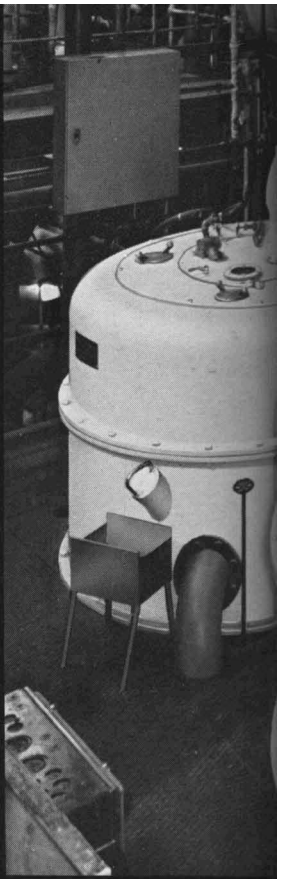
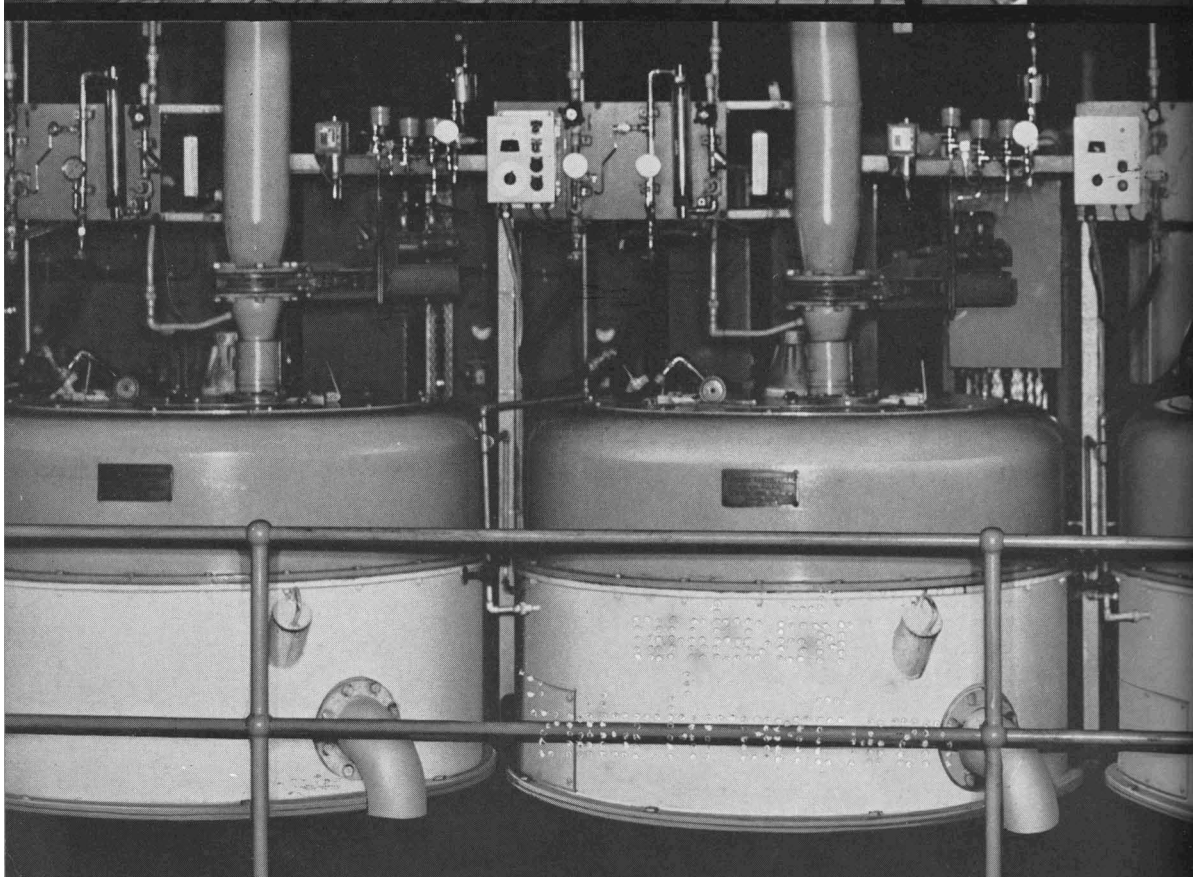
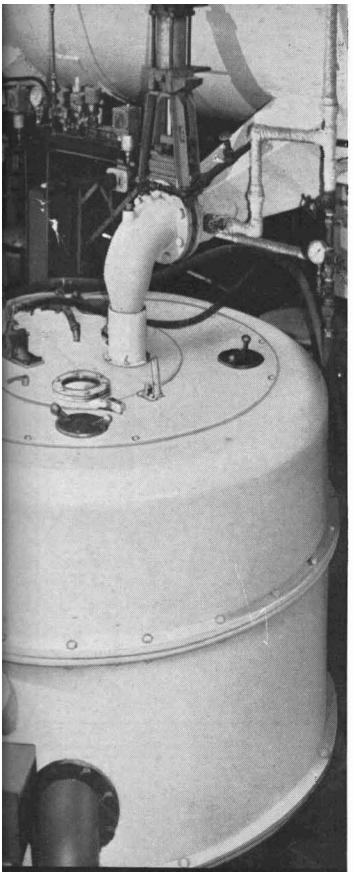
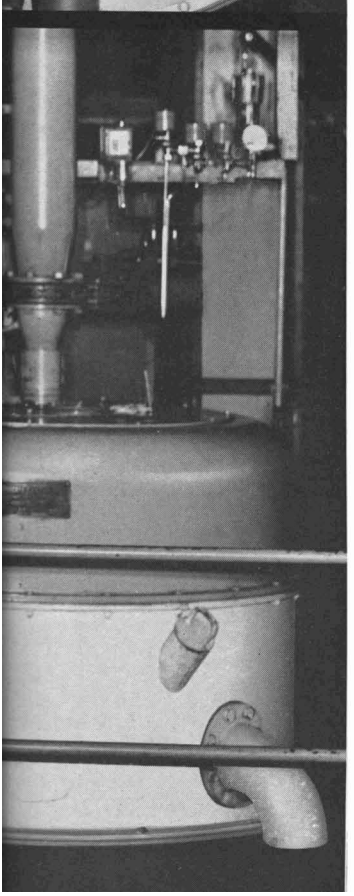
THE International Sugar Journal

OCTOBER 1970









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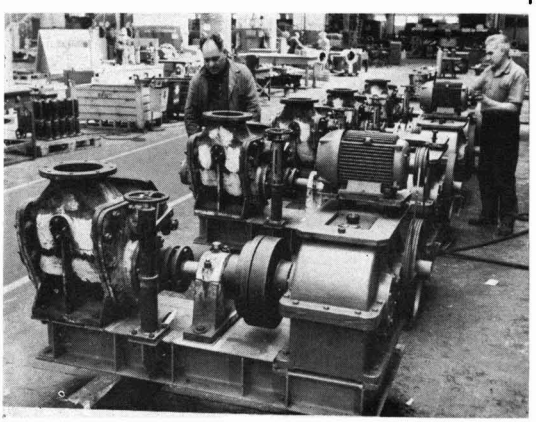
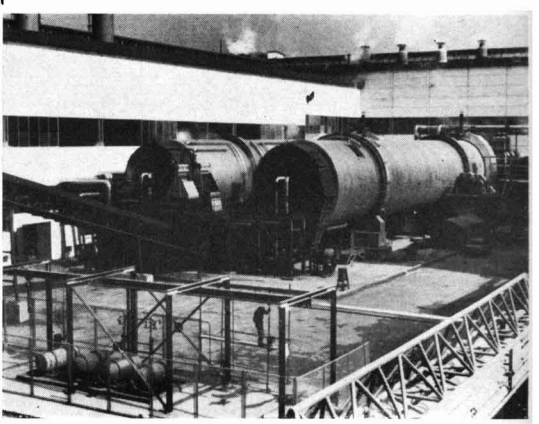


1. Assembly of massecuite pumps.



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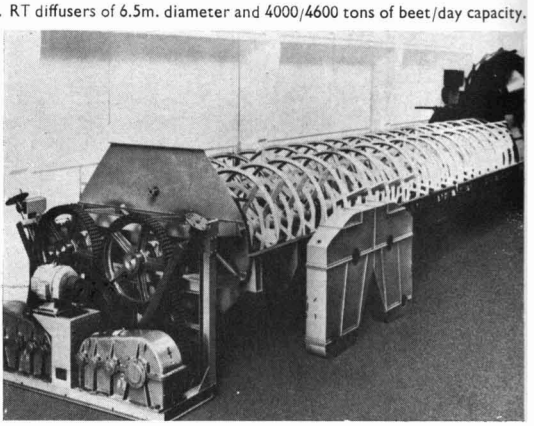

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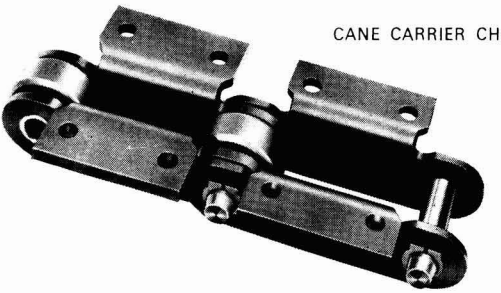
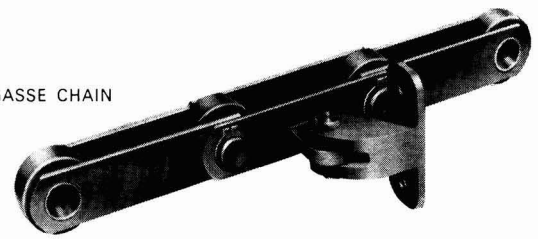


BAGASSE CHAIN



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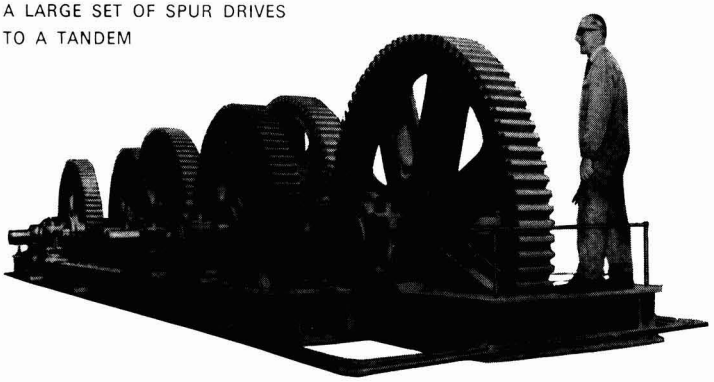

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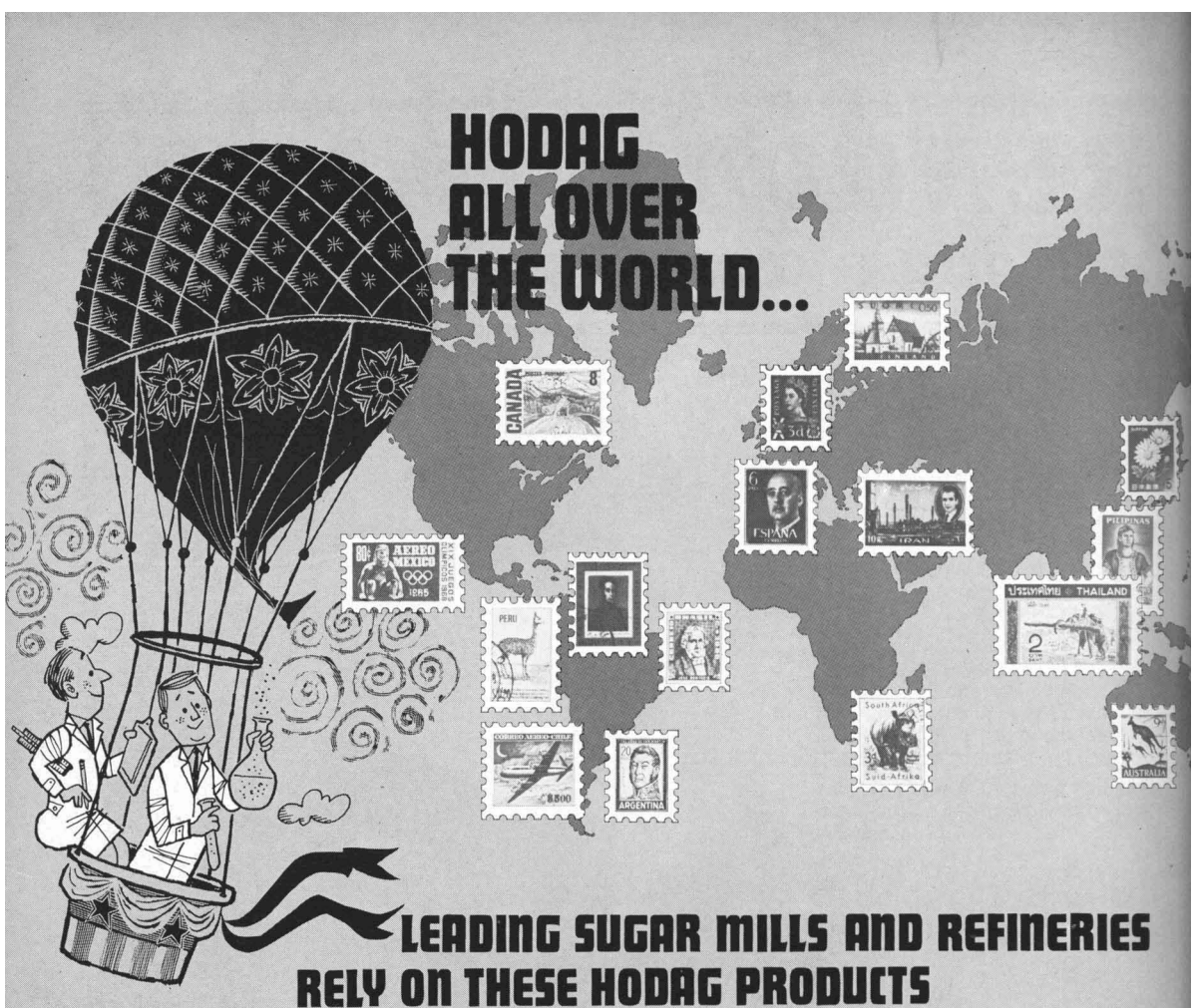

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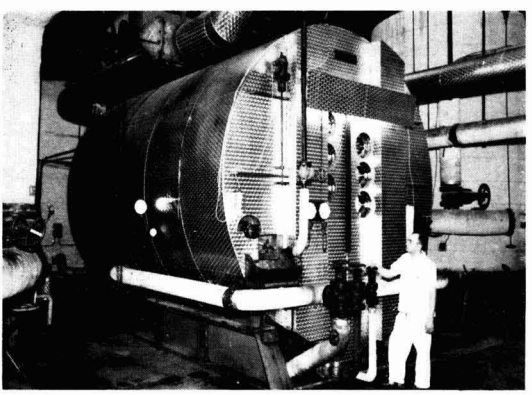
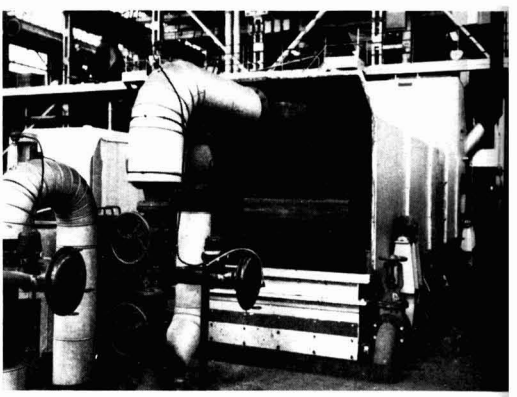
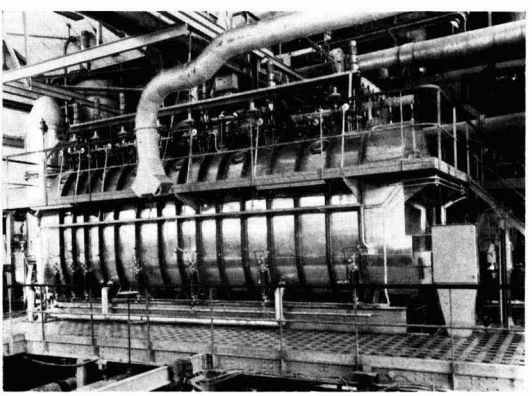


