane carrier to permit a clear view of cane tipping and carrier operations. A teleprinter linked to the weighbridge automatically repeats all the truck identification data fed into a master machine by the weighbridge clerk, a continuous pH recorder calibrated from 4 to 6 units monitors the 1st expressed juice from No. 1 mill and thus indicates the cane freshness, while a continuous sample tracker automatically controls the timing and rate of juice sampling from the designated rakes of sample trucks and is linked to a specially designed automatic juice sampler in the laboratory adjacent to the sample control room.

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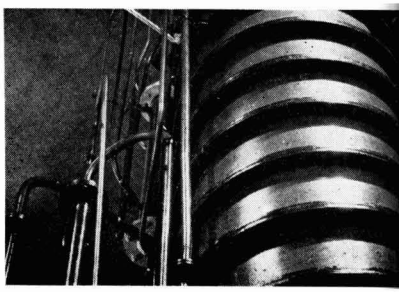
Gas chromatography—general. H. GRUSZECKA. *Gaz. Cukr.*, 1973, **81**, 63–66.—The fundamentals, equipment and procedure of gas chromatography are described, with particular attention being focused on column dimensions, charging and efficiency, retention time of the compounds under investigation, the effect of temperature and selection of carrier and detector.

[1] *I.S.J.*, 1974, **76**, 55.

By-products



Construction and start-up of a citric acid factory at Pelplinie (Poland). F. NOWAK and W. BARTOSZEK. *Gaz. Cukr.*, 1973, **81**, 6–9.—Processes and equipment at this new citric acid factory, which uses molasses from sugar factories in Gdańsk and Bydgoszcz provinces, are described.

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Change in the techno-chemical and microbiological parameters of molasses mash during sterilization. T. P. SLYUSARENKO, V. N. SHVETS and E. I. KNOGOTKOVA. *Izv. Vuzov, Pishch. Tekh.*, 1972, (6), 115–118. Since it has been found that bacteria die more rapidly in a wet than a dry medium, tests were carried out to determine the effect of molasses concentration on bacterial reduction in alcohol fermentation. By diluting the molasses to 50–60% dry solids before sterilization, melanoidin formation was reduced while the biological value of the molasses was maintained, and the efficiency of the subsequent thermal treatment was enhanced, more so than by increasing the molasses temperature. Complete sterilization was obtained by heating for 1–3 minutes at 110–130°C.

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Method of operational control of "amido" pulp production. Z. O. ZINGEL' and E. A. KIRUTA. *Sakhar. Prom.*, 1973, (3), 54–55.—Details are given of an analytical method for checking the distribution of ingredients in a mixture of beet pulp, urea and molasses used as animal fodder. Based on the fact that the urea-molasses solution in freshly prepared fodder lies on the surface of the pulp, the method involves dissolving 2 g of fodder, filtering and determining the optical density of the filtrate. The method is rapid, and values agree closely with Kjeldahl nitrogen values.

* * *

How to preserve sugar beet pulp. A. DEVUST, R. ARNOULD, A. MOREELS, M. MARTENS and P. H. VERSTRAETE. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1972, 149–159.—Tests showed that it is preferable to store pulp for use as animal fodder separately from beet tops and leaves in order to reduce losses. The most suitable means is storage in watertight concrete silos, or previous dehydration to avoid fermentation.

* * *

Environmental factors affecting the activity of ammonifying micro-organisms in the treatment of distillery waste. D. S. DAHIYA and K. A. PRABHU. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G35–G39. Organic materials in distillery waste may be converted into simpler compounds by suitable micro-organisms, thus reducing the pollution load resulting from such wastes. Suitable ammonifying bacteria were cultured and the effects of a number of factors on their growth examined; volatile acids, metallic ions and ash concentrations had no appreciable effect on the ammonification process which is favoured, however, by completely anaerobic conditions, as well as by the presence of glucose, sucrose and raffinose as carbon sources and by yeast protein and peptone as nitrogen source.

* * *

Studies on the utilization of carbon dioxide from a distillery in the preparation of carbonates. II. D. L. N. RAO and A. GHANI. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G49–G52.—Plant costs are given for the manufacture of pure precipitated chalk from milk-of-lime using distillery fermentation gas as the source of CO_2[1]. The economics of the process are discussed.

* * *

Treatment of distillery waste by nitrifying bacteria. K. A. PRABHU and G. PRAKASH. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G57–G60. Nitrifying bacteria were isolated from biomanure and garden soil, purified by enrichment culture and acclimatized to organic matter loading using ammonified distillery spent wash in several passages. Pollution removal was found to be 65–70% over a period of 7 days.

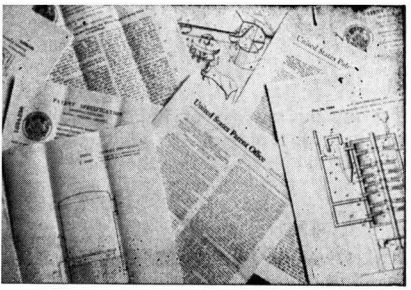
* * *

Manufacture of food, fodder and bakers' yeast. K. A. PRABHU, A. K. NIGAM and G. PRAKASH. *Proc. 38th Ann. Conv. Sugar Tech. Assoc. India*, 1972, G61–G66. A process is described for yeast production by cultivating a strain of *Torula* on cane molasses which had been clarified, diluted and fortified with nutrients. After aerobic fermentation, the wash is centrifuged or filtered to give a compressed yeast which may then be dried for use as food or animal fodder.