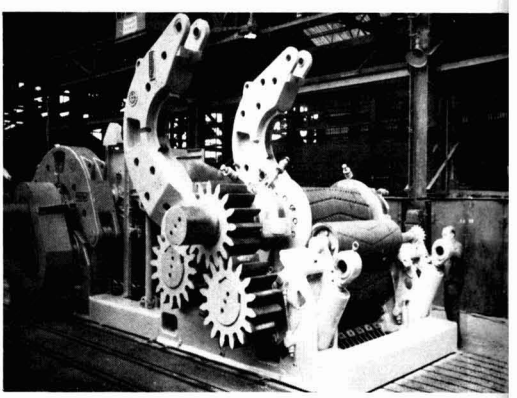
Horizontal vacuum pan with plate type heating element



Prescalder



Continuous vacuum pan



Self-setting cane mills (top housing members raised)

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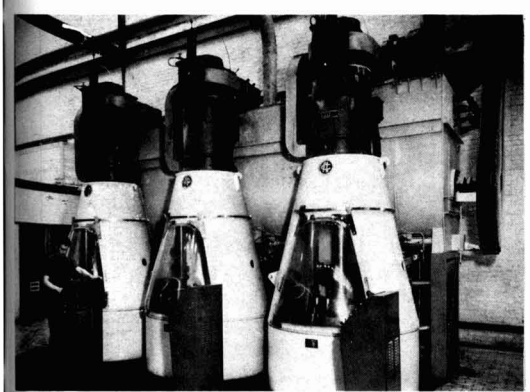

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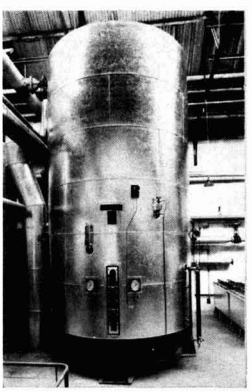
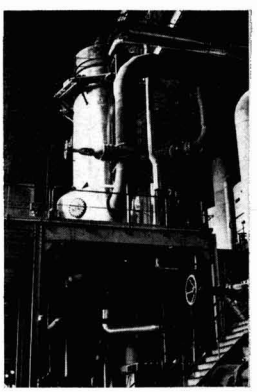
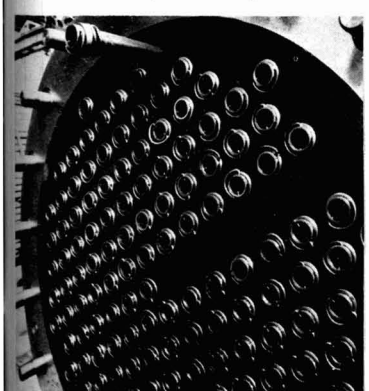


Annular space overflow evaporator



Falling film evaporator



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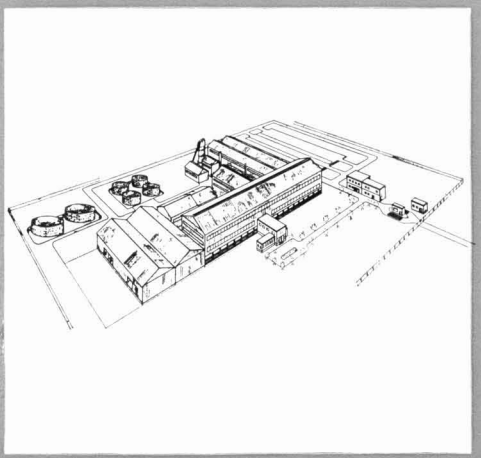

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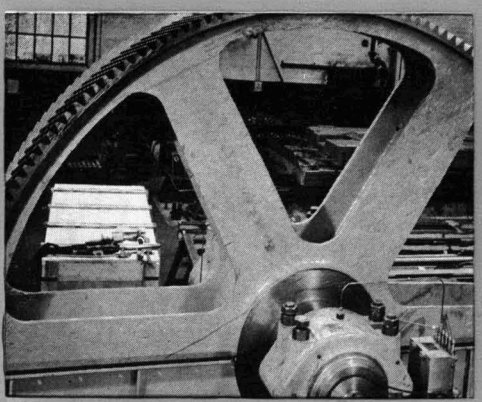

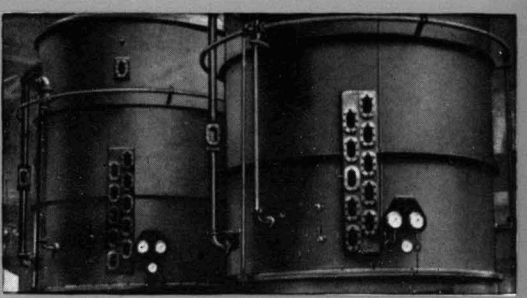

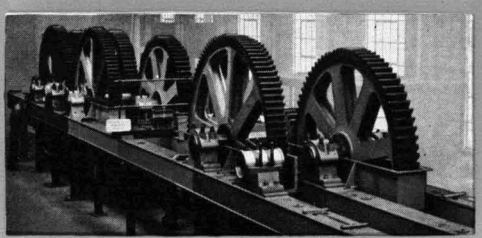

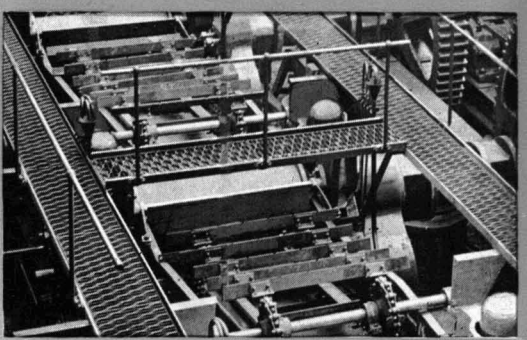

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International Sugar Journal

October 1970

Contents

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Extraction de la canne par broyage—approche moderne du problème. 1re partie. W. R. CRAWFORD. *p.* 291–298

L'auteur discute des points importants à prendre en considération en vue d'augmenter la capacité d'extraction des moulins à canne conventionnels mais en usant de méthodes susceptibles de répondre aux exigences modernes. Dans cette première partie, il considère brièvement les objectifs du broyage. Suit une discussion sur la préparation de la canne, en particulier les facteurs affectant la performance des broyeurs, et l'évaluation du degré de rupture des cellules.

* * *

Cause, prévention et mesure de la prise en masse du sucre raffiné—revue. 2e partie. D. F. BAGSTER. *p.* 298–302

On considère les facteurs affectant la prise en masse du sucre raffiné, comprenant l'humidité et la température, la dimension des particules, la compression et la densité de la masse, les additifs, la granulation, et le mouvement des grains de sucre. Suit une discussion sur le conditionnement du sucre en vue d'éliminer l'humidité liée et d'éviter ainsi une prise en masse importante du sucre lors de l'emmagasinage ou du transport.

* * *

Recherche sucrière chez Tate & Lyle. 2e partie. *p.* 303–304

Cette partie du rapport annuel condensé traite de la recherche sucrière, comprenant la décoloration des liqueurs de sucre par des agents tensio-actifs, en particulier en liaison avec la phosphatation ou la carbonatation; l'emploi de résines échangeuses d'anions pour la décoloration des liqueurs; l'analyse de rhum et d'alcool industriel; l'évaluation du charbon actif; les investigations sur les causes et la prévention de la conglomération des cristaux au cours de la cuisson; et divers aspects microbiologiques en particulier, la production de protéines au départ de microorganismes cultivés sur un substrat d'hydrates de carbone et le problème de la détérioration de la canne coupée.

Zuckerrohrextraktion mit Hilfe von Mühlen. Teil I. W. R. CRAWFORD. *S.* 291–298

Der Verfasser diskutiert die hauptsächlichen Gesichtspunkte für die Verbesserung der Extraktion bei den konventionellen Rohrmühlen unter Verwendung von Methoden, die darauf abgestellt sind, den modernen Anforderungen zu entsprechen. Im ersten Teil dieser Arbeit wird kurz der Zweck des Mahlens behandelt. Dann folgt eine Diskussion der Rohraufbereitung, insbesondere der Faktoren, welche die Leistung der Shredder beeinflussen, und der Ermittlung des Ausmasses des mechanischen Oeffnens der Zellen.

* * *

Ursache, Verhinderung und Messung des Zusammenbackens von Raffinade—ein Übersicht. Teil II. D. F. BAGSTER. *S.* 298–302

Es werden die Faktoren behandelt, die das Zusammenbacken von Raffinade beinflussen, einschliesslich Luftfeuchtigkeit und Temperatur, Teilchengrösse, Pressung und Schüttgewicht, Zusätze und Körnung sowie Bewegung der Zuckerkristalle. Es schliesst sich eine Diskussion über die Behandlung des Zuckers zur Entfernung der gebundenen Feuchtigkeit und damit zur Vermeidung starken Zusammenbackens des Zuckers bei der Lagerung oder beim Transport an.

* * *

Zuckerforschung bei Tate & Lyle. Teil II. *S.* 303–304

Dieser Teil des zusammengefassten Jahresberichtes behandelt die Forschungsarbeiten über Zucker einschliesslich: Entfärbung von Zuckerkläre mit Hilfe von oberflächenaktiven Stoffen, insbesondere in Verbindung mit Phosphatation oder Carbonatation; Verwendung von Anionenaustauscherharzen zur Entfärbung von Klären; Analyse von Rum und Industriealkohol; Bewertung von Aktivkohle; Untersuchungen über die Ursachen und die Verhinderung der Konglomeratbildung beim Kochprozess; verschiedene mikrobiologische Fragen, insbesondere die Proteingewinnung aus auf Kohlenhydraten gezüchteten Mikroorganismen und das Problem der Schädigung von geschnittenem Rohr.

Extracción de la caña por molienda—el camino moderno. Parte I. W. R. CRAWFORD. *Pág.* 291–298

El autor discute los puntos mayores que tienen que considerarse en el aumento del extracción de molinos convencionales por uso de métodos que tienen por fín la satisfacción de requerimientos modernos. En este primer parte, considera brevamente los fines de molienda, y entonces discute la preparación de caña, en particular los factores que afectan el cumplimiento de desfibradores, y valoración del grado de rotura de célulos.

* * *

Causa, prevención y medida de aterronamiento del azúcar refinado—una revista. Parte II. D. F. BAGSTER. *Pág.* 298–302

Los factores que afectan el aterronamiento del azúcar refinado se consideran; estos incluyen humedad y temperatura; tamaño de los partículos; compresión y densidad de la masa; aditivos y granulación, y movimiento de los granos de azúcar. Se presenta una discusión del acondicionamiento del azúcar para eliminar la humedad liada y así evitar aterronamiento importante del azúcar en almacenaje o en transporte.

* * *

Estudios azucareros en Tate & Lyle. Parte II. *Pág.* 303–304

Este parte de la Memoria Anual resumida trata de investigaciones sobre azúcar, y incluye la descoloración de licores azucareros con agentes tensioactivos, especialmente en conjunción con fosfatación o carbonatación; el uso para descoloración de resinas para cambio de aniones; análisis de ron y de alcohol industrial; valoración de carbones activos; investigaciones sobre causas y prevención de conglomeración de cristales en cocción; y algunos aspectos microbiológicos, en particular la producción de proteina de microorganismos desarrollados sobre carbohidratos y la problema de la deterioración de caña cortada.

THE

INTERNATIONAL SUGAR JOURNAL

VOL. LXXII OCTOBER 1970 No. 862

Notes & Comments

International Sugar Agreement.

Allocations made from the Hardship Fund, mentioned in our last issue[1], were announced on the 17th August. These and the resulting quotas in effect of the Members concerned are as follows, the quotas for other Members being unchanged:

	Allocations	*Quotas in effect*
	(metric tons, raw value)	
Brazil	20,000	481,611
British Honduras	3,000	23,313
Dominican Republic	4,000	133,270
Fiji	10,000	147,370
Mauritius	25,000	177,595
Swaziland	8,000	58,474

Notifications of shortfalls submitted to the Council in May amounted to 406,000 tons and it was subsequently announced that Mexico had renounced her entire export quota of 86,000 tons. Colombia has also cancelled 32,000 tons of sugar from her world quota[2], as a result of a huge increase in domestic consumption which has reduced the quantity available for export. Thus at least 474,000 tons of shortfalls are undistributed, while it is probable that others will have been declared by the notification date at the end of September. Thus the Council will have ample amounts for re-distribution should this become necessary, without increasing quotas above the 90% of basic totals with which the year started.

The criteria for further redistribution of shortfalls, announced in June[3], were a prevailing price over 3·80 cents per lb and a price of 3·90 or over during five consecutive days. At the end of August, the price went over 3·90 cents and it was anticipated that the Executive Committee would soon meet to work out the redistribution as the prevailing price edged up to 3·80 cents. Perhaps this imminence of more sugar was the cause of a fall in the daily price to below 3·90 cents just as the prevailing price reached 3·80 cents; in any case, no meeting was required.

The prevailing price has remained above 3·80 cents, however, while the daily price has fluctuated just below 3·90 cents; at the time of writing it is 3·89 cents and consequently there might easily be a further redistribution of shortfalls to report in our next issue.

* * *

World sugar production 1969/70.

F. O. Licht K.G. recently published their fourth estimate of world sugar production for 1969/70[4] and these are reproduced elsewhere in this issue.

The European beet sugar figures are very little different from the third estimate[5], since final figures were available from most countries at that time. The reduction of 1·4 million tons is mainly due to low sugar outturn in Turkey and in East Europe, especially in Czechoslovakia, Poland and the USSR, partly offset by increases in West Europe, and in the EEC in particular.

Significant changes have been made in the cane sugar estimates, however, the largest being an upward revision of more than 500,000 tons for Cuba, and the new figure is slightly less than the actual official outturn. The figures for Brazil and the West Indies have been reduced by 100,000 tons and 82,600 tons, respectively, with slight revisions for other countries. Estimates for Mauritius, Somalia and South Africa have also been raised, but the second major change, after Cuba, is a rise of 328,000 tons in the Indian crop estimate, now set at 4,750,000 tons. Licht points out however, that Indian consumption during the year has increased to a much greater extent that they had previously expected, and that this increase will balance the increase in the sugar production forecast. Nevertheless, consumption and quota exports under existing agreements will not be sufficient to take up the high production (which compares with 3,953,280 tons in 1968/69 and 2,497,703 tons in 1967/68) so that India will have a large increase in sugar stocks at the end of the 1969/70 crop year.

---

[1] *I.S.J.*, 1970, **72**, 257.
[2] *Public Ledger*, 12th September 1970.
[3] *I.S.J.*, 1970, **72**, 193.
[4] *International Sugar Rpt.*, 1970, **102**, (20), 1–5.
[5] *I.S.J.*, 1970, **72**, 161.

Commenting on Licht's estimate, C. Czarnikow Ltd. write[1]: "The combined beet and cane total for 1969/70 of 73,127,000 tons represents an increase of almost four million tons over the output in the previous season. This is much larger than the customary growth in output and has led to an expansion in stocks. Of this quantity some three-quarters of a million tons is represented by the compulsory stocks designed by the ISA to be under the control of the ISO, while in the case of India some part of the increased stock follows a switch from the production of gur to centrifugal sugar. It seems probable that in the 1970/71 crop year the curbs of the International Sugar Agreement, coupled with a lower output in Europe and in Cuba, will result in a drop in world production."

Woodhouse, Drake & Carey Ltd., agreeing with this outlook, predict that consumption in 1971 could be 2·5 million tons over production[2].

* * *

Trinidad Government purchase of control in Caroni Ltd.

In the light of the policy of the Government of Trinidad and Tobago that there should be increased local participation in the sugar industry, the Government and Tate & Lyle have been holding discussions and negotiations on the form and extent of such local participation. As a result the Government have offered to purchase, and Tate & Lyle have agreed to sell 51% of the total Ordinary Stock of Caroni Ltd., 70·59% of which is currently owned by Tate & Lyle. The agreed price is 1s 10d per stock unit (against a middle market quotation of 1s 3d) to be satisfied by a cash payment of 30%, the balance to be paid in ten equal annual instalments bearing interest at 5·35%.

In order that all Ordinary Stockholders in Caroni Ltd. may have an opportunity of participating in this transaction, Tate & Lyle are proposing to offer to purchase for cash at 1s 10d per Ordinary Stock Unit, 51% of each minority holding. As soon as formalities with the Government are completed, formal offers will be sent to Ordinary Stockholders. The effect of this transaction will be that Caroni's accounts will not be included in the consolidated accounts for 1970 of Tate & Lyle Ltd., since Caroni Ltd. will no longer be one of the Group's subsidiaries.

The Trinidad Government has made it clear, however, that it wishes Tate & Lyle, as a substantial minority stockholder, still to be actively involved in the operations and management of the Company.

As regards the past year's activities, the 1970 sugar crop in Trinidad has been completed. The Company's production amounted to 196,668 tons, compared with 213,444 tons last year. This major drop in production has been caused by the fact that the yield of sugar from the cane during the past crop has been the lowest for more than 30 years. This phenomenon has been experienced throughout the sugar industry of the Caribbean this year and, as a result, sugar production has been abnormally low, although a near-record crop was reaped in Trinidad. It is estimated that final sugar production is some 31,000 tons less than would have been the case with normal yields.

Wage Awards of 10% for 1969, 7% for 1970 and 5% for 1971 were recently confirmed by the Industrial Court of Trinidad and Tobago, and, as a result of the additional burden of these awards and of the major agricultural disaster, Caroni Ltd. has made a loss estimated at about £950,000 for the year ended 30th June 1970.

* * *

World sugar balance, 1969/70.

F. O. Licht K.G. have recently published their third estimates of the world sugar balance for the crop year September 1969/August 1970 and these are reproduced below with corresponding figures for 1968/69 and 1967/68[3].

	1969/70	1968/69	1967/68
	(metric tons, raw value)		
Initial stocks	19,598,303	20,373,630	19,101,239
Production	73,408,546	68,150,055	67,899,778
Imports	24,093,229	21,518,532	21,939,635
	117,100,078	110,042,217	108,940,652
Consumption	72,169,184	69,039,578	66,631,083
Exports	24,343,707	21,404,336	21,935,939
Final stocks	20,587,187	19,598,303	20,373,630
Production increase	5,258,491	250,277	2,258,224
,, ,, (%)	7·72	0·37	3·44
Consumption increase	3,129,606	2,408,495	1,174,201
,, ,, (%)	4·53	3·61	1·79

Since the second estimate was made in April, final figures have become available in many cases and, in the cases of India and Cuba especially, production has been much greater than expected. In addition, consumption figures for the USSR, published by the International Sugar Organization, have proved lower than expected, while consumption in India has increased to a greater extent than earlier forecast. In Japan also, the ban on cyclamates in food has resulted in an additional rise in sugar consumption.

The overall picture is of a considerable increase in production which is more than the rise in consumption during the period, so that stocks rose during the year by about a million tons. But, as C. Czarnikow Ltd. point out[4], if consumption in 1970/71 rises by 3·5%, which is by no means unreasonable, it will amount to 74·7 million tons and carry-over stocks represent 27·6% of these requirements, or some 14 weeks supplies compared with the "normal" level of 13 weeks.

Further, indications are that production in 1970/71 will show little, if any, increase over 1969/70, so that final stocks for 1970/71 may well show a reduction. It is thus not surprising that the markets were not badly affected by the new estimate and the picture of increased stocks which it presented.

[1] *Sugar Review*, 1970, (982), 136.
[2] *Public Ledger*, 8th August 1970.
[3] *International Sugar Rpt.*, 1970, **102**, (21), 1–3.
[4] *Sugar Review*, 1970, (983), 140.

Cane extraction by milling—the modern approach

By W. R. CRAWFORD, D.Sc., Ph.D., M.Sc., Whit. Sen. Sch.

(C. W. Murray Award-Winning paper, 1970)

PART I

Introduction

SOME twelve years ago, under the auspices of the H.S.P.A., experiments on a pilot plant scale were undertaken, in a Hawaiian sugar factory, to examine the practicability of the continuous extraction of sugar cane by a process of lixiviation in a so-called diffuser. These experiments, which have been reported by PAYNE[1], led to a revival of interest in this process.

Since then several diffusion plants have been installed at different locations in the cane sugar world but to the writer it seems that the first flush of enthusiasm for the new-style diffusion has now dwindled to a modest trickle.

If this, in fact, is the case, then there must be reasons for it, and the more important of these seem to be:

1. The paucity of reliable data on diffuser performance, and the alleged adverse effects of this method of extraction on problems met with in the boiling house.

2. The fact that, in many up-graded modern factories, conventional milling is yielding extractions which are at least as good as diffuser extractions, with only normal boiling house problems.

This latter reason is particularly true of Queensland where the great majority of factories have been expanded and modernized during the past decade. As an example of what can be achieved by conventional milling consider the following results obtained by two Central Queensland factories during the 1968 campaign. The figures are average values for the entire crushing season, and weights given in this paper are in *long* tons.

It is perhaps of interest to note that the large factory, A, can produce results just as good as the factory of half of its capacity.

Because milling figures such as the above can be obtained by conventional milling at high crushing rates, the writer believes that the time is opportune for a look at some of the modern practices which have made this possible. In the discussions which follow he will draw, where necessary, on his own experience, and that of others, of milling research carried out over the past twenty years. As might be expected with such a long-established industry, some research work has, inevitably, simply provided scientific proof of established practices. On the other hand carefully planned and executed research has taught us much about the mechanics of milling cane although, regrettably, the application of some important findings has been delayed by the idiosyncracies and, perhaps, anachronism of some mill operators.

Objectives of Milling

There is only one real objective in cane milling: to extract the greatest possible amount of sucrose from the cane. Unfortunately, however, the engineer, or other person in control of the milling plant, can extract only juice which contains not only sucrose, or pol, but many impurities as well. To date, even with reported high diffuser extractions, our chemists have apparently been unable to set an upper limit to juice extraction which would lead eventually to the most economical recovery of sucrose.

It would appear, then, that the mill operator is, at present, primarily charged with rupturing as many sucrose-containing cells as possible, and securing maximum extraction of the resulting juice, consisting of a mixture of sucrose, water and impurities.

A secondary, although important, objective is to produce a final bagasse which will burn readily in the

Table I. Milling figures

Factory	*Total cane crushed, tons*	*Tons cane per hour*	*Tons fibre per hour*	*% Pol extraction*	*% Reduced extraction*	*% Final bagasse moisture*
A	677,769	231·26	32·26	96·90	97·27	48·02
B	443,863	125·26	17·76	97·18	97·52	46·01

During the same campaign the highest average pol extraction in Queensland was 97·29% (reduced extraction 97·65% and fibre rate 32·75 tons/hr), this being for a factory where the tandem comprises five 78-in three-roll mills with a number of feeding devices *plus a large bed-type diffuser.*

[1] *Proc. 11th Congr. I.S.S.C.T.*, 1962, 971–991.

boilers. This second objective does not always follow automatically from the successful attainment of the first, because if juice has been efficiently replaced by imbibition water then high extraction can go hand-in-hand with relatively high final bagasse moisture.

In considering how best we may aspire to high extractions, the writer believes that the milling tandem may conveniently be separated into three sections, each of which has a distinctive fundamental function, although here and there some overlapping may occur.

These sections are:

1. The preparatory devices, the function of which is to rupture sugar-containing cells, while still leaving the prepared cane in a state suitable for milling.
2. The No. 1 milling unit.

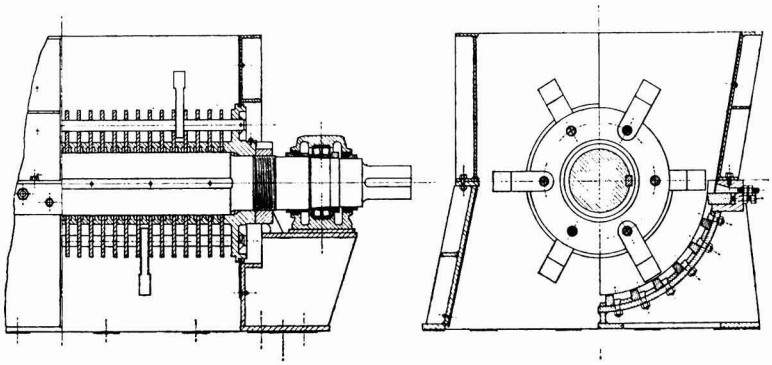

Fig. 1 Heavy-duty shredder

3. All bagasse milling units. This section will include imbibition and maceration circuitry.

It will be noted that the writer makes use of the expression "milling unit". This is because many modern mills make use of feeding devices of one sort or another, and such combinations may be regarded as a milling unit.

We will proceed to consider these sub-divisions of the milling tandem in greater detail.

Cane Preparation for High Extraction

General

Even the earliest investigators of the influence of cane preparation on milling performance were agreed that finer preparations yielded higher extractions. Deerr[2] noted this in his historic press experiments.

The twin objectives of preparation should be to rupture the greatest possible number of sucrose-containing cells while still retaining fibre shreds of length sufficient to promote mill feeding, by felting of the feed blanket.

All modern factories use rotating knives, of moderately high speed, for preliminary preparation of the cane, whether the latter be in whole sticks, or in the short billets produced by chopper-type harvesters. Efficient knife preparation does rupture an appreciable number of juice cells, but not enough for modern practice and, in the writer's opinion (and that of every factory operator in Australia and Fiji), the knives must be followed by a shredder.

With a suitable shredder, such as described below, cell rupture of up to 85% can be achieved. Payne[3] has stated that two such shredders in series can increase the cell rupture to 95%. This, of course, was to prepare the cane for direct diffusion and may be unnecessary for milling.

There are two reasons for seeking a high degree of cell rupture. First, the large volume of rich liberated sugar juice leads to a much higher extraction at the first milling unit which, as every miller knows, makes it much easier to obtain a high overall extraction. Second, there is a carry-over of free pol, and this, together with the disintegration of the cane, which is augmented by its passage through No. 1 unit, permits easier and more rapid absorption of the maceration juice, thus increasing its effectiveness in diluting the residual juice.

To achieve these desirable results a modern heavy-duty shredder is required.

The shredder

All experimental work and experience over the past few years show clearly that the objectives outlined above can best be realised by the use of swing-hammer shredders with the hammers operating over a breaker sector consisting of a series of breaker bars, or a washboard-like arrangement.

The first swing-hammer shredder was probably the Searby, which had comparatively light and short hammers, these operating on a fixed anvil bar. It was found that this arrangement did not give the

[2] *Report of the work of the H.S.P.A.*, 1912.
[3] *Proc. 13th Congr. I.S.S.C.T.*, 1968, 103–121.

cell rupture required today, and the modern shredder is of massive all-steel construction with long hammers up to 40 lb in weight. Such a shredder is shown schematically in Fig. 1, and Fig. 2 is a photograph of a similar shredder ready for delivery. Both shredders have an axial shredding length of 84 in and are of about 50 in diameter over the hammers.

of the knifed cane, a shredder will absorb about 32 hp per ton fibre per hour. This was somewhat of a generalization and, unfortunately, no attempt was made to correlate power input with percentage cell rupture, although the writer believes that in most cases it would have been appreciably lower than the 85% sought today.

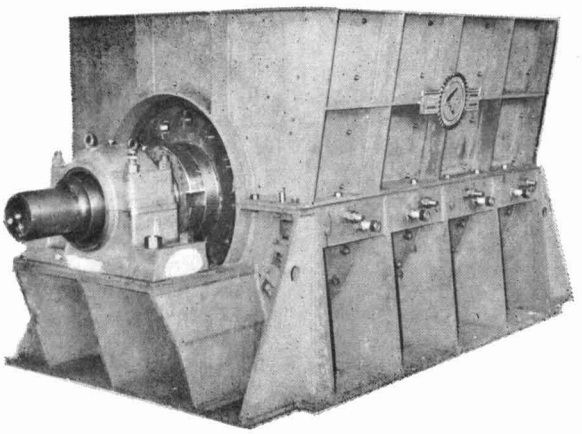

Fig. 2. Heavy-duty shredder

As will be seen, the construction is massive and all steel, with manganese steel breaker bars which may be adjusted and replaced. The rotor, running in double-spherical anti-friction bearings has a double-ended shaft to accommodate flywheels to supply additional energy during transient peak loads, if thought necessary. These shredders are sometimes driven by independent motors, one at each end. The design lends itself to easy removal of hammers for re-conditioning and replacement.

Mechanical aspects of shredder design and behaviour have received appreciable attention in Queensland of recent years. SHANN and MCWHINNEY[4] have investigated the efficacy of various hammer hard-facing techniques with a view to extending the period between hammer changes. They reported that solid steel alloy hammers of the chromium-molybdenum types, and mild steel hammers with alloy inserts of high chromium carbide type gave the most favourable results, but warned that the economics of each case must be carefully considered.

SHANN and CULLEN[5] have considered aspects of hammer design, and the most recent study is that of CRAWFORD[6], on the mechanics of swing-hammer shredders.

The power required for effective shredding with high cell rupture is considerable. NICKLIN[7], and MULVENA and NICKLIN[8], have measured the power input to shredders in a number of Queensland factories and their general conclusion was that, allowing for transient peaks caused by uneven feeding

Working with a batch-type swing-hammer mill at the University of Queensland, SOLOMON[9] found that the degree of preparation, i.e. its fineness, was, very significantly, a linear function of the work done on the cane. Here again no correlation with cell breakage was attempted, but the degree of preparation was assessed by the "bulk density" method described further on in this Section.

From the results of experiments on a large factory shredder in Queensland, which will be published this year, it would appear that there is indeed a very significant relationship between cell rupture and power input, so that we should examine closely the factors in design which will enable us usefully to increase this input.

The dynamical analysis of CRAWFORD[6] has established a relationship between the power transferred from a shredder rotor to the cane, the design parameters, the operational speed and the angle of swing-back of the hammers.

[4] *Proc. 33rd Conf. Queensland Soc. Sugar Cane Tech.*, 1966, 151–156.
[5] *Proc. 35th Conf. Queensland Soc. Sugar Cane Tech.*, 1968, 95–99.
[6] *Proc. 36th Conf. Queensland Soc. Sugar Cane Tech.*, 1969, 329–342; *I.S.J.*, 1969, **71**, 259–262, 293–296.
[7] *Proc. 34th Conf. Queensland Soc. Sugar Cane Tech.*, 1967, 171–182.
[8] *Proc. 35th Conf. Queensland Soc. Sugar Cane Tech.*, 1968, 273–280.
[9] *Proc. 30th Conf. Queensland Soc. Sugar Cane Tech.*, 1963, 95–99.

Refer to the diagrammatic representation of a shredder in Fig. 3 and the following notation.

W = weight of individual hammer..... lb
R = disc radius at pivot of hammer ..... ft
n = number of hammers
h = distance of hammer C.G. from pivot .. ft
N = rotor speed ..... r.p.m.
θ = angle of swing back of hammer over breaker sector ..... rad
δ = angle swept over the breaker sector .... rad
ψ = angle swept between initial contact with the cane and the start of the breaker sector ..... rad

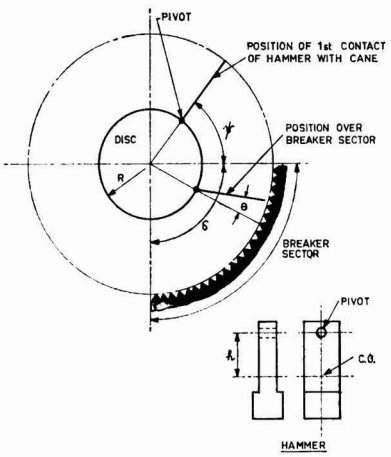

Fig. 3. Shredder mechanics

Provided the machine is mechanically sound and the hammers and breaker sector in good condition, then the power transferred to the cane is closely approximated to by the equation:—

$$H = \frac{W R N^3 n h (\psi + 2\delta)}{1{\cdot}937 \times 10^8} . \theta \quad \text{hp}$$

It is seen that we may regard the power input H as a linear function of θ, the hammer swing-back angle, and the power characteristics are, therefore, a series of straight lines passing through the origin. The slopes of these lines is $\frac{W R N^3 n h (\psi + 2\delta)}{1{\cdot}937 \times 10^8}$, and by manipulating the various parameters we can change this slope and so change the value of H for any given value of θ.

If an existing shredder is not achieving the desired objectives (we shall see presently how this can be assessed), then certain measures may be taken to improve matters by inducing it to accept more power.

These are:

1. At a specified throughput the hammer swing-back angle is a function of the initial setting, or gap, which may be defined as the radial distance from the leading edge of the hammer, when in a radial position, to the top of the breaker bars or washboard. If this setting has been chosen too large the shredder settles to work with a small value of θ and, consequently, the power input is low. If the setting be gradually reduced the angle θ and the power input will both increase. This is the commonly used practical method of improving shredder performance, and the writer is merely showing *why* the power input increases.

This method when applied to shredders of normal construction is time-consuming, and the writer is strongly of opinion that it calls for a simple means of adjusting the breaker sector as a complete unit.

The method is probably limited in existing shredders by cane throughput requirements.

2. If we think of improving performance by increasing hammer weight W, one of the parameters of the power equation, we should be thinking in terms of total hammer weight, i.e. the product $W \times n$ in the power equation. It may be assumed that an optimum array of hammers has been determined.

In certain Searby shredders in which the hammers are folded over to give a greater pivot bearing area it is possible to double the total hammer weight by doubling the hammer thickness. If a T-head is added a further weight gain may be achieved. Beyond this little can be done by way of hammer weight increase.