* * *

Coefficients of friction of a mixture of dried pulp, molasses and urea. M. G. PARFENOPULO and N. E. KARAULOV. *Sakhar. Prom.*, 1973, (4), 36–38.—Coefficients of friction of pulp-molasses-urea mixtures (to be used as animal fodder) on surfaces of various materials have been determined as a function of the molasses and urea contents and the values tabulated for use in calculating drying, transport, mixing and briquetting parameters.

[1] *I.S.J.*, 1973, **75**, 290.



Patents

UNITED KINGDOM

Agglomerable sugar composition. CPC INTERNATIONAL INC., of Englewood Cliffs, N.J., USA. **1,286,275.** 7th October 1969; 23rd August 1972.—An agglomerable sugar composition comprises a crystalline sugar (dextrose, sucrose, lactose or a mixture of these) with 1–10% (2–4%) of a starch hydrolysate (with a moisture content of <5%) having a dextrose equivalent of 5–25 (10–13, 10–15) and a descriptive ratio of at least 2. Ctiric acid, magnesium stearate and an artificial flavouring agent may be incorporated.

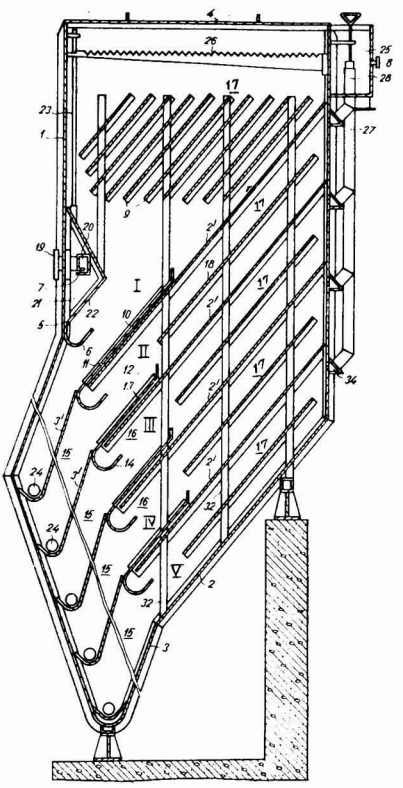
* * *

Improved structural member. TATE & LYLE LTD., of London E.C.3, England. **1,286,469.** 27th May 1969; 23rd August 1972.—A two-stage process for producing board in the form of structural members comprises, first, distributing a dry, heat-hardenable resinous binding agent (a synthetic phenol-formaldehyde novolak resin with hexamine as a catalytic hardener), having a melting point lower than the temperature at which hardening of the resinous binding agent occurs, in powder form uniformly through a mass of fibrous material (bagasse, comminuted in a rotary mill having mesh sizes of 3/16—1 inch) so that the binding agent is present in an amount of 7–20% by weight of fibre. The mixture is formed into a mat and subjected to dielectric heating (for 2–4 min) to raise the temperature of the resin to a point where it fuses but does not start to cure to any appreciable extent (70–95°C). The mat is cooled without compression, when the fibres are bonded together to give a "green board". In the second stage this green board is placed in a press and subjected to sufficient heat to cure the resin (to 110–150°C) while also being moulded into the required, e.g. corrugated, shape.

* * *

Clarifier. SEPARA BRNO, of Brno, Czechoslovakia. **1,287,360.** 22nd May 1970; 31st August 1972.

The clarifier is divided into compartments I – V by a series of baffles 2′, 3′ which are parallel with the lower surfaces 2, 3 but are linked by a series of further baffles 10 having a vertical upper section 12 and a curved lower section 14; the baffles 10 are mounted slightly above baffles 2′ providing a series of channels 11 connecting adjacent compartments. Further sloping baffles 9, 18 are located in the compartments and withdrawal means 24 for mud are located in the bottoms of the sumps 15 of the compartments.



Muddy feed enters the clarifier through port 19 and is evenly distributed by means of pipe 20 and channel 7 into deaerating compartment 21 formed by plates 22. The change in flow speed permits separation of entrained air which rises through pipe 23 and is discharged above the liquid level in the clarifier. Mud sedimentation speed is higher than the juice upward movement speed so that it falls on the baffles and slides down into the sumps and is removed. Clear

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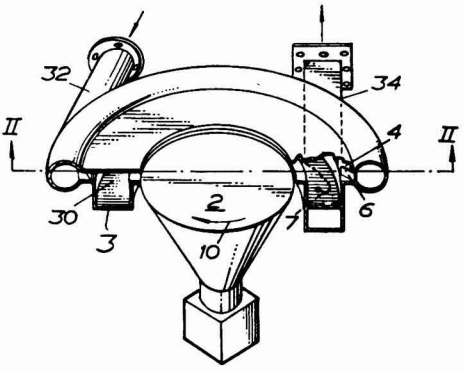
juice overflows at the top of each compartment and over the baffle 26, entering the pipes 27 leading to control box 25 from which it goes to process.

* * *

Production of sucrose (from deteriorated cane). TATE & Lyle LTD., of London E.C.3, England. **1,290,694.** 12th November 1969; 27th September 1972.—During the production of sugar from cane, dextranase [active between pH 4·5 and 7·0 (4·5 and 6·0) and from 25 to 55°C (40 to 50°C)] is added at a point where process conditions are such that the dextranase can degrade dextran present. The dextranase (or mixture of dextranases) is specific for the dextrans present and is produced by a suitable micro-organism in the presence of dextran as sole carbon source. It is added (at 1–50 I.U. per 100 ml) to raw juice [for at least 5 minutes (10–30 min)] before heating and liming and may be preceded by heating to 40–50°C. Dextranase may alternatively be added during the process of refining raw sugar containing dextran and may be added also to the recovery syrup. The enzyme may be added as an aqueous solution or in solid form on a carrier.

* * *

Discharge of solid particles (low-grade sugar crystals) from centrifugals. THOMAS BROADBENT & SONS LTD., of Huddersfield, Yorkshire, England. **1,293,761.** 16th November 1968; 25th October 1972.—Surrounding the frustro-conical basket 10 of a continuous centrifugal is an annular chamber 3 into which discharges sugar crystals which climb over the top of



basket 10. Surrounding the chamber 3 is a toroidal-shaped manifold linked to the chamber by a narrow annular passage 4 in which are located plates 6 at an angle to the appropriate radius. Air entering the manifold through pipe 32 is directed by the plates 6 into the chamber directly against the crystals, thus reducing their speed and the danger of damage.

* * *

Citric acid fermentation. PFIZER INC., of New York, N.Y., USA. **1,293,786.** 19th April 1971; 25th October 1972.—A citric acid-producing strain of *Candida* (*C. guilliermondii* ATCC No. 9058) is cultivated in an aqueous nutrient medium containing carbohydrate, e.g. cane molasses, the accumulation of citric acid being increased by the addition of at least 100 p.p.m. w/v on *n*-hexadecyl citric acid or *trans*-aconitic acid.

* * *

Centrifugal basket. MASCHINENFABRIK BUCKAU R. WOLF AG., of Grevenbroich, Germany. **1,294,939.** 25th March 1970; 1st November 1972.

The effect of stresses on the basket shell 1 of the batch-type centrifugal are reduced by the use of elliptical holes 4 around the shell and over most of its height, round holes being provided (5, 6) at the top and bottom. The proportions of the stresses are

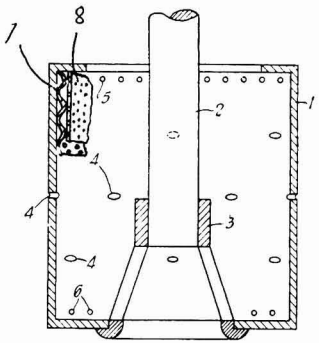


FIG.1

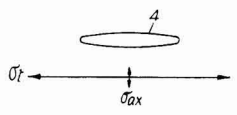


FIG.2

indicated at δ_t and δ_{az}, and it may be seen that the axial component is negligible so that the design can be such as to accommodate the tangential stresses only. The semi-axis ratio of the ellipses is greater than 1:5 (1:10) and the holes are formed by electro-chemical erosion.

* * *

Molasses feed mixtures. KNAPSACK AG., of Knapsack-bei-Köln, Germany. **1,295,571.** 1st January 1971, 8th November 1972.—Dried feed, e.g. bran, is mixed with molasses before, during or after addition and mixing with [3–75% (5–25%) on molasses of (particles less than 0·06 mm of)] CaO and/or $Ca(OH)_2$, alone or mixed with MgO and/or $Mg(OH)_2$.

* * *

Fatty acid sucrose esters. DAI-ICHI KOGYO SEIYAKU Co. LTD., of Kyoto, Japan. **1,295,721,** 5th February 1970; 8th November 1972.—A process is claimed for the purification of a sucrose ester from a crude reaction mixture containing 10–80% of ester and 5–40% of an anionic surface-active agent as well as unreacted substances. The mixture is dissolved or

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dispersed in (5–18 times its weight of) a solution of (3–10 parts of) an organic solvent (e.g. methyl ethyl ketone, petroleum ether, ethyl acetate, etc.) with (2–8 parts of) water, to form a system. To this an acid or acid salt is added to lower the pH to 3·5–5·0, and the sucrose ester recovered in the organic liquid layer together with the acidified surface-active agent. Alternatively a salt or hydroxide of a metal having a valency of at least 2 (Al, Ba, Ca, Mg, Zn, Cu, Ag, Sn or Co) (bleaching powder) is added to the system (at <70°C and at pH 6–10) to form a salt by double decomposition, the salt then being removed to recover the sucrose ester. Alternatively (the water content of the system is reduced to <50% and) a water-soluble substance (a saccharide) added (at —20° to +60°C) (at 50–100°C) to precipitate the sucrose ester.