3. The parameter h may be slightly increased by changing the hammer shape, so moving the centre of gravity away from the pivot. The improvement in power input is very limited and it is doubtful if the cost of specially shaped hammers can be economically justified.

4. It is quite evident from the power equation that increasing rotational speed is a most potent way of increasing power input, and hence improving shredding ability. This speed effect has been observed by the writer when operating the Sugar Research Institute experimental mill shredder, and it is clearly illustrated in Fig. 3 of the 1968 paper by PAYNE[3] which is reproduced here as Fig. 4. This illustration also shows the "displacebility index", which is PAYNE's term for free pol, or pol in ruptured cells. The commonly used shredder speed is about 1000 r.p.m. and the only design problems associated with higher speeds appears to be the maximum allowable peripheral speed of the rollers in the large anti-friction bearings in present-day use, although heavy shredders have been run successfully at 1200 r.p.m. with double spherical roller bearings of 11 in inside diameter. Should this problem arise there are, no doubt, several ways of solving it. For example, it would be possible to use pairs of somewhat smaller bearings at each end of the rotor shaft, these pairs to be mounted in spherical seated housings.

It seems that the obvious choice for a prime mover for a factory shredder is a variable-speed steam turbine, driving through suitable reduction gearing. Provided the shredder design is sound, this will allow experimental work, on commercial shredders, to

relate speed and other parameters to cell rupture and particle size. Such experimental work does, of course, entail close co-operation between research organizations and factories.

5. If in an existing shredder we were able to reduce the pivot radius R, and so increase the hammer length, then both W and h may be increased. If the new product WRh is greater than the original product, then a power input increase may be obtained. However, because with larger and heavier hammers it is usually not possible to have as many hammers as in the Searby, we should also examine the product $WRhn$.

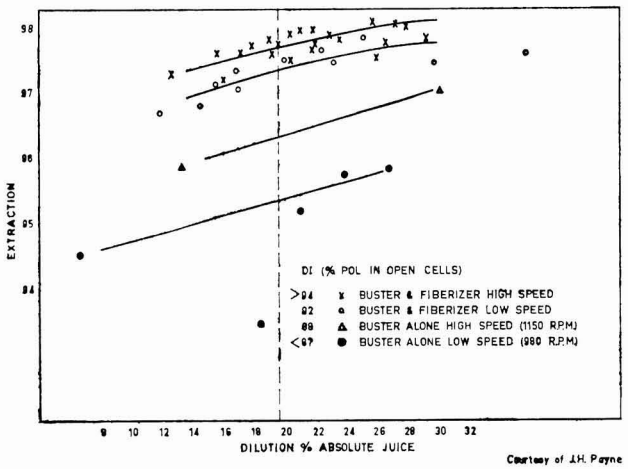

Fig. 4. Pol in open cells *vs.* shredder speed

Although this procedure may have limitations because of older-type shredder design features, it is of interest to compare the figures for two shredders, one a somewhat modified Searby, the other a modern shredder with heavy hammers, and generally of massive construction.

(1) *Searby.* $W = 9$ lb; $n = 144$; $R = 16{\cdot}385$ in; $h = 3{\cdot}115$ in; diameter over hammers 48 in.

In this case:

$WRh = 9 \times 16\,385 \times 3{\cdot}115 = 459$ lb.in², and

$WRhn = 459 \times 144 = 66{,}000$ lb.in²

(2) *Modern Shredder.* $W = 39$ lb; $n = 87$; $R = 13$ in; $h = 7{\cdot}66$ in; diameter over hammers 50 in.

Here we have:

$WRh = 39 \times 13 \times 7{\cdot}66 = 3880$ lb.in², and

$WRhn = 3880 \times 87 = 336{,}000$ lb.in².

These figures bring out vividly the potential for power input increase with the heavy shredder, and Fig. 5 has been prepared to show how the theoretical power input varies with various parameters for these two shredders. It has been assumed that both shredders operate at 950 r.p.m. Both are 84 in wide and, in calculating powers from the power equation, δ was taken as 90° over the breaker sector, and ψ as 54°.

Shredder operation, results and ancillary equipment

In some respects a cane shredder is similar to a crushing mill. Its throughput, or capacity, clearly depends on the peripheral speed of the hammers and its setting, or gap, over the breaker sector. As in mills, and as already advocated, to get the best results both of these parameters should be easily adjustable. Designs for adjustable shredder sectors have been prepared, and in one Queensland factory—Racecourse, in the Mackay district—an adjustable sector was fitted to the modified Searby shredder already mentioned. No figures of variation in cell rupture due to changing the setting have as yet been made available to the writer, but by the courtesy of the Directors and Management of this factory the writer is able to quote the following results:

Week ending 2nd November, 1968.

Average crushing rate 230·8 tons/hr.
Average fibre content 14·928% cane.
Number of breaker bars—7.
Swept angle of breaker sector about 45°.
Modified hammer weight 12 lb.
Number of hammers—144 (in 6 rows).
Diameter over hammers 48 in.
Shredder speed—960 r.p.m.

Hammer gap, or setting, varied uniformly from about 1 in at the first breaker bar to about $\frac{3}{8}$ in at the last one.

The percentage pol in open cells varied somewhat during seven tests carried out during the week, owing perhaps to

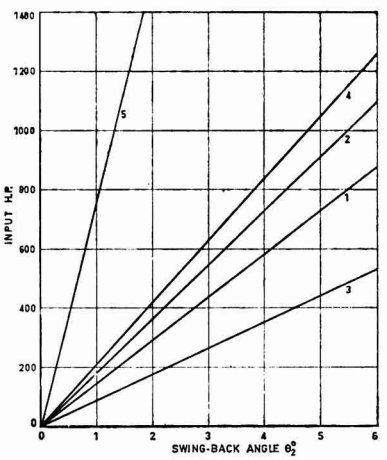

Fig. 5. Power absorption by shredders. Modified Searby shredder (950 r.p.m.): 1. 9-lb hammer; 2. h increased by 25% by changing hammer shapes; 3. breaker sector reduced to $\delta = 45°$; 4. 13% speed increase to 1235 r.p.m. Heavy-duty shredder (950 r.p.m.): 5. 39-lb hammers.

variations in rate and type of cane being processed. Results were:

Table II. Pol in open cells

Test No.	1	2	3	4	5	6	7
Cane Type	Q.58	Q.68	Q.63	Q.58	Q.58	Q.58	Q.63
Condition	Chopper Ratoon	Stick Ratoon	Plant Stick	Chopper Ratoon	Plant Stick	Chopper Ratoon	Chopper Ratoon
% pol in open cells	78·0	74·0	77·5	81·0	73·8	68·0	73·5

Although these are good results they do not reach the high values we seek in the modern approach to milling, perhaps owing to the fact of limited power absorption by the fairly light shredder.

A few other results have come to hand but these will be commented upon in the Section on the No. 1 Milling Unit.

The method of feeding partially prepared cane to a shredder has a direct bearing on the results achieved, and on the mechanical behaviour of the machine. Just as in a mill, the aim should be to feed the cane at a uniform rate. All too often one sees great "dollops" of cane falling from the cane carrier into the shredder. Now a shredder is essentially a stable machine, in the dynamical sense, because the rotating hammers form a system which always tends to a state of minimum potential energy. However with the very non-uniform type of feed mentioned above, the hammers can oscillate wildly, setting up unwanted stresses and vibration. In addition the shredding is of poor quality and much windage is caused.

The writer is in favour of the installation of feed metering rolls. Such rolls are in use in Hawaii and they have been considered by others, as various patent applications show. The present suggestion visualizes a pair of grooved rolls of fairly light construction, perhaps 24 in in diameter. They could be driven by electric motor through a variable-speed electro-magnetic coupling, with appropriate gearing where necessary.

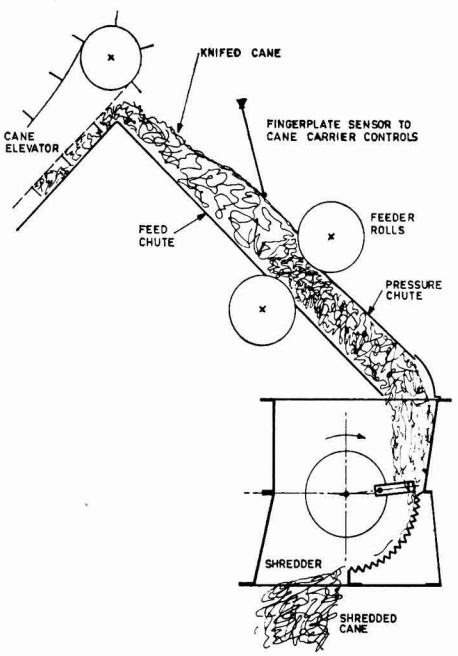

Fig. 6. Shredder feed control system

The arrangement would be as shown diagrammatically in Fig. 6.

Knifed cane from the carrier would fall into a hopper inclined at about 60° to the horizontal, just as does the feed to a mill from the cane elevator which usually now follows the shredder. This material enters the feeder rolls and passes between them at a predetermined rate. This rate is, of course, fixed by the crushing rate. The opening between the rolls would be adjustable, and its magnitude would depend on the required crushing rate and the speed of the rolls. Both would be adjusted, in the first instance, at a given crushing rate, so that just sufficient pressure to prevent slip was exerted by the rolls.

The rate of feed from the cane carrier to the feeder rolls would be controlled by a finger plate as indicated in Fig. 6. This finger plate, or sensing drive, could then be connected to any one of a number of automatic carrier control systems, and in this way the crushing rate could be maintained reasonably constant, while at the same time ensuring regular and uniform feed to the shredder.

For sizeable changes in crushing rate, apart from mill adjustments, it would only be necessary to increase the speed of the shredder feed rolls.

It may be noted that in Fig. 6 the direction of rotation of the shredder is shown as maintaining the general direction of entry of the knifed cane. Many earlier shredders used the reverse direction, but this, obviously, must use more power. The direction shown has found considerable favour in Australia.

Assessment of cane preparation

Having installed our shredder it must be tuned to give optimum results by determining the best setting or speed or both.

To do this we require a method of determining the pol, or Brix, in ruptured cells, and it is only of comparatively recent years that acceptably accurate methods of making these determinations have been devised. For accurate assessment of cane preparation two tests are required:—

1. For the determination of pol, or Brix, in ruptured cells.
2. For the separation of a sample of shredded cane into a number of fractions of different size to obtain information on its potential "feedability" in milling.

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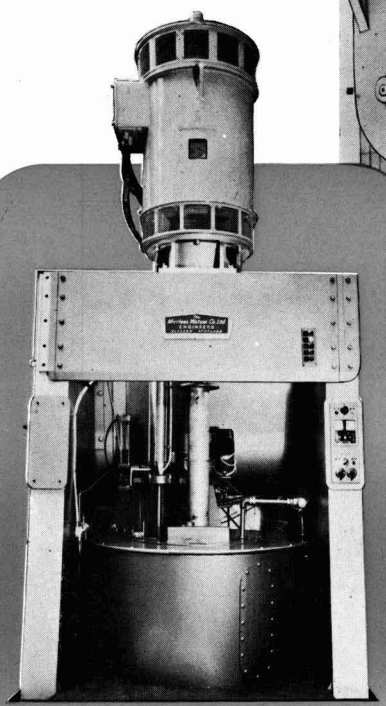

Continuous

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The continuous separation of molasses is only possible according to the thin-layer principle, i.e. a thin massecuite layer must slide over the centrifugal screen in order to permit good separation of the molasses in a short time. The thickness of the layer is determined by quantity and viscosity of the massecuite and by the basket speed.

The modern lines of Mirrlees Centrifugals are illustrated in the above photograph of one machine of a battery of 13—48" x 30" Fully Automatic Re-cycling Centrifugals being erected in our works. Note the complete and uncluttered accessibility of the working front; the control console incorporating a mimic diagram of the cycle stages and the fault annunciator on the pelmet.

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The separation into different fractions is a time-consuming process but, fortunately, in most canes the feedability requirement, of fibre lengths of up to about 4 in, is automatically attained by a modern swing-hammer shredder, although some extra care should be taken with certain low-fibre canes which powder into sawdust-like particles on shredding.

Several methods of finding the pol, or Brix, in ruptured cells have been described, amongst the most recent being those of PAYNE[1], ALDRICH and RAYNER[10] and FOSTER[11]. Fundamentally the methods are alike, but may differ in detail. With due acknowledgements the method of FOSTER is described below.

It is first necessary to obtain a representative sample of the prepared cane. This should be done by sampling to the full blanket depth at three or four positions transversely across the feed blanket. This is repeated a number of times, and the total collected sample thoroughly mixed and reduced to a convenient sub-sample by normal quartering techniques.

Two extraction processes are then carried out.

A. Cold leaching. Prepared cane (1000 g) and water at room temperature (10,000 g) are placed in a modified bottle-neck cylindrical can container of about 3 gal capacity, and of about 10 in diameter. The lid is sealed, using a rubber "O" ring, and the container, with its contents, rotated on a jar roller of suitable size at 70 r.p.m. for a period of 10 minutes.

It has been shown, by several research bodies that, after this leaching, the whole of the juice which was contained in ruptured cells has been washed out into the added water. The pol of this liquid is, therefore, determined, and is denoted by X.

B. Total pol in prepared cane. For this determination a wet disintegrator is used. This machine has been developed in a number of countries. In using the Queensland model 2000 g of prepared cane and 6000 g of water at room temperature are placed in the fixed cylindrical container in which rotates a co-axial high-speed spindle, carrying three sharpened knives at its lower end. The container is sealed with a juice-tight lid, and after rotation of the spindle for 40 minutes the cane is completely disintegrated. It is considered that at this stage the mixed liquid in the container holds the whole of the pol in the original sample. This pol is determined and denoted by P.

If the ratio of pol readings, $\left(\frac{\text{cold leaching}}{\text{disintegrator}}\right) = \frac{X}{P} = r$, and the fibre % cane is F, then it can be shown that the % pol in ruptured cells is:

$$K = \frac{1000\,r}{4 - r - \frac{1{\cdot}25F}{100}(1 - r)}\ \%,$$ so that K can be readily calculated.

Practical variations in F have little effect on K, and if, for example, we put $F = 14\%$ then

$$K = \frac{1000\,r}{(3{\cdot}825 - 0{\cdot}825\,r)}.$$

Where a shredder is in use tests such as these should be carried out on a regular schedule, as they provide invaluable information on the condition of the hammers, the need for their replacement and possibly the need for adjustment of shredder setting and speed.

FOSTER and SHANN[12] have attempted to relate the pol in ruptured cells to a "mean thickness of shred" obtained by sieving dried cane or bagasse to give a number of fractions of different size, and defined as:

$$t = \frac{\Sigma\,(\text{percentage of fraction} \times \text{its nominal thickness})}{100}$$

They had a measure of success in this correlation, but their experiments were too few to give conclusive results.

A number of earlier research workers, notably SPOELSTRA[13] and BEHNE[14], attempted to define degree of preparation by separating the material into fractions of various size and calculating a "fineness factor". Such procedures are very time-consuming and some years ago the writer conceived the idea that, since the bulk density of prepared cane, at a specific low pressure, increases with the fineness of the material, use might be made of this fact to establish a simple qualitative, comparative measure of degree of preparation by a rapidly-carried-out measurement of bulk density.

A programme of testing this theory was therefore set up and during milling tests with the experimental

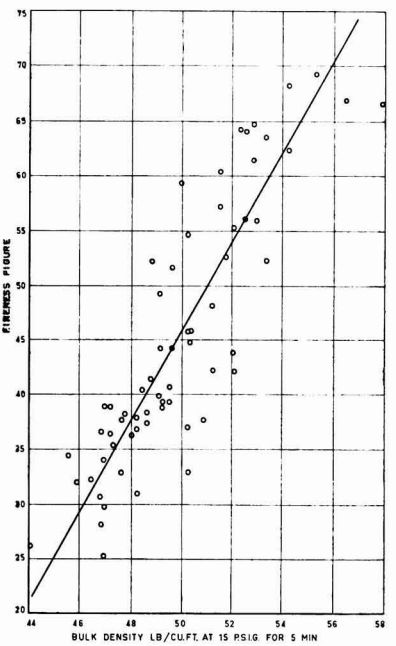

Fig. 7. Fineness figure *vs.* bulk density

[10] *Proc. 11th Congr. I.S.S.C.T.*, 1962, 1004–1011.
[11] *Tech. Circular Sugar Research Institute* (Queensland), Dec. 1968.
[12] *Proc. 13th Congr. I.S.S.C.T.*, 1968, 142–149.
[13] *Archief*, 1934, (23), 917.
[14] *Tech. Comm. Bureau Sugar Expt. Sta.*, 1940, (1).

mill the prepared cane was sampled at short intervals, the total composited sample being 4–5% of the cane crushed.