* * *

Process for desalinating sugar solutions. TAITO K.K., of Tokyo, Japan and ASAHI KASEI KOGYO K.K., of Osaka, Japan. **1,296,244.** 7th July 1970; 15th November 1972.—A sugar solution is subjected to electrodialysis between a cation perm-selective membrane and a non-selective ion-permeable membrane having a cation or anion exchange capacity of less than 0·3 meq/g of dry membrane. The sugar solution is passed as a dilute stream through a dilution compartment formed on the cathode side of each of a number of non-selective membranes, while an electroconductive concentration stream (e.g. NaCl, Na_2SO_4 solutions or sea-water) is passed through a concentration compartment formed on the cathode side of each of a number of cation perm-selective membranes arranged alternately with the non-selective membranes. A number of additional anion perm-selective membranes may be interposed between the other membranes and an electro-conductive rinse stream (NaCl, Na_2SO_4 solutions or sea-water) passed through the middle compartments formed on the anode side of each of the non-selective membranes.

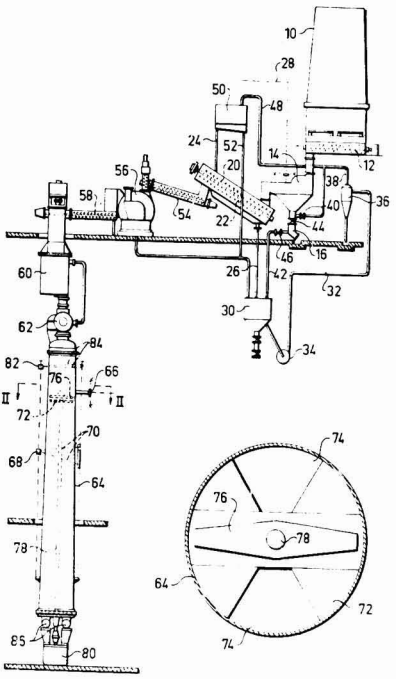
* * *

Beet harvesters. S. A. HERRIAU, of Cambrai (Nord), France. **1,298,208.** 3rd December 1969; 29th November 1972.

* * *

Bagasse pulp production. R. B. REINHALL, of Lidingo, Sweden. **1,298,745.** 22nd January 1970; 6th December 1972.

Raw material is delivered from hopper 10 by conveyor 12 to a separator 14 in which it is mixed and agitated with a solution of cooking chemicals; the heavier particles of e.g. sand fall to the bottom and are discharged through pipe 16 while the floating raw material overflows to the dewatering device 20 in which it is raised by a screw 22 while being washed with a counter-flow of chemicals in solution admitted through pipe 24. The solution drains into a container 30 where foreign matter is collected before the solution is recirculated to separator 14 and pipe 24 by way of pump 34, cyclone 36 and screen 50.



The washed and chemical-impregnated raw material is delivered to the conveyor 54 feeding a press 56 in which the moisture content is reduced and the drier material is carried by conveyor 58 to a bin 60 from which it is fed by distributor 62 into the digester 64. Steam is admitted into this through several conduits 66 to maintain a pressure of 6–10 kg.cm^{-2} and a corresponding temperature for pulp production. The digester has a partition 72 at its upper end with openings 74 through which the bagasse can fall under the action of a scraper 76 carried by the vertical shaft 78 driven by motor 80. A layer of pulp is maintained between the limits 84 by a controller 82 and is initially heated by steam before it falls through the gaps 74 in partition 72. This is achieved by the operation of scraper 76 under the direction of a controller 68 which maintains a level of material within the digester between the limits 70. After digestion is complete the pulp is withdrawn from the digester through discharge ports 86.

* * *

Extraction of cane juice. T. M. HAMILL, of Kailua, Hawaii, USA. **1,300,683.** 19th April 1971; 20th December 1972.—Bagasse from a mill in a tandem is subjected to a low pressure [50–800 p.s.i. (300–500 p.s.i.); 5–30% (10%) of the subsequent high pressure] which expresses a part of the imbibition liquid and natural juice it contains without rupturing any cells. The pressed bagasse is macerated with an imbibition liquid and subjected to high pressure (2000–5000 p.s.i.) in the subsequent mill which ruptures cells as

well as expressing juice and imbibition liquid. The liquid expressed by each low-pressure treatment is passed as imbibition liquid to a preceding low-pressure treatment, while that expressed by a high-pressure treatment is passed as imbibition liquid to a previous high-pressure treatment.

* * *

Sugar product. SOUTH AFRICAN SUGAR ASSOCIATION, of Durban, Natal, South Africa. **1,300,693.** 19th April 1971; 20th December 1972.—The polarization of a high-pol raw sugar for refining is reduced to 97–99·5 by mixing it with 0·1–4% of invert syrup in the form of fully or partially inverted raw sugar solution, raw syrup, *A*-molasses, *B*-molasses, final molasses or high-test molasses.

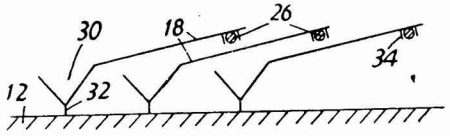
* * *

Beet harvester. UKRAINSKY NAUCHNO-ISSLEDOVATELSKY INSTITUT SELSKOKHOZYAISTVENNOGO MASHINOSTROENIA, of Kharkov, USSR. **1,301,209.** 9th December 1970; 29th December 1972.