After thoroughly mixing, a sample of 15 lb of prepared cane was placed, as naturally as possible, in a circular steel pot of about $13\frac{3}{4}$ in diameter and about 14 in deep. Various pressures were applied to this sample through a steel plate attached to the ram of the available hydraulic press.

The bulk density was calculated from the height of the sample under pressure, and various consolidation times were considered.

It was found that a pressure of 15 p.s.i. was the highest that could be used without expressing juice from the sample. This was accordingly adopted.

In the same way it was found that a 5-minute consolidation period at this pressure was sufficient to allow reasonable stability to be reached. All tests were carried out in duplicate.

Concurrently with these bulk density measurements sieve analysis was carried out, using a series of sieves with the following apertures: $\frac{1}{2}$ in, $\frac{5}{16}$ in, $\frac{3}{16}$ in, $\frac{1}{8}$ in, 0·047 in, 0·028 in and 0·016 in.

A "fineness figure" was then calculated from the formula proposed by BEHNE[14], which was:

$$S = \Sigma \frac{\text{percentage retained on each sieve}}{\text{length of sieve aperture in mm}} .$$

This gave the excellent correlation with bulk density shown in Fig. 7. Subsequent work showed that bulk density is also influenced by fibre content, and this, together with the inadequacies of sieve analysis, accounts for some of the scatter of points in Fig. 7.

The practical suggestion arising from this work was that, at very little expense in both equipment and staff, a constant check could be kept on the quality of cane preparation, after some preliminary work to establish satisfactory values of bulk density for various districts and canes.

This method has been widely used in Queensland, and it is regrettable that, with the advent of satisfactory methods of determining cell rupture, no effort has yet been made to correlate the latter with bulk density. If this can be successfully done the value of the method will be considerably enhanced.

(To be continued)

Cause, prevention and measurement of the caking of refined sugar—a review

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PART II

Factors affecting caking: the avoidance of caking

(a) *Humidity and temperature*

Above has been mentioned the effect of temperature gradients and humidity differences producing by different causes a crystallization of syrup layers on or near the surface of sugar grains. Obviously to avoid caking of sugar such temperature and/or humidity differences must be avoided. LYLE[7] said that sugar must be cooled to within 5–10°C of ambient temperature prior to bulk transport. However, the ambient temperature itself can easily change more than this in a day.

KELM and BECK[18] gave conditions for satisfactory storage of white sugar as 20°C, relative humidity 60%. WERNER[25] wrote that high purity sugar of 0·02 to 0·04% water can be stored at 20–22°C. TUBB[65] described the storage of sugar at 30°C but states that a colour increase of about 10% per month occurs. MAGEE[20] reported that even when the water content was lowered to 0·01% sweating took place when the sugar bulk was cooled. It probably has not been emphasized enough that it is not possible to make a non-caking sugar[42].

Conceivably a sugar which is perfectly dry and sealed from the atmosphere would remain free running but any contact with the atmosphere would bring the natural hygroscopicity of sucrose into play. Such a sugar would then absorb moisture which could be lost on subsequent heating with associated caking.

MEADE[8] suggested conditions for warehousing packaged refined sugar, stating that close control of humidity is not essential. This is consistent with the existence of the flat portion of the ERH curve (Fig. 1), where moisture content of sugar varies little with humidity. The precautions recommended are keeping

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[65] *Proc. 27th Meeting Sugar Ind. Tech.*, 1968, 28.

the warehouse 3–5°C warmer than outside in moderate weather but never allowing the temperature to fall below 60°F and ensuring ample air circulation around all stacks. For soft brown sugars where the moisture content is so much greater than in white sugar the recommended conditions are different, warm moist air being desirable. For raw sugar, relative humidities in the region of 60–65% are recommended[2,66] and sealed storage desirable[6,26].

Returning to white refined sugar, DONALDSON and JOYNER[11] suggested a critical absolute humidity range governing the caking of sugar in storage. Storage under humidity in excess of this critical region results in a moist sugar with poor flow characteristics and a definite tendency to set. Storage below the critical region does not cause caking but a drop in humidity in excess of the range does. The upper limit of the critical humidity range appears to be approximately 135 grains water per cu.ft. air. A drop in humidity of 50–60 grains from this point causes caking. These particular limits were determined at 90°F.

The flushing of bulk sugar by air in order to control the moisture levels either with a view to preventing caking in the silo or to lower the water content of the sucrose so that caking does not occur in subsequent handling is well established[9,10,11,33,38,48,67] and is reviewed in the next main section.

POWERS[68] warned that it is essential that consideration be given to sugar *in situ* so that vital ancillary observations and measurements can be made. Completely misleading reports may be produced if based only on samples received in the laboratory.

(*b*) *Effect of particle size*

Since smaller particles have a greater surface area per unit of bulk volume it is not surprising that fine particles have a greater percentage of water at a given ERH[16].

WERNER[25] showed a graph of % water *vs.* particle size indicating a great increase in % water below about 0·5 mm. KELM and BECK[18] claimed caking is avoided if 90% of the crystals are not less than 0·4 mm with 0·04% water. WERNER recommended sifting off grains and nodules (agglomerated particles) less than 0·3 mm. HOWES[12] listed grain size and grain size distribution as factors influencing caking. DOWLING[38] showed that +40 mesh and unscreened sugars used by him contained the largest amount of bound moisture and stated that this verifies the belief that conglomerates contain the largest amount of bound moisture. MAHONEY and REED[48] found that fine fractions tended to set more. NELSON[21] indicated that the severity of caking depends on the points of contact and the smaller the grains the worse the setting.

DOUWES DEKKER[58] noted that finer molasses sugar gave harder cakes.

It is generally agreed that a more even grain size has many advantages[12,38,39,69] and that the use of mechanical circulation in the vacuum pans is a very effective means of achieving this. Pan boiling is therefore to be taken as a major influence in sugar caking.

MCGIMPSEY[70] found that the time to reach equilibrium in conditioning granulated sugar was less for finer sugars.

(*c*) *Compression and bulk density*

Little has been reported on the influence of compression on caking. HOWES[12] stated that compression in bulk or in stacks will tend to fuse fine crystals together, more so in the presence of migrating moisture vapour.

NELSON[21] listed pressure among the factors affecting the severity of caking. More pressure produces (a) more contact points and (b) greater chance of fusing any syrup film.

KAMODA[61] found shear strengths at different pressures with a view to plotting shear stress *vs.* normal stress to find the cohesion.

(*d*) *Additives and granulation*

The use of additives to prevent caking is a possibility albeit probably not feasible for bulk handled white sugar. GRAHAM and AGATE[71] have a patent for adding 0·5% methyl cellulose, 0·5% alginate, and 2% glycerol to brown sugar. The free flowing property is probably due to initial separation of the crystals by the dry additives followed by coating the crystals with glycerol. YAMANE and IWAKURA[46] investigated caking strength as a function of glycerol percentage for soft sugars.

NELSON[21] suggested the use of fine pulverized edible starch or an inert organic compound.

Starch has the additional advantage that it will absorb water and will therefore keep the atmosphere between crystals dry.

In the fertilizer industry granulation has often been found successful as a caking preventative. So-called conditioners (such as kaolin and kieselguhr) to prevent granules sticking together were found not to prevent crystallization[15]. Rather, crystallization occurs beneath the coating of conditioner and the conditioner apparently aids the extension of the crystallizing phase over the granule surface, thus preventing localized growth at points of contact.

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[66] HORIKI: *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1965, **16**, 16.

[67] CONSTABLE: *Proc. 19th Meeting Sugar Ind. Tech.*, 1960, 154.

[68] *Proc. 12th Session ICUMSA*, 1958, 98.

[69] NEILSON and BLANKENBACH: *Proc. 23rd Meeting Sugar Ind. Tech.*, 1964, 109.

[70] *Proc. 19th Meeting Sugar Ind. Tech.*, 1960, 167.

[71] U.S. Patent 3,264,117 (1966).

(*e*) *Movement of sugar grains*

DOUWES DEKKER[57] noted two types of setting or caking:

(i) A high humidity type where the sugar is exposed first to a relative humidity in excess of 55–60%, and then to a lower one. This produces a very hard cake which, if broken, will reset immediately.

(ii) A low humidity type where the relative humidity is decreased from 55–60% to a lower one. This cake is relatively brittle, but once broken will not reset.

DONALDSON and JOYNER[11] also reported that hot damp sugar which was allowed to cool in a sealed container caked into a mass that broke into lumps. This reset rapidly on standing.

Provided one has lowered the moisture content of individual grains sufficiently, sugar which has caked will not reset (unless of course further temperature or humidity gradients are imposed). This emphasizes the importance of breaking up caked sugar as a means of preventing further caking. Since release of bound moisture takes time[9,10,12,38], the handling of sugar when the release of this moisture is advanced will break up any set already formed and make the sugar more free flowing. Several writers have noted the value of movement of bulk materials in avoiding further caking[4,8,15,19,48,67].

DONALDSON and JOYNER[11] pointed out that the conditioning process, itself designed to remove water and thus prevent a tendency of sugar to cake, does actually cause caking during conditioning. Breakage of the bonds formed then results in a sugar less likely to cake.

Conditioning of sugar

The purpose of conditioning of bulk refined sugar is to allow sufficient time and provide suitable contions for the removal of bound moisture, either with a view to avoiding severe caking in the silo being treated or in subsequent transport or storage. By having a flow of air and by suitably insulating the silo, thermal and humidity gradients are smoothed out. SCHWEITER[23] mentioned another advantage, that this process removes any residual molasses smell which can occur on silo storage.

STACHENKO *et al.*[10] distinguished between theoretical conditioning and practical conditioning. With theoretical conditioning one allows complete equilibrium of the water, i.e. all the bound moisture is given time to migrate and dissipate at the surface of the crystal. The final water content of the sugar depends on the sugar quality and the relative humidity. For a good cane sugar this can be expected to be 0·005–0·007% at 50–60% relative humidity. However, as the rate of curing drops off rapidly with time, one speaks of practical conditioning where bound water is brought to a level where sugar will not be likely to cake, provided wide temperature fluctuations are not encountered during shipment.

SCHWER[33] has performed a number of experiments on conditioning variables. He showed the existence in centrifugalled sugar of a constant rate period of water removal, a falling rate and a "diffusion controlled" period[32]. Fig. 3 illustrates this. The relative humidity of the conditioned air (up to 60%) was found to be unimportant and air flow rates between 0·5 and 4 litres per minute on a 60 g sample produced the same rate of moisture loss. The use of a vacuum resulted in a lower rate of moisture loss, while a partial vacuum gave results substantially the same as those at atmospheric pressure.

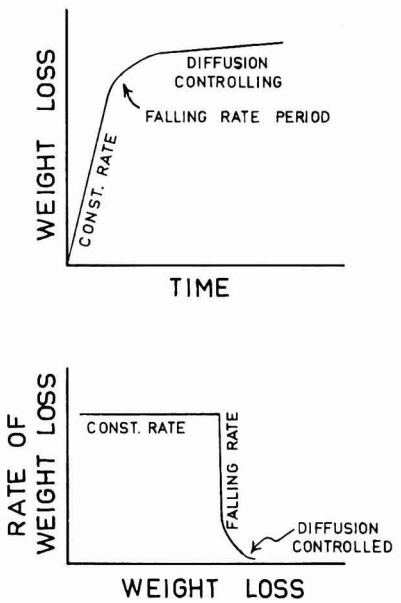


Fig. 3. Illustration of terms related to drying of solids

Temperature as a variable was found to be very important, rates of conditioning increasing markedly with increase in temperature. All this evidence points to the fact that the rate of loss of bound moisture is not gas side-controlled but is dependent on crystallization or diffusion in or on the crystals.

It is instructive to plot known crystallization rates as a function of temperature. Fig. 4 was constructed by cross-plotting the data of SMYTHE[72]. It is seen that the rate, admittedly for high shear speeds, increases greatly with temperature. Diffusion rates increase in a similar manner. An equation given by REID and SHERWOOD[73] for diffusion coefficients in dilute solution gives a dependence on temperature as

[72] *Aust. J. Chem.*, 1967, **20**, 1087.

[73] "The Properties of Gases and Liquids" (McGraw-Hill, New York), 1958, p. 284.

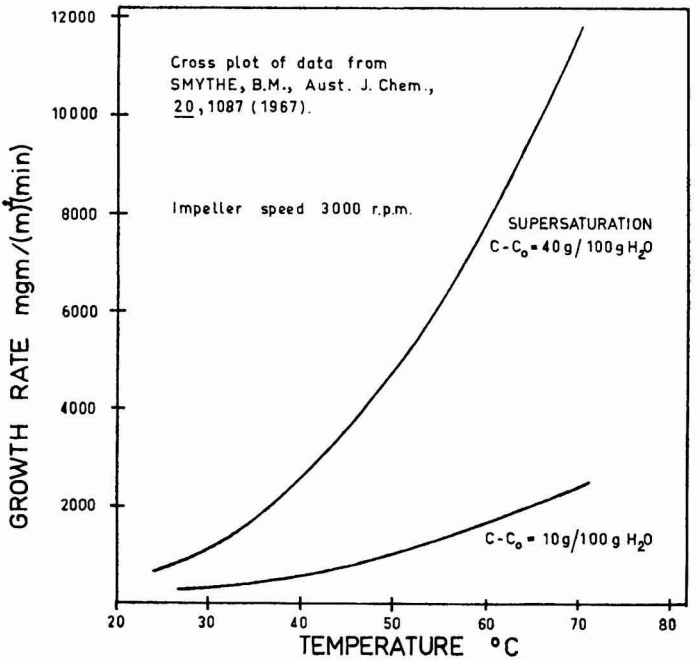


Fig. 4. Rate of sucrose crystal growth as function of temperature

follows: $D \propto \frac{T}{\mu}$ where T is the absolute temperature and μ the viscosity of solution. Assuming a similar temperature dependence for the undoubtedly concentrated solutions on the crystal, it may be seen in Fig. 5 that the diffusion process is dependent on temperature in a manner similar similar to that of crystallization rate.

DOWLING[38] showed that conditioning with dry air does not speed up the process of conditioning over the rate obtained with 30% relative humidity air. The rate of conditioning was found to fall off with the colour of the liquor to the pans.

In addition to the data of SCHWER there is ample evidence to show that conditioning at room temperature takes the order of days whereas raised temperatures reduce the curing period[10, 11, 70]. Fig. 6 illustrates the temperature effect.

It is interesting to note that the slopes of typical water loss curves for different temperatures fall off to about the same value after the first day. There does not appear to be much advantage in using hot conditioning for longer than this period.

MAHONEY and REED[48] described the use of cold dry air in a Kathabar unit, which tumbles sugar in a flow of cold dry air. This does have the advantage of lowering the sugar temperature to the ambient so that thermal gradients are less likely to be troublesome.

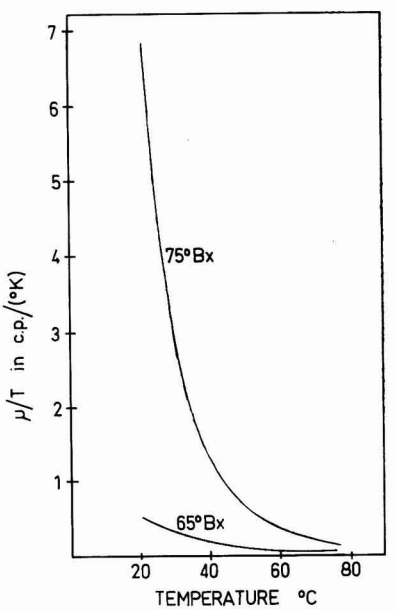


Fig. 5. Ratio of viscosity to absolute temperature for sucrose

STACHENKO *et al.*[10] passed air upwards countercurrently through conditioning silos. Residence times of 20 hours (single silo) and 40 hours (two silos) were investigated with an air flow of 1200 c.f.m. for approximately 1,700,000 lb of sugar. The water content of the sugar was lowered from 0·038% to 0·018% with a 20-hour residence time and to 0·013% for 40-hour operation. The average temperature of the sugar in the silo was 125°F with the shorter residence time and 115°F for the longer. Two-silo operation was reckoned to be essential in the Canadian climate. A refrigeration unit was employed to bring the dew point of the air supply down to 40–50°F. It is noteworthy that the air flow rates used for the large scale were less in proportion than those used in the laboratory by SCHWER and by STACHENKO *et al.*

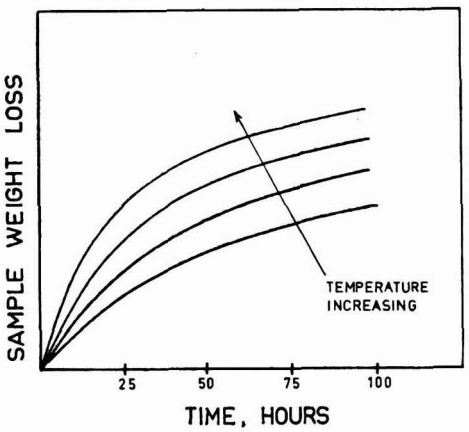


Fig. 6. Drying curves at different temperatures

STACHENKO *et al.* pointed out that it is important to avoid "rat-holing" of the sugar in the bin, where sugar passes quickly down through the centre of the bin to the outlet while much sugar remains at the sides. Such a state would lead to large variations of residence times.

CONSTABLE[67] used a 20-hour conditioning period during which sugar was moved from one bin to a second. Each bin had a capacity of 130,000 lb. The sugar cooled from 105°F to 80°F with water content dropping from 0·02–0·025% to 0·007–0·015%. Filtered air at 500 c.f.m. was used for each bin. No statement is made about prior temperature or humidity adjustment of air though mention is made of refrigerated, dehumidified air for scavenging screw conveyors to the outside.

RODGERS and LEWIS[9], in summarizing US practice, quoted 24 hours residence time and the use of lithium chloride to dry the air. They suggest that 24 hours is too short a time as the problem is governed by crystallization and not evaporation.

WERNER[25] described a process in which ambient air is heated sufficiently to give a relative humidity less than 50%, with temperature limits of 20°C and 34°C. Another process where unheated air is dried with silica gel was mentioned. Natural air circulation is used for this though he gave an example where forced circulation of the dried air is employed[74].

TUBB[65] described the selection of a Weibull silo from other available designs. Air at 30°C and of about 70% relative humidity is passed up a centre duct, into the air space above the sugar and then down the hollow silo walls. Sugar is fed in at about 30°C and the explicit purpose here is to store material in a free running state, not to condition it. TUBB claimed that there is no need to condition sugar in the English climate. Precautions to avoid explosions and contamination are elaborated upon.

It is difficult to compare the results of various processes. For instance, the sugar to the conditioners described by STACHENKO[10] is of 0·038% water. That cured by CONSTABLE[67] was 0·02%

The effectiveness of conditioning processes is usually evaluated in terms of the water content of the conditioned sugar, whereas it is more important to know if caking will occur. STACHENKO *et al.* said no caking was found on the walls of the silos when they were cleaned. CONSTABLE said that no cases of caking were experienced. MAHONEY and REED noted the difficulty of getting unbiased reports from customers.

Associated with the problem of storage is that of condensation. STACHENKO *et al.*[10] have placed emphasis on avoiding temperatures below the dew point as the conditioning air takes up water from the sugar and hence the dew point rises. They illustrated this with calculations comparing heat losses from the silo with the heat removal necessary to reach the dew point. RODGERS and LEWIS[9] indicated that there may be sources of water not in the sugar, from condensation and leaks. BEHNE[2] mentioned how drips may fall from the roof of a storage space when the outside temperature falls. MEADE[8] said that bulk tankers should be swept out with pre-dried air prior to loading.

Associated with the problems of avoiding condensation and thermal gradients is the choice of materials of construction of silo walls. SCHWEITER[22,23] warned against using concrete, the water content of which could dry out over long periods. STACHENKO *et al.*[10] found epoxy lining was scoured and used fir wood. Care must be taken to ensure that the wood is properly supported to take not only static but also dynamic stresses. CONSTABLE[67] used glass fibre; KELM and BECK[18] suggested aluminium-lined concrete; MEADE[8] advised using insulation such as "Masonite", glass fibre, or an air layer.

BREITUNG[75] described the use of air-heated steel silo walls and floor, the outside being insulated with rock wool. However, CONSTABLE[67] warned against using steel because of sweating and scaling. MAGEE[20] discussed how one may use an air-insulated bulk tanker to avoid temperature gradients but cold tanker supports may project through the insulation and condensation could result in the colder region where the support joins the tank.

[74] WESCHKE: *Zeitsch. Zuckerind.*, 1961, **86**, 617.
[75] *ibid.*, 553.

Sugar research in Tate & Lyle

(Annual Report, 1969, Tate & Lyle Research Centre, Keston, England)

PART II

SUGAR RESEARCH

Chemistry and sugar technology

Many years of research work on the nature of the carbonatation and bone char processes have shown that both processes were characterized by the specific removal of anionic impurities, including a large proportion of the colouring matter. In a search for alternative chemical means of removing this type of impurity, it has been found at Tate & Lyle that many cationic surface-active agents will precipitate colour and other high molecular weight impurities from sugar liquors, the precipitate then being removable simply by filtration with fine-grade filter-aid. However, removal of the precipitate is much more effective when addition of the cationic surfactant is coupled with a conventional defecation process such as phosphatation or carbonatation. When the surfactant is added during phosphatation, the impurities precipitated by it are scavenged by the Ca phosphate and the resulting floc has the remarkable property of retaining bubbles of air introduced on aeration. (This function of the surfactant is used in mineral ore flotation processes.) Extremely rapid flotation occurs when trace quantities of an appropriate anionic polymer is added, sufficient flotation to yield 50% brilliant decolorized subnatant liquor occurring in less than 1 min. The most satisfactory surfactants have been found by extensive studies to be long hydrocarbon chain derivatives having an optimum chain length in the hexadecyl or octadecyl region. This discovery has provided the chemical basis for a new refining process (which is the subject of pending world-wide patent applications) in which defecation and decolorization are brought about simultaneously in a single reactor. In many cases the treatment is so effective that further decolorization is unnecessary for white sugar production; but where a high quality refined sugar is required, polish decolorization with carbon or bone char may be used, although the ideal for this is ion exchange resin, which is not fouled by colouring fractions as would normally happen, since they are now removed by the cationic surfactant. Investigations at Tate & Lyle have shown that while conventional phosphatation removes 12–25% of the colouring matter, phosphatation in the presence of 500 p.p.m. of surfactant will remove 50–75% colouring matter.

Most of the dissolved colouring matter in refinery liquors is made up of a polymer derived from the thermal degradation of reducing sugars, which usually carries a net anionic charge proportional to the number of free carboxylic acid groups on the molecule. The distribution of the charge on the polymer molecule is obtainable by adsorbing the colouring matter on a DE-32 anion exchange cellulose column and eluting the fractions with sodium chloride solution. Automatic integration of the effluent colour permits the liquors to be analysed without need for preliminary concentration of the colouring matter. Molecular size distribution in the colorant solutions may be determined by gel filtration, and an equivalent molecular weight may be calculated, assuming that purely anionic colouring matter exists as an extended linear polymer, whereas the Maillard reaction yields globular products. The decolorizing capacities of 32 commercial anion exchange resins have been determined, the performance of each resin being determined for both anionic (glucose) colorant (retained by exchange with Cl^- ions) and amphoteric (glycine) colorant. The decolorizing efficiency is determined by the molecular size of the colorant in relation to the resin matrix permeability, which regulates the rate of colorant diffusion to the ion-exchange sites, this being also temperature-dependent. The total net anionic charge on the molecule controls the strength of interaction, the more highly charged molecules displacing the less highly charged. The higher the net charge the greater will be the inhibition of self-elution and regeneration. The degree of matrix adsorption is determined by the molecule polarity, the less polar lipophilic colorant being retained by a non-ionic mechanism. The highly polar Maillard colorants are not retained when the net charge is zero or positive. Differences in the performances of resins may be due to matrix porosity and hydration, while ionic interaction has also been found, by the use of polyanionic sulphonate dyes, to depend on the relative positions of anionic groups in the molecule; not all groups necessarily exchange. The properties of different resins are sometimes complementary, so that two or three resins employed in series will give almost complete colour removal up to the capacity of the resin. Complementary resins may also be used in a mixed bed, depending on the mechanism of their action, the appropriate combination of resin depending on the composition of colorant to be removed.

As regards boiling of standard liquors which had been treated with ion exchange resin, it has been found that there is no significantly greater tendency towards colour formation after resin decolorization than after bone char treatment. Amines arising from resin breakdown during alkaline regeneration do not catalyse colour formation, although new resin does contain catalysts, one of which has been identified as benzoic acid. However, these compounds should be removed during the initial washing of the resin before use. The extent of colour formation during boiling was found to depend on the initial colour of the liquor.

A rapid and reproducible method for rum and industrial alcohol analysis has been developed, in

which the sample is injected directly into a gas-liquid chromatographic column; by this means higher alcohols are determinable down to 2 p.p.m.

The evaluation of activated carbon by determining the quantity (mg) of methylene blue adsorbed by 1 g of ground carbon in equilibrium with a solution of 1 mg/litre concentration, which is designed to give a measure of the surface area in pores greater than 1 nm in diameter has been found to have the following disadvantages: the activity of the carbon is related to the amount of surface accessible to the adsorbate molecule during the period of contact and not to the total available surface, so that grinding should be eliminated; the amount of methylene blue adsorbed is dependent on the pH of the system; and work on model carbon systems has shown that the molecule cannot penetrate pores less than 1·5–2·0 nm in diameter. Evaluation tests involving the iodine and molasses numbers are considered to be equally suspect. A better guide to carbon activity has been found to be the adsorption of the CTAB molecule (cetyl trimethyl ammonium bromide), which is apparently independent of pH and provides a measure of the surface area in pores greater in diameter than 1·5 nm, while the adsorption rate is directly proportional to the solution colour removal rate. However, it is emphasized that no single test can be used to evaluate decolorizing carbon activity, since this is a complex function of the surface area and porosity and the composition and chemical nature of the surface.

Tests at two refineries were carried out to determine whether alcohol slurry used for pan seeding contributed to conglomeration because of its poor particle dispersion. Improvement in crystal uniformity was obtained when the particles in the seed slurry used had been completely dispersed and the slurry stabilized with a surface-active agent, from which it is concluded that the larger crystals had grown from the injected slurry whereas the smaller crystals had nucleated during boiling. The correlation between seed volume and M.A. of the final product was improved with the stabilized seed slurry compared with standard slurry. In further tests on conglomeration, reduction of the seed dose increased the crystal regularity index (C.R.I.) and the M.A., while addition of KCl up to 4% concentration increased the C.R.I. but not the M.A. A consistent but only marginal improvement was obtained by addition of Hodag "CB-6" surface-active agent. Several other surface-active agents behaved similarly, but the effects of sucrose monostearate and glyceryl monostearate were only equivalent to a simple adjustment in the seed volume. None of the additives were thus considered for recommendation in high-purity boiling.

Negative turbidity of sucrose solutions was found to occur in spectrophotometric measurements of absorbance, whereby the absorbance measured at 900 nm and at 420 nm was less than that of the reference cell of distilled water. This is attributed to a refractive index phenomenon connected with the specific spectrophotometer used.

Light-scattering in sucrose solutions is to be studied to determine molecular weights of polysaccharides, colouring substances, and other macromolecules, small particle shapes and sizes, and the absolute turbidity of sugar liquors.

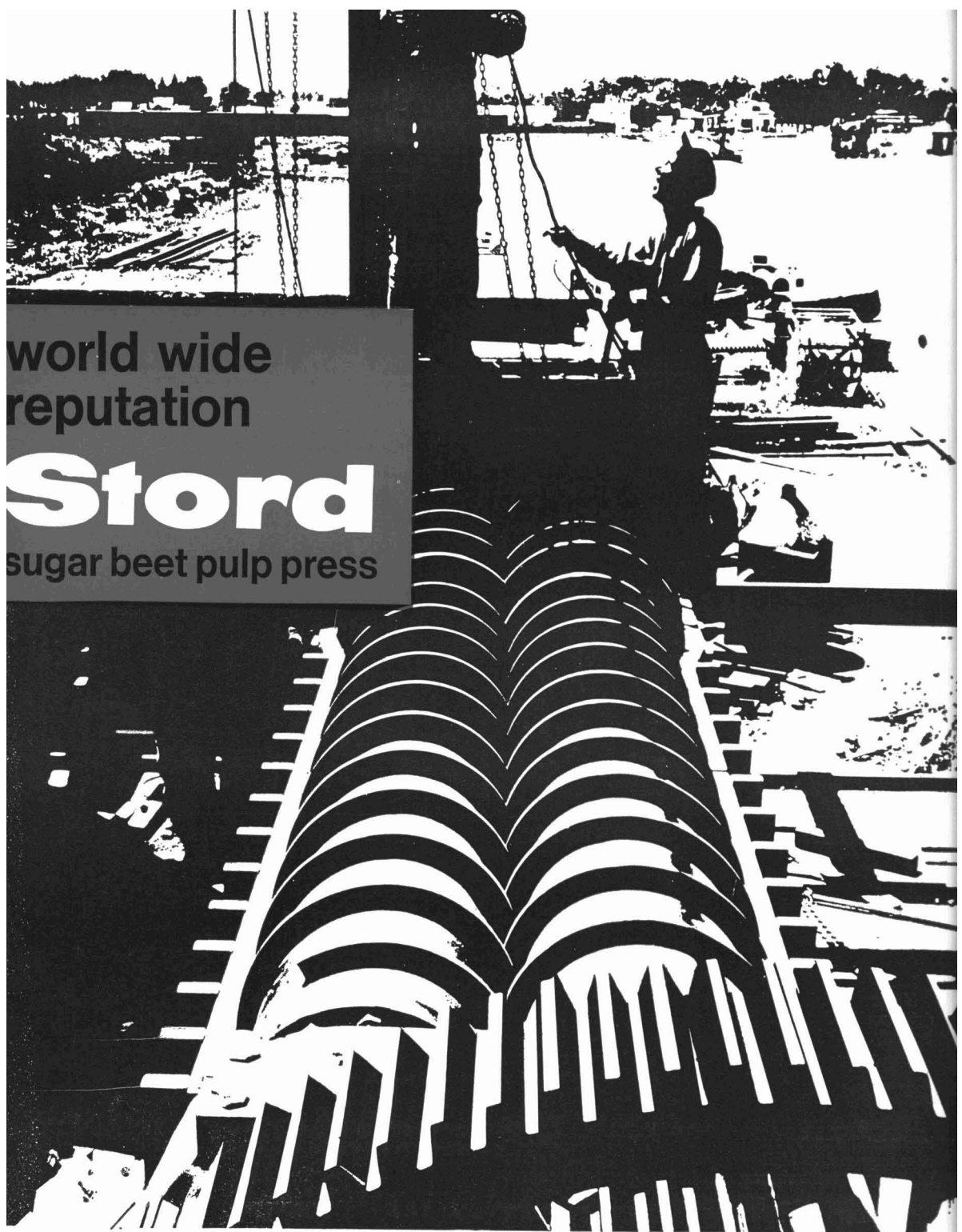
Microbiology

Studies over the last 3–4 years have been directed towards the production of protein by growing micro-organisms (yeasts, fungi and bacteria) on carbohydrates. The work is aimed at finding new uses for by-products such as molasses and bagasse, while new possibilities are being investigated for the utilization of indigenous carbohydrate crops in those parts of the world short of protein. More than 150 different fungi have been found to grow well on an agar medium based on carob extract. Maximum yields of mycelium and protein were obtained at 13% initial sugar level with six selected fungi grown on a carob extract, molasses, or an unnamed synthetic medium. No toxicity has been found in tests with rats fed on the proteins obtained.

Experiments on the digestion of cellulosic materials such as bagasse and beet pulp by micro-organisms to produce protein-enriched animal fodder have yielded a number of different products which are being assessed for their value in animal feeding.

The growth of micro-organisms, particularly fungi, in fermenters, particularly a tower fermenter, is the subject of a study with a unit set up at the University of Aston, in Birmingham. Results of investigations on aeration in culture vessels provided with stirrers have led to improved aeration efficiencies in the fermenters at Tate & Lyle Research Centre. The production and use of organic compounds produced by the metabolic activities of micro-organisms have also been investigated, gel permeation chromatography being used to separate and identify the compounds, which include microbial enzymes such as are used in modern food processing.

In a study of the problem of sour cane including work carried out at Frome, Jamaica, micro-organisms isolated from stored cut cane were tested for their ability to cause deterioration in a synthetic cane juice. *Leuconostoc mesenteroides* isolates produced acidity, inversion and gums, while other bacteria also contributed to spoilage, so that deterioration in the quality of press juice from stored cane occurred even when *L. mesenteroides* was absent. Although the dextran content is the best measurements of the extent of deterioration, the levels were not always related to the degree of infection, suggesting that not all dextran is of microbial origin. Some correlation has been found between the dextran levels in crusher juice and total weekly rainfall. Of possible methods for preventing *Leuconostoc* infection of cane, the only one that appears to be practical is minimizing the delay between cutting and milling. Dextran levels in the mill juice can be reduced by treatment with an enzyme (for which a patent has been taken out) although infection is not prevented.