* * *

Juice distributor for thin-layer evaporator. SOC. FIVES LILLE-CAIL, of Paris, France. **1,302,623.** 30th September 1970; 10th January 1973.

Above the upper tube-plate 12 of a descending-flow thin-layer evaporator is a feed arrangement to ensure uniform distribution of juice over the whole heating surface which thus gives maximum evaporation and minimum thermal juice damage. The device comprises a series of overlapping plates 18, the upper ends of which are located by U-brackets 34 on radial supports 26 which are part of an annular frame mounted above the tube-plate. At the lower ends of the plates 18 are bends which form a trough 32, the ends being closed by triangular plates.



Juice is delivered from an entry pipe into an annular trough resting on the framework and overflows onto the upper surfaces of the plates 18. It runs down the plates and collects in the troughs 30, overflowing through indentations along the length of the lower edges and so passing uniformly over the radius of the tube plate.

* * *

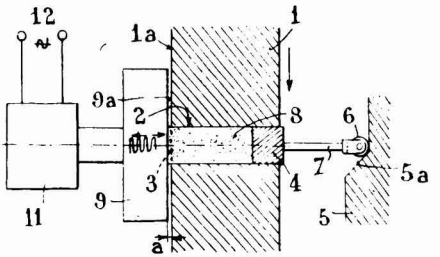
Beet harvester. SVENSKA SOCKERFABRIKS AB., of Malmö, Sweden. **1,303,716.** 23rd October 1970; 17th January 1973.

* * *

Method of separating fructose and glucose. R. TATUKI, of Goshogawara, Aomori, Japan. **1,304,483.** 19th April 1971; 24th January 1973.—See US Patent 3,671,316[1].

Moulding sugar tablets. GÉNÉRAL SUCRIÈRE S.A., of Paris, France. **1,305,740.** 24th July 1970; 7th February 1973.

The support 1 includes a number of moulds 2 into which sugar 8 is filled. The support moves to a position whereby the open end 3 is faced by a stop member 9, the clearance being of the order of 0·2 mm, and the sugar is then compressed by the action of



piston 4 which is moved into the mould 2 by the cam 5, cam-follower 6 and rod 7. Simultaneously, the stop member 9 is subjected to ultrasonic vibrations of frequency >20,000 Hz and amplitude about 0·15 mm; the vibration and compression produce a compact moulded tablet. The mould and support mechanism may be flat or in a rotary mechanism.

* * *

L-glutamic acid fermentation. AJINOMOTO CO. INC., of Tokyo, Japan. **1,306,843.** 3rd March 1970; 14th February 1973.—A suitable micro-organism (a *Brevibacterium*, *Corynebacterium* or *Micrococcus* bacterial strain) is cultured on a nutrient medium containing an assimilable carbon source, e.g. cane molasses, glucose, an assimilable nitrogen source, e.g. ammonium acetate, and organic and inorganic nutrients, under aerobic conditions, in the presence of (⩾5 g/litre of) an anti-oxidant and an antifoam agent.

* * *

Crystallization of glucose and fructose. TEIKOKU HORMONE MANUFACTURING CO. LTD., of Tokyo, Japan, and JAPAN CHEMURGY CO. LTD., of Yokohama, Japan. **1,308,174.** 26th June 1970; 28th February 1973.—Dextrose and levulose are crystallized (at —20°C to 70°C) from a solution containing them, in the presence of (20–99% of) a liquid polyhydric alcohol (glycerin, propylene glycol or ethylene glycol) and (1–80% of) a liquid monohydric alcohol [of formula $C_nH_{2n+1}OH$ where $n = 1$–5 (ethanol)], the combined weight of alcohols being 0·1–20 times the weight of sugars present. The mixture of sugar solution and polyhydric alcohol is concentrated (at ⩾100°C) until its water content is ⩾15% of the sugar present and ⩾5% of the entire solution; the monohydric alcohol is added and the crystallization performed. Alternatively both the alcohols may be added to the solution of sugars to give a supersaturated solution which is then seeded with dextrose or levulose to crystallize the sugars (at 0–50°C). The dextrose is crystallized before the levulose.

[1] *I.S.J.*, 1973, **75**, 291.

Sugar Industry Technologists, Inc.

33rd Annual Meeting, 1974

The 33rd Annual Meeting of Sugar Industry Technologists, Inc., will be held in the Hyatt Regency Vancouver Hotel in Vancouver, B.C., Canada, during the 5th–8th May 1974.

Programme Chairman J. A. METZLER (Godchaux-Henderson) is making the final selection of the ten Technical Papers to be presented.

Mr. STANLEY E. GEORGE, General Superintendent of British Columbia Sugar Refining Co. Ltd., and Chairman of the Local Arrangements Committee has arranged an attractive and interesting programme of events.

The Symposium subject this year will be "The Energy Crisis", a topic of immediate and paramount interest to the sugar refining industry, to be chaired by Mr. GEORGE FAWCETT (Savannah) and moderated by Mr. KENNETH R. HANSON (Amstar).

The Meade Award Plaque (along with a cash honorarium) will be presented by STEPHEN STACHENKO, Chairman of the Award Committee, to the authors of the "Best Paper" given at the 32nd Annual Meeting in Miami Beach, Florida, viz. "A New Automatic Defecation-Decolorization Station Using the Talofloc Process," by A. E. NORCOTT, C. V. RICH and J. T. RUNDELL, of Tate & Lyle Enterprises Ltd.

The late F. A. Seaford.—It is with great regret that we have to report the death of TONY SEAFORD, Director of Sugar Technology for Fletcher and Stewart Ltd. and U.K. Regional Vice-Chairman of the International Society of Sugar Cane Technologists. Born in 1921 at Uitvlugt Sugar Estate in the then British Guiana, where his father was Chief Engineer, he was educated at Repton and went on to take his M.A. at Cambridge. He served in the Royal Electrical and Mechanical Engineers and in 1947 joined Booker Bros. McConnell & Co. Ltd. as Factory Engineer at Enmore where he later became Chief Engineer. In 1949 he was made Assistant to Bookers' Technical Adviser in Georgetown and in 1952 became Chief Technical Superintendent of Bookers Sugar Estates Ltd., two years later becoming Technical Director. In 1958 he was appointed Managing Director of Demerara Sugar Terminals Ltd., concerned with the design and construction of the new sugar terminal at Georgetown. He left Guyana in 1961 to join Fletcher and Stewart Ltd. where he was particularly concerned with the design of sugar machinery. In 1968 he became a Director of Bookers Agricultural and Technical Services Ltd., the consultancy division of the Booker Group, and subsequently travelled a great deal expanding his wide circle of friends in the sugar industry by whom he will be sadly missed, particularly at the June Congress of the ISSCT of which he had been an active member for a considerable time.

* * *

Trinidad sugar production, 1973[1].—Sugar production in Trinidad amounted to 183,738 long tons in 1973 in comparison with 230,888 long tons in 1972, which represents a decrease of about 47,000 tons. As a consequence, sugar exports during the first half of 1973 were reduced to 144,019 tons as against 170,952 tons in 1972.

* * *

New Brazil sugar factories[2].—The Instituto do Açúcar e do Alcool (IAA) has invited offers for the installation of sugar mills at Manaus and near Cariri (Ceará) at a total cost of 200 million cruzeiros ($32,000,000).

Brevities

Fletcher and Stewart Ltd. contract for Sudan project.—A £15,500,000 contract was signed in December whereby Fletcher and Stewart Ltd. are to build a complete new 6500 t.c.d. sugar factory as part of the North West Sennar Sugar Scheme some 300 km south of Khartoum in the Sudan. Civil construction work started in January and planting of cane in the establishment of the agricultural development has begun. Completion of the factory is due in March 1976 and within 8 years of operations commencing it is expected that the cane area will have been increased from 8600 acres to about 22,000 acres, by which time the factory should be producing 153,000 metric tons of white sugar per year. The contract is the largest ever won by Fletcher and Stewart and is their seventh for a complete new factory in the past five years.

* * *

Angola sugar imports from Mozambique[3].—Sugar production in Portuguese West Africa is around 70,000 tons per year. Whilst in previous years there has usually been a surplus for export, internal consumption, particularly for the country's industrial needs, is now so high that local production has not been able to satisfy even the home market. It has been necessary, therefore, to start importing from Portuguese East Africa. A contract for 24,000 tons was recently signed, of which 10,400 tons is destined for the Luanda area and the remainder for the central and southern regions.

* * *

British Sugar Corporation Ltd. headquarters move.—The headquarters of the British Sugar Corporation Ltd., in which the UK Government has a one-third interest, has been moved from London to the enlarged Central Offices in Peterborough. With Britain's membership of the EEC there have been changes in the beet sugar industry and it is thought the change will improve efficiency, including relations with the farmers under contract to supply beet for the Corporation's 17 factories. The Sales Department of B.S.C. will remain at Tower Place in London.

* * *

Jamaican sugar development plan[4].—A six-point plan to restore Jamaican sugar production to 450,000 tons a year within the next three years has been jointly arrived at by the island's Government and the sugar industry. As announced by the Minister of Industry, the plan is as follows: all unused cane lands are to be returned to cultivation; greater production of cane from existing cultivation; improved water supply for irrigated cane fields; more group activity by cane farmers in the areas of harvesting and transport of cane; a greater per centage of clean cane to be delivered to the factories; and the improvement of labour productivity in the reaping of cane. The Prime Minister told a meeting of sugar technologists in Mandeville that the industry was in grave danger of running out of profitable markets because of the increasing cost of production of sugar in Jamaica.

* * *

Caroni Ltd. 1972/73 report.—Prolonged drought, the worst in over 50 years, was experienced throughout the Caribbean and resulted in sugar production shortfalls in Trinidad and other countries of the area. Rainfall was only 42 inches and there was a reduction of about 520,000 tons in cane production. In 1973 sugar production was 165,412 tons compared with 206,013 tons in 1972. A further serious financial loss is anticipated as a result of the effects of the 1973 drought on the 1974 crop, in respect of reduced cane growth.

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[1] F. O. Licht, *International Sugar Rpt.*, 1973, **105**, (30), 7.
[2] *Bolsa Review*, 1973, 7, 550.
[3] *Standard Bank Review*, November 1973, 22.
[4] *W. Indies Chron.*, 1974, **89**, (1512), 9.