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Sugar cane agriculture

The water requirements of sugar cane. G. J. HAM. *Producers' Rev.*, 1969, **(9),** (9), 5–9.—This is a paper delivered at the symposium on water problems in tropical Queensland, arranged by the Water Research Foundation of Australia. It refers especially to the Lower Burdekin District with 61,734 acres under cane, 99% of which is dependent on irrigation. Results of recent lysimeter studies in the area are reported. It would seem that to produce an average crop in the Lower Burdekin 60–65 inches of water would be needed, varying somewhat with soil type.

* * *

Grade farm banks to dispose of run-off water. ANON. *Producers' Rev.*, 1969, **59,** (9), 29–31.—The correct grading, by means of a mechanical grader, of sloping cane lands is described and lucidly explained by means of diagrams. These banks are made with gently undulating sides (1 in 80 or 1 in 200 according to soil type), to allow machinery to pass over them and are grassed over to assist further in preventing soil erosion.

* * *

Early application of aqua ammonia suggested. ANON. *Producers' Rev.*, 1969, **59,** (9), 35–37.—The favourable experiences of several Queensland cane farmers in applying aqueous ammonia prior to planting and immediately after harvest to encourage young plants and ratoons to make vigorous early growth are quoted. It is stated that young cane that received pre-plant applications was more vigorous and a better colour than cane which had received the usual side dressing, which must cause some root disturbance.

* * *

Protect against cane grubs. ANON. *Producers' Rev.*, 1969, **59,** (9), 41.—When BHC soil treatment is neglected or not properly applied serious cane damage may be caused by the pest. The unfortunate experience of several growers is quoted. Both Frenchi and Greyback grubs are discussed.

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Sugar cane variety trials in Saint Croix, U.S. Virgin Islands. A. J. OAKES and R. M. BOND. *Turrialba*, 1969, **19,** 176–190.—Results are given of field trials made during 1952–66 on 4 major soil types in different rainfall belts. Varietal performance was assessed by considering the influence of soil type, rainfall, crop and harvest date on yield and sucrose content. Significant differences were found with different soil types. Rainfall exerted a marked influence on sucrose content. Barbados varieties gave the best overall performance.

* * *

Irrigation requirements of sugar cane in the Alajuela area of Costa Rica. S. A. GAVANDE and M. A. GONZALEZ. *Turrialba*, 1969, **19,** 221–234.—In parts of Costa Rica the practice of irrigating sugar cane in dry seasons has greatly increased in recent years. Some farmers with a cheap or easy water supply from surface streams over-irrigate their cane. This article gives some estimated values of irrigation requirements, based on some soil physical and climatological measurements for sugar cane in 4 representative soils of Costa Rica. It is considered that soil moisture-indicating devices, if properly installed in the field, can greatly simplify the problem of knowing exactly when and how much water to apply.

* * *

Physical properties of some soils devoted to sugar cane in Costa Rica. M. A. GONZALEZ and S. A. GAVANDE. *Turrialba*, 1969, **19,** 235–245.—Physical properties of 8 sugar cane soils are discussed, 3 being andosols, 2 latosols, 2 lacustrines and one alluvial soil. In all the soils the clay content increased with profile depth, while the organic matter content decreased. The infiltration rate was found to vary with soil texture, compaction and constituent variables, being higher in volcanic ash soils, but low in latosols.

* * *

Herbicides for the control of weeds in sugar cane intercropped with soya beans and groundnuts. S. Y. PENG and W. B. SZE. *Trop. Agric.* (Trinidad), 1969, **46,** 333–342.—A complex pattern of agriculture involving sugar cane and intercrops or rotational cropping is practised in Taiwan. This paper reports continuation of earlier work on weeds and intercrops of cane in Taiwan. Eight herbicides and three frequencies of hand weeding were compared. Intercropping with soya beans or groundnuts had no significant effect on yield of cane or sugar. Herbicides affected the yield of intercrops and herbicides with high selectivity are required. Intercropping significantly reduced the number of cane tillers for the first six months.

* * *

Duration of freezing: the effects on field cane. J. E. IRVINE. *Sugar Bull.*, 1969, **48,** (1), 10–12.—Evidence is put forward to show that the duration of freezing is very important in determining the amount of damage incurred by the cane. At the Houma Station

4 hr at 21°F was sufficient to completely freeze mill cane; 48 hr at 31°F achieved the same results. Tables show the changes in juice quality in several varieties caused by freezing.

* * *

A discussion of the "hilling-up" practice with sugar cane in Taiwan. Y. J. HSIA. *Taiwan Sugar*, 1969, **14**, (4), 6–11.—Hilling-up, or the placing of loose soil round the sugar cane stool, is widely practised in cane-growing countries of the East but not in other cane growing countries, especially where mechanical harvesting takes place. The pros and cons of the practice are discussed and results of some recent experiments given. In general, hilling-up, under prevailing conditions, gave higher yields of cane. However, there was no advantage in deep hilling-up (not more than 15 cm), nor in hilling-up more than once. One operation should suffice and will save labour.

* * *

A brief introduction to the rotation system of sugar cane and pineapple in the gravel soil of Taitung Sugar Factory farm. L. W. HUEI and T. Y. JEIH. *Taiwan Sugar*, 1969, **14**, (4), 12–14.—The ability of the pineapple plant to resist drought or a low level of soil moisture is emphasized. The differences in root penetration of pineapple and cane are pointed out, that of cane being much greater. The manuring and mulching practised with a pineapple crop proves of great benefit to a subsequent sugar cane crop.

* * *

Farm machinery operation in the Taiwan sugar industry. W. C. HSU. *Taiwan Sugar*, 1969, **14**, (4), 21–23, 11.—Discussion is concerned chiefly with tractor operations, tractor maintenance, transportation and new planting operations. The Taiwan Sugar Corporation owns no less than 422 tractors which work some 40,000 hectares of land. More attention might be given to the training of operators and repair men. Railway transportation to the mill is good and infield transportation is improving. Cane planting and harvesting machinery is urgently needed in order to economize in labour.

* * *

Agricultural nematology. M. A. COSTILLA. *Didactic Univ. Nac. Tucumán, Facul. Agron. y Zootec.*, 1969, (5), 39 pp.—In recent years much attention has been given to the study of nematodes, especially those that attack agricultural crops or economic plants. This is because of the great amount of damage they can do. General information about nematodes is given—classification, morphology and anatomy (illustrated with diagrams). Laboratory methods of studying nematodes and possible control are discussed.

* * *

Sugar cane breeding programme in Argentina: comments and suggestions. J. A. MARIOTTI. *Misc. Univ. Nac. Tucumán, Fac. Agron. y Zootec.*, 1969, (29), 21 pp.—The objectives in the cane breeding programme are listed under seven headings, resistance to cold and suitability for mechanical harvesting being among them. The problem of obtaining viable seed and the induction and synchronization of flowering is discussed at some length.

* * *

Studies in sampling in sugar cane for the evaluation of various characteristics. J. A. MARIOTTI, M. S. VITRIU, J. A. ESPADIN H. and V. M. ROIG P. *Misc. Univ. Nac. Tucumán, Fac. Agron. y Zootec.*, 1969, (31), 13 pp. An investigation was carried out in 1968 to ascertain the best size of sample for the purposes of determination of cane characteristics, e.g. stalk height, diameter and weight, fibre, juice Brix, etc. A number of commercial varieties were included in the tests and data were statistically analysed. A high degree of variation was shown in regard to stalk weight and a low degree by juice characters. For stalk weight at least 10–15 stalks are required. For stalk height and diameter and for fibre a 5-stalk sample suffices.

* * *

Weed control main theme of 1969 mechanization demonstration. ANON. *S. African Sugar J.*, 1969, **53**, 736–739.—An account is given of the 1969 Annual Mechanization Demonstration of the South African Sugar Association. More than 1000 visitors attended and 30 agricultural machinery suppliers staged exhibits. Many of these are described or illustrated with photographs. Important points to be considered in weed control are outlined.

* * *

Know your weeds: Common weed species in the Victorias Milling district. ANON. *Sugarland* (Philippines), 1969, **6**, (7), 10–16, 27.—The more troublesome weeds of sugar cane in the island of Negros in the Philippines are illustrated with photographs and described. The worst weeds, arranged approximately in order of importance, are considered to be *Cyperus rotundus*, *Echinochloa colonum*, *Eleusine indica*, *Cynodon dactylon*, *Panicum repens*, *Portulaca oleracea*, *Euphorbia hirta*, *Digitaria sanguinalis*, *Physalis angulata*, *Stachytarphyta jamaicensis*, *Vernonia cinerea* and *Amaranthus viridis*.

* * *

The influence of variety on the drying and deterioration of cut cane. M. PINEDA L. *Bol. Azuc. Mex.*, 1969, (235), 42–45.—The extent of the deterioration that can take place with cut cane during the delay between harvesting and milling is pointed out. Several factors may be concerned in determining the extent of the juice deterioration or loss of sucrose, such as temperature, humidity, sun intensity, degree of exposure of cut cane and variety of cane. In regard to the latter a considerable variation has been found among varieties grown in Mexico. This is discussed.

Sugar beet agriculture

Experiments on mechanical thinning of sugar beet seedlings. C. D. ZANCHE. *Ind. Sacc. Ital.*, 1969, **62,** 180–190.—Four different tractor-drawn mechanical sugar beet thinners are described and their performance discussed. Two of the thinners work on a rotary principle.

* * *

Development of sugar beet breeding lines and varieties resistant to yellows. J. S. MCFARLANE, I. O. SKOYEN and R. T. LEWELLEN. *J. Amer. Soc. Sugar Beet Tech.*, 1969, **15,** 347–360.—Breeding for resistance to the two sugar beet virus diseases, beet yellows (BY) and beet western yellows (BWY) has been under way in Europe since 1948 and in the USA since 1955. Progress made so far in the USA is described. Two hybrids that utilized a US 75 selection as the pollen parent have been released as commercial varieties with the designation US H9A and US H9B. Under yellows conditions these have both given over 20% higher sugar yield than the standard check variety.

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Spraying trials with "Thiabendazole" against *Cercospora beticola* in 1967/68 in North Italy. F. KOCH and E. SCHRÖTER. *Zucker*, 1969, **22,** 638–641.—The effect of spraying with "Thiabendazole" was compared with spraying with "Fentin" acetate in the 1967 and 1968 seasons. It was found that a spraying rate of 600 g/ha (a.i.) and higher rates, produced about the same protective effect. Because of the short incubation period of the fungus and the high summer temperature in northern Italy and rapid development of the beet leaves it was not possible to reduce the number of sprayings.

* * *

Membrane feeding used in determining the properties of beet wi[illegible]er yellows virus. J. E. DUFFUS. *Phytopathology*, 1969, **59,** 1668–1669.—Laboratory studies are reported on BWYV, a circulative aphid-transmitted virus of widespread distribution in the USA and composed of a number of strains. The technique employed is fully described. The virus withstood drying and has remained active for at least 3 years.

* * *

Varietal resistance to yellows, vector control and planting date as factors in the suppression of yellows and mosaic of sugar beet. F. I. HILLS, W. H. LANGE and J. KISHIYAMA. *Phytopathology*, 1969, **59,** 1728–1731.—It was found that populations of apterous aphids (*Myzus persicae*) were reduced by 60% by varietal resistance and by 85% by insecticide applications. Varietal resistance and insecticide application reduced infection by the yellows viruses, but only the latter reduced infection by the beet mosiac virus. Root yield was correlated with escape and delay in yellows infection. Results suggest that varietal resistance may be due to resistance to virus transmission by the green peach aphid.

* * *

Effect of simulated hail injury on yield and quality of sugar beets. O. NEEB and C. WINNER. *Zucker*, 1969, **22,** 659–665.—Portions of the leaves were removed in varying degrees and at different times during the growing season, results of root and sugar yield being recorded. Some earlier results were confirmed by the experiments. Defoliation during July and August had the most severe effects on yield and sugar, much more so than defoliation early in the summer.

* * *

Results of experiments during 1958–68 on the use of newer fungicides against *Cercospora* disease of sugar beet. G. C. BONGIOVANNI. *Ind. Sacc. Ital.*, 1969, **62,** 237–246.—Copper treatment gave a 10% average increase in sugar yield. Triphenyltin derivatives gave a 24% increase. There was no appreciable difference between "Fentin" acetate and "Fentin" hydroxide. Experiments during the last three years showed that the three fungicides "Thiabendazole", "Benomyl" and "Thiofanata" were equal to, or even superior to, triphenyltin derivatives. They also have the advantage of being less toxic to man and warm-blooded animals.

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Trials of seed sowing of sugar beet with different types of precision drill. G. BARALDI and E. FRANCIA. *Ind. Sacc. Ital.*, 1969, **62,** 247–265.—Eleven makes of precision drill were used in the trials. These are described and illustrated. Differences were noted in the regularity of the placement of seed with different machines. Wider spacing of beet seed gave lower total yields of roots and sugar. Reseeding, in spite of favourable weather, did not give good results.

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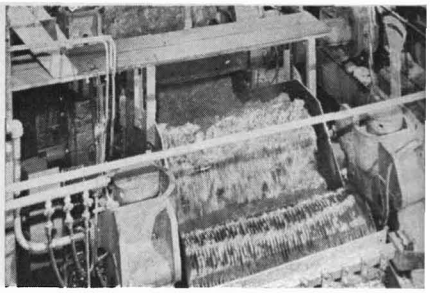
Docking disorder: a programme of field experiments. ANON. *British Sugar Beet Rev.*, 1969, **38,** 67–68.—The stunting disorder of sugar beet, known as Docking disorder, has responded well to overall soil fumigation (dichloropropene) for destruction of nematodes, but this treatment is expensive. Experiments with row fumigation are discussed. Several injection machines will be available in 1970 for growers whose crops have suffered from this malady.

Cane sugar manufacture



Studies on the working of (the) milling diffusion system at Sakharwadi. D. P. KULKARNI and J. R. UNDE. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Manufacturing), 41–66.—Operational results of the DDS diffuser at Sakharwadi are discussed and tabulated. High extraction was achieved under wide variation in fibre content, and reducing sugars analyses show that less inversion occurs compared with when milling. Preliminary investigations have been made on the effects of variations in retention time, temperature and pH in the diffuser.

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Use of "Sedipur TF2" as a settling agent. B. B. PAWAR. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Manufacturing), 80–85. Laboratory trials showed that the addition of the flocculant to juice taken from the continuous liming and sulphitation tank increased the settling rate and reduced the mud volume. It is proposed to carry out factory trials during the period of January-February when clarification difficulties cause slowing down of the crushing rate.

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Effect of "Instol" (a mixture of surface-active agents) on low-grade crystallization. K. A. SHAH, K. K. SHARMA and P. K. AREN. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Manufacturing), 86–94.—"Instol" was tested by boiling strikes in adjacent pans, one with and one without the surface-active agent, by boiling sugar for one week with and one week without "Instol", and by addition to crystallizers. Different amounts were used and at different stages in boiling. No useful influence was detected in promoting the exhaustion of molasses.

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First chemical cleaning of the boilers in Sakthi. K. K. MENON. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 1–6.—An account is given of boiler cleaning using "Clensol", an inhibited hydrochloric acid solution.

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Juice weighing scale with roller and ball bearings. R. K. KULKARNI. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 7–9.—An illustrated account is given of the Maxwell-Boulogne juice scale which has been fitted with roller and ball bearings in place of the original knife edges. The scale works smoothly and well, and it is anticipated that the bearings will last very much longer than the knife edges which wore rather quickly, leading to errors in weighing and chemical control.

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Milling of cane in conventional three-roller mills. S. K. SARAPH. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 10–12. Factors affecting mill performance are briefly discussed, including proper preparation, mill feeding, work openings, etc.

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Some aspects of economical installation of (an) evaporator station. S. K. SARAPH. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 13–14.—Literature references to high efficiencies of evaporators and juice heaters are quoted and a call made for investigation and improvement of performances of Indian plant.

* * *

Process of protective coatings in (the) sugar industry. S. K. CHATTOPADHYAY. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 15–21.—Aspects of corrosion protection are discussed and recommendations made for the appropriate treatment of cane sugar factory equipment.

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A concept and design of vacuum pan for low-grade massecuite. B. B. PAUL. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 22–31.—An earlier pan design[1] was intended for high-grade massecuites and is modified for low-grade. The pan is of the low-head type and the top tube plate is made slightly conical to aid massecuite flow. Circulation is also aided by helical guide strips in the peripheral downtake which impart horizontal movement to the massecuite on its downward passage. The saucer-shaped bottom of the pan is provided with steam jacket to promote vapour formation below the calandria. The new design of pan reduces boiling time by 20% compared with that of a conventional pan with a central downtake, and it operates with lower pressure steam.