Brevities

Fives-Cail Babcock.—In December 1973 an Extraordinary General Meeting of Fives Lille-Cail S.A., decided to approve the investment of all its assets, rights and obligations into a new Company, Société Fives-Cail Babcock, which also took over the assets and liabilities of Société Babcock-Atlantique. This merger combines the industrial facilities of the two companies which were the main two subsidiaries of the financial company formed in 1970 by the merger of the parent companies of the two industrial concerns. Readers will have observed the new title in the FCB advertisements in this Journal during 1974.

* * *

New Indian sugar factory[1].—It is reported that the sugar factory under erection at Kichha, Naini Tal district, will start operation from the 1973/74 crushing season.

* * *

Turkey sugar expansion[2].—It has been announced that five new sugar factories are to be built in Turkey during the next three years. One is to be at Afyon and another at Mus; the locations of the other three have not yet been decided.

* * *

Brazilian sugar factory for Zaire[3].—Brazil is to build and deliver to Zaire a $14 million sugar factory to be built by a consortium of three Brazilian firms, with an annual capacity of 30,000 metric tons of sugar and 6 million litres of alcohol.

* * *

Belize sugar production, 1973[4].—Sugar production in Belize reached a record total of 70,170 tons, or 203 tons higher than the 1972 output.

* * *

Bolivian sugar factory tender call[5].—The Association of Cane Growers of Santa Cruz has called for tenders for the construction of a 4000 t.c.d. sugar factory, a 350 gal/hour distillery, a 4 tons/day plant for manufacture of dry yeast, and a dry ice plant.

* * *

USSR beet crop, 1973[6].—According to recent information from the Soviet Union the quantity of beet harvested in 1973 amounted to 86·8 million tons compared with 76·4 million tons in 1972. There is usually a gap of around 8 million tons between the quantity harvested and that actually processed to sugar, however, and assuming that this occurred in 1973 it would mean a total slice of 78·5 million tons or 4·5 tons below the plan figure for 1973. On a basis of the average extraction rate of the previous five campaigns, 78·5 million tons of beet would yield 9·85 million tons, raw value, for 1973/74.

* * *

Jamaican import of Cuban sugar[7].—Jamaica imported 6000 tons of Cuban refined sugar in February to alleviate a growing domestic shortage. Insufficient production from the current local crop had obliged the Jamaican Government to ban all sugar exports in January until supply could cover domestic requirements. The shipment is on a deferred exchange basis and the Sugar Industry Authority will not be required to pay for it; instead it would remain on Cuban credit and, when local 1974 production meets demand, a similar amount will be returned to Cuba or a destination of Cuban choice. It was difficult and at times impossible to buy sugar in stores in Kingston during January and negotiations had been started to obtain a supply from Canada but these proved abortive. The shipment of Cuban sugar would have cost 2½ million Jamaican dollars (about £1,250,000) if it were paid in cash.

Brazil sugar exports[8].—The Brazilian Instituto do Açúcar e do Alcool has announced that in 1973 2,975,629 tons of sugar were exported in comparison with 2,637,522 tons in the previous year. Authorized sugar production in 1974/75 is said to be somewhat below 8 million tons and exports in 1974 are expected to be even higher.

* * *

Indonesian sugar industry rehabilitation loan[9].—An International Development loan of 50 million dollars is to be applied to the modernization of nine Government-owned sugar factories in Java. The total cost of the project will be $80,000,000 and it is hoped that the investment will give an increase of 200,000 tons in sugar production by 1978.

* * *

New Honduras sugar factories[10].—Negotiations are being undertaken for the delivery of a sugar factory by Brazil to Honduras, to start operation in 1975 with an initial capacity of 22,000 tons of sugar per year. A second factory having a daily crushing capacity of 3000–4000 tons is also planned.

* * *

Venezuela imports of sugar from Cuba[11].—Venezuela is to import 4000 tons of sugar from Cuba; although domestic production was satisfactory and supplies secured, speculators had caused an artificial shortage in trying to push up prices.

* * *

New cane sugar factory for Iran[12].—A cane sugar factory is to be erected at Dimcheh in the Province of Khuzestan. The annual capacity is put at 100,000 tons and a plant is to be erected nearby for conversion of the bagasse to paper pulp.

* * *

Zaire sugar development study[13].—Preliminary studies have been carried out by a Chinese Agricultural Mission on the feasibility of growing sugar cane in the Mwera valley, some 75 km north-west from Lumumbashi, and of establishing a sugar factory. The Compagnie Sucrière de Kaliba (SUCRAF) expected to increase its production of cane sugar to between 16,000 and 20,000 tons during 1973, as compared with 14,300 tons in 1972. Local production is still far short of demand.

* * *

New Brazilian sugar factory[14].—According to a report from the Ministry of Agriculture, a new sugar project by the Ometta Group, in Jaiba, in the north of the state of Minas Gerais, is to comprise a sugar cane plantation of 35,000 hectares as well as a factory, to start operation in 1975. During the first stage of the project the annual production of the sugar factory is to amount to 60,000 metric tons.

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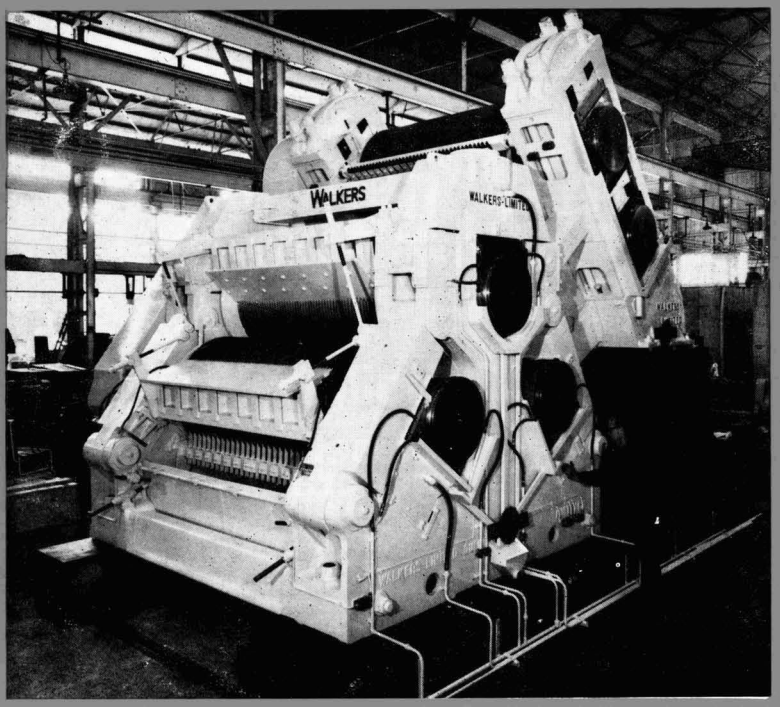
[1] *N.S.I. News*, 1973, **9**, (1), 3.
[2] *Consudel*, August 1973; through *Sucr. Belge*, 1973, **92**, 429.
[3] *Reuters Sugar Rpt.*, 16th October 1973.
[4] F. O. Licht, *International Sugar Rpt.*, 1973, **105**, (30), 7.
[5] *Amerop Noticias*, 1973, (1), 9.
[6] F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (3), 6.
[7] *The Times*, 2nd February 1974.
[8] F. O. Licht, *International Sugar Rpt.*, 1974, **106**, (3), 7.
[3] *Amerop Noticias*, December 1973, 17.
[10] F. O. Licht, *International Sugar Rpt.*, 1973, **105**, (33), 6.
[11] *Reuters Sugar Rpt.*, 21st November 1973.
[12] F. O. Licht, *International Sugar Rpt.*, 1973, **105**, (33), 7.
[13] *Standard Bank Review*, December 1973, 19.
[14] F. O. Licht, *International Sugar Rpt.*, 1973, **105**, (34), 10.



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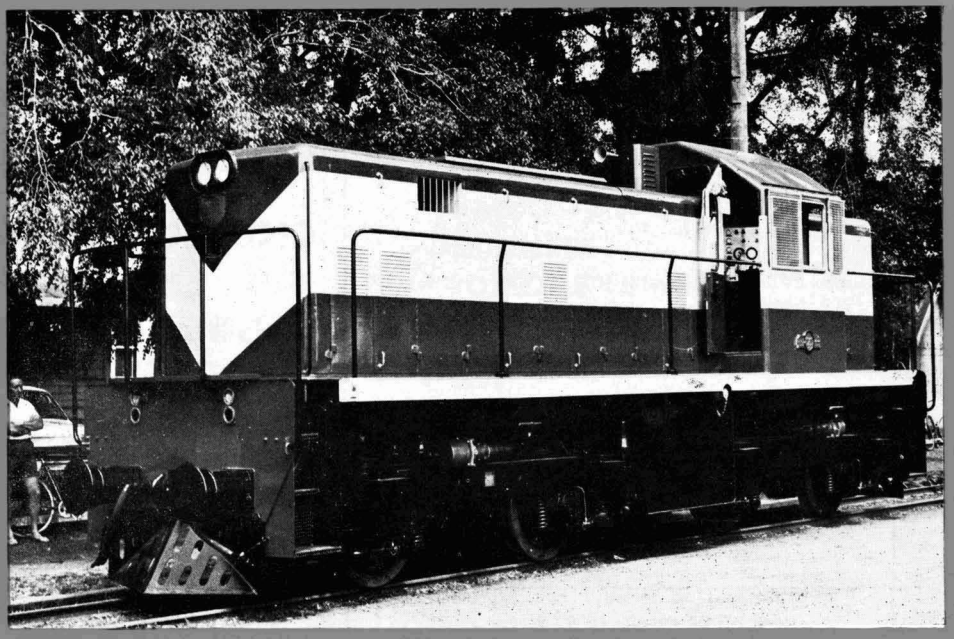

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Printed by JOHN ROBERTS & SONS, Salford, Manchester; and published by the Proprietors THE INTERNATIONAL SUGAR JOURNAL LTD., at 23a Easton Street High Wycombe, Bucks. Entered at the New York Post Office as Second-Class Matter.

PRINTED IN GREAT BRITAIN.