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A concept and design of syrup sulphiter. B. B. PAUL. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Engineering), 32–36.—See *I.S.J.*, 1970, **72**, 177.

[1] *I.S.J.*, 1966, **68**, 118.

Technique of sugar boiling. D. P. KULKARNI. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 1–5.—Fundamental aspects of sucrose crystallization are discussed as are practical aspects, high and low-grade boiling, chemicals used and new developments.

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Low-grade boiling. S. G. GUPTE. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 5–7.—Recommendations are made for achieving successful low-grade boiling.

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A plea for following the D.M.C. process for production of white sugar without sulphur. NATIONAL SUGAR INSTITUTE. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 7–11.—The D.M.C. process[1] and its modifications are surveyed.

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Pan boiling in raw sugar manufacture. M. K. PATIL. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 12–14.—The 2-boiling and 2½-boiling systems as used in a number of countries in the Western Hemisphere are described and recommended for raw sugar manufacture in India in place of 3- and 4-boiling systems, and a number of factors affecting grain size and quality are discussed.

* * *

Instrumentation in pan boiling. V. D. DIWAN. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, (I—Seminar), 14–18.—Conditions necessary for successful instrumentation are listed and briefly discussed, e.g. constant vacuum, constant steam pressure, etc. Types of instruments and their function are then described, and advantages which can accrue from the use of instruments and automation are listed.

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Conditioning of molasses. M. G. JOSHI. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 19–22.—Molasses conditioning (temperature adjustment and dilution) is necessary so that its addition to a pan does not give a temperature "shock" which might cause crystallization of false grain, and so that any fine crystals present are dissolved. A locally-made conditioning tank at the author's factory is described. The removal of insolubles from molasses by centrifuging has been found by workers in Peru and Australia to be beneficial and it is considered that this treatment should be given attention in India.

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Bold grain boiling. M. Y. LONKAR and A. D. PATHAK. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 23–26.—Compared with normal grain, boiling of bold grain sugar is accompanied by increases in massecuite % cane, sugar losses, steam consumption and bagasse usage, and by reductions in pan floor capacity and centrifugals capacity. Evaporator capacity may be affected if the clarification process needs to be changed.

Methods of graining for low-grade massecuites. Y. K. ATHAWALE. *Proc. 23rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1969, (I—Seminar), 26–30.—The "waiting" and "shock" methods of graining are briefly mentioned and the full seeding technique discussed in more detail, with aspects of seed preparation, the determination of supersaturation, and introduction of seed into the pan.

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Addition of final molasses to the exhaustion crystallizers. T. MÉNDEZ C. *Bol. Ofic. A.T.A.C.*, 1969, **24,** 213–215.—Final molasses exhaustion by cooling is limited by difficulties in handling the massecuite; these can be remedied by dilution with water, with the feed syrup supplied to the massecuite, or by reheating the cooled massecuite. These all have their disadvantages and it is considered better to add final molasses, diluted to 70-75°Bx, for lubrication. Suitable equipment is briefly described.

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Influence of non-sugars on the manufacturing process. J. C. GONZÁLEZ M. *Bol. Ofic. A.T.A.C.*, 1969, **24,** 231–240.—The relationship between non-sugars and molasses formation is discussed as well as the individual effects of polysaccharides, formation and elimination of non-sugars in clarification, formation of non-fermentables, the importance of nitrogen, and aspects of boiling, including molasses produced, purity drops between massecuites, retention formulae, non-sugars balance, etc.

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New developments in handling and storage of bagasse. J. H. PAYNE. *Sugar J.*, 1970, **32,** (8), 18.—See *I.S.J.*, 1970, **72,** 177.

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Some aspects of sugar cane diffusion. S. L. SAXENA and S. K. D. AGARWAL. *Sugar J.*, 1970, **32,** (8), 19–21.—The extent to which sugar extraction in commercial equipment is the result of true diffusion and of lixiviation is discussed, and it is considered that the former is responsible since conditions of retention at 70°C for 30–40 minutes will result in destruction of semi-permeable cell walls, and also since extractions of up to 97% can be achieved after passing through two mills where cell breakage achieved is only 83·3–85%. Use of shredders for cane preparation is briefly discussed as are the roles of draft, temperature, and retention time; the possibility of inversion in diffusers and the use of lime to raise the pH; and the dewatering of exhausted bagasse.

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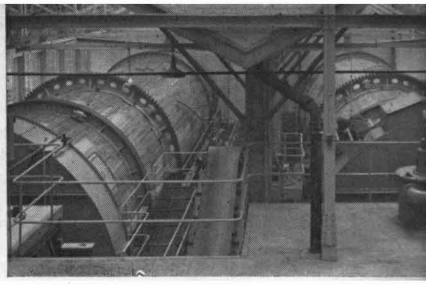
Continuous centrifugals. R. HARDY. *Rev. Agric. Sucr. Maurice*, 1969, **48,** 227–230.—The operation and disadvantages of the early "Hydromat" continuous centrifugal are described and an account given of the improvements found in modern machines such as are now in use in Mauritius. Recent performance data are tabulated for three sugar factories, indicating at two of them the improvement of performance as operators became more accustomed to the machines.

[1] Gupta: *I.S.J.*, 1966, **68,** 340.

Beet sugar manufacture



(Beet) Storage tests (in Austria). A. GRAF. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 61–62. Beet stored for 40 days in a pile 6 m high, 50 m wide and over 150 m long was subjected to forced ventilation at the rate of 22 cu.m. air/hr/ton of beet, whereby the temperature was reduced to 11·52°C compared with 13·51°C in an unventilated pile. While beet and sugar losses were substantially reduced, for better distribution of the air it is suggested that the air draft be increased by 30–40% and the air feed pipes lengthened.

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Beet quality as a function of topping. L. WIENINGER and N. KUBADINOW. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 72–73.—Best results, expressed as thick and raw juice and beet quality, were obtained when beet was manually harvested and topped. After this method, the techniques used gave results in the descending order: mechanical topping at normal height > mechanical topping at above-normal height > leaf removal only.

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Thin juice production after a lime-phosphoric acid process. W. BRAUNSTEINER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 76.—Although treatment of juice with lime and phosphoric acid caused an initial reduction in melanoidin N, peptide N and colour to around zero, subsequent heating to 85°C at pH 12 caused a reappearance of all three. A considerable fall in total N in the initial stage was reduced in subsequent stages.

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Tests on formalin distribution in diffusion plant. F. HOLLAUS. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 76–77.—Tests at three Austrian sugar factories to determine where the maximum formalin concentration occurred and the level of this concentration in diffusers, the furthest point from the formalin feed at which formalin could be found in a tower diffuser, and the concentration of formalin in the raw juice in the bottom tower zone, gave insufficient results to permit an optimum disinfection scheme to be established for the diffusers. A simple iodometric titration method revealed a formaldehyde concentration of 0·1% in raw juice during the campaign.

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Investigation on the CO_2 and O_2 concentration in beet piles. B. HOMOLAR. *Jahresber. Zuckerforschung-Inst.* (Vienna), 1968/69, 77.—Tests at two sugar factories with equipment in a portable cabinet demonstrated the suitability of the system for determination of the CO_2, O_2 and temperature distribution in beet piles. A study of the effects of wind and ambient temperature on the composition of the atmosphere inside the pile enabled quantitative estimates to be made of the effect of ventilation on this atmosphere. Tests were also conducted on storage of beets in sealed containers at various temperatures.

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Sulphitation of sugar factory juices. H. POLLERES. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 84–85.—Spectroscopic studies of the effect of sulphite on the browning products from sugar are discussed. Since sulphitation causes conversion of a proportion of the hexoses and trioses in the juice to stable sulphonic acids, which cannot condense further to form colorants, and since an excess of sulphite considerably inhibits the formation of a browning product from invert sugar and its highly reactive decomposition products, it is suggested that better results could be obtained in sulphitation by increasing the SO_2 feed (in practice the invert sugar:sulphite ratio is generally about 1:5).

* * *

The behaviour of albumins during juice purification with lime. J. BARTSCH. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 90–91.—In experiments on coagulation of raw juice colloids with aqueous $Ca(OH)_2$ it was found that added sucrose did not impair the sedimentation whereas glutamine increased the fine particle size (from 0·0175 to 0·0240 mm) by virtue of its surface-active properties while the larger particles remained unaffected. In dilute raw juice, lime-colloid coagulates formed had a maximum size of 0·055 mm and contained almost all of the $Ca(OH)_2$, and all of the colloids were precipitated. When 1:60 dilute press juice (containing 98 mg reactive N per kg) was used instead of raw juice, the size of the coagulate particles fell to a maximum of 0·045 mm, indicating that the coagulate from raw juice does not contain protein and pectins but decomposition products of these. Amino-acids and dipeptides are not the major constituents, since these form a coagulate with lime having a maximum size of 0·025 mm.

* * *

Control in carbonatation. W. O. BERNHARDT and F. G. EIS. *J. Amer. Soc. Sugar Beet Tech.*, 1969, **15**, 384–387.—In the customary carbonatation control, a feed-back system adjusts gas flow to correct a deviation from the pH set point as measured in the treated juice, such a deviation generally being due to a change in saccharate milk addition. To eliminate the variability

in juice pH which results from the time-lag between measurement and the effect of the corrective action, a new system has been adopted at Woodland sugar factory. Here the saccharate milk, at automatically controlled density and temperature, is delivered from a buffer tank through a flow rate recorder/controller governed by the level in the tank. The flow rate is converted into a pneumatic signal and through a ratio relay which provides another pneumatic signal controlling the gas input so that compensation for variations in saccharate milk supply is instantaneous. The pH of the treated juice is measured and governs the action of the ratio relay so that the gas flow relative to saccharate milk is controlled to give the desired final pH which may be easily adjusted in consequence. Control of the juice alkalinity is far superior by the new system compared with the old.

* * *

Waste water recirculation as a means of river pollution abatement. W. W. BLANKENBACH and W. A. WILLISON. *J. Amer. Soc. Sugar Beet Tech.*, 1969, **15**, 396–402. With freezing weather usually continuous after 1st November, all beets for the Fort Garry sugar factory near Winnipeg must be harvested early and piled. Handling by grabs damages the roots and results in leaching of some sucrose by the flume water which also receives most of the loam soil which is attached to the piled beets. To avoid river pollution, a 5,000,000 gal/day recirculation system has been adopted in which the flume water is passed through a travelling water screen to remove coarse organic material, and then through a vibrating screen station. Milk-of-lime is added to raise the pH to over 11·5 (which gives excellent coagulation and sedimentation) and the water enters a clarifier from which the overflow returns via a surge tank to the flume and beet washer supply tank. The underflow from the clarifier is pumped to a disposal area which is graded to give good drainage to a collection ditch; the clear water from the latter (usually of higher clarity than the clarifier overflow) is pumped back to the clarifier. The concentration of dissolved solids climbs steadily during the first six weeks of operation but stabilizes at about 10,000 p.p.m. (6000 p.p.m. B.O.D.), after which no more sugar is presumably lost from the beets to the flume water.

* * *

Evaluation of a technical sugar extraction process. F. SCHNEIDER, D. SCHLIEPHAKE and A. WOLF. *Zucker*, 1970, **23**, 37–42.—Observations were made of the change in cossette and juice concentration during diffusion in a BMA tower. Two laboratory test procedures were developed for determining diffusion parameters using cossettes of various shapes and sizes. Comparison of laboratory diffusion under ideal boundary conditions with the process under normal practical conditions showed that the separation efficiency in the laboratory unit agreed with values obtained with a comparable diffusion system. The effects of change in juice draft and diffusion time on pulp losses were determined and errors resulting from use of the SILIN formula for calculation of diffusion efficiency investigated.

* * *

Hoppers and silos for bulk storage. W. WEILANDT. *Zucker*, 1970, **23**, 42–49.—Problems connected with bulk storage are considered and various types of hopper and reclamation equipment manufactured by West German firms are surveyed. Equipment for measurement of the charge level is also described.

* * *

Low-grade massecuite crystallization with blowing of air over its surface. S. A. BRENMAN, A. L. SOKOLOVA and YU. D. KOT. *Izv. Vuzov., Pishch. Tekhnol.*, 1969, (6), 63–65.—Low-grade massecuite in a crystallizer is further concentrated by subjecting it to a stream of hot air at 78–80°C blown over its surface and its crystal content increased in this way from 37·6 to 60·0% instead of the 49·0% achieved merely by cooling[1]. Even better results, so far as molasses exhaustion is concerned, were obtained by combining the hot air treatment with injection of water into the massecuite, when the crystal fraction was increased to 50·6%.

* * *

Sweetening-off carbonatation mud in a zig-zag shaped channel. V. I. GORBATYUK. *Izv. Vuzov, Pishch. Tekhnol.*, 1969, (6), 146–149.—A laboratory test-piece consisting of a vertical zig-zag shaped tube is described which was used in tests on sweetening-off carbonatation mud by means of a stream of water ascending against a free-falling stream of mud. Results are given in the form of a graph of mass transfer *vs.* flow rate.

* * *

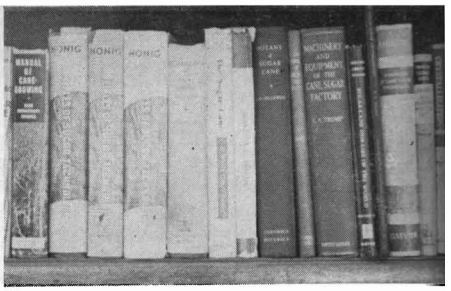
Sugar industry relationship with water conservation. I. RADICS. *Cukoripar*, 1969, **22**, 213–215.—The organization of water conservation in Hungary is discussed and the quality of sugar factory effluent and its effect on drainage canals considered. Means of solving the problem of effluent disposal and results so far achieved are described.

* * *

Comparative aggressiveness of fungi: the agents causing pile rot in sugar beet under different temperature regimes. YU. S. TOPOROVSKAYA. *Dostizhenie Nauki-Proizvodstvu* (Kiev), 1966, 106–108; through *S.I.A.*, 1969, **31**, Abs. 69–1201.—Petri dishes containing 2% beeta gar-agar were inoculated with fungi extracted from beet either diseased in the vegetative period or rotted in piles. 15 samples were taken from each crown and grown at 26°±1°C, 16°±1°C or 4°±1°C in sterile cultures, designed by SHEVCHENKO for *Botrytis cinerea*, *Rhizopus nigricans*, *Phoma betae*, *Fusarium* and *Penicillium*. Results are tabulated. *Botrytis* predominated at low temperature and was the only species which was more numerous at 16° than at 26°C. *Rhizopus* and *Fusarium* were more active than *Botrytis* at 26°C. The activities of *Phoma* and *Penicillium* increased most in the ranges 4–16°C and 16–26°C, respectively.

[1] See also *I.S.J.*, 1970, **72**, 181.

New books



Guide to the literature of the sugar industry. M. SCHALIT. 172 pp.; $6\frac{1}{2} \times 10$ in. (Elsevier Publishing Co. Ltd., 22 Rippleside Commercial Estate, Barking, Essex, England.) 1970. Price: 65s 0d.

In this work the author approaches the task of compiling a bibliography on sugar literature by separating the book into 12 sections plus 3 appendices and a name and a title index. After a general introduction which also covers libraries and general works on sugar there are 11 chapters entitled: "Bibliographies, abstracts and reviews, indexes and patents"; "Government publications"; "Dictionaries, directories and yearbooks"; "Publications on sugar economics"; "Periodicals"; "Organizations and their publications"; "Publications on agriculture and agronomy, including entomology, pathology and plant breeding"; "Publications on technology and sugar chemistry"; "Handbooks and tables"; "Publications on history and biography"; and "Translation and translations". The 3 appendices include a bibliography of American doctoral dissertations on sucrose, sugar, sugar beet and cane since 1938; Sugar Research Foundation Technical Reports 1945–1953; and a bibliography of papers presented at the British Sugar Corporation Technical Conferences 1948–1966.

Undoubtedly the work will prove of great benefit to those sugar technologists who wish to increase their knowledge of developments in the industry, although criticisms can justifiably be made of the book. To start with, the list is incomplete, particularly as regards proceedings and journals published in the USSR which, although not specifically concerned with the sugar industry, do contain articles and papers on sugar technology. There are many books which are not mentioned which, although out of print (as are some which are included), still deserve some attention if the aim is to present as complete a bibliography as possible. The bias is obviously on the American side, but this is perhaps understandable since the author is American. Sometimes it is difficult to decide whether views expressed by the author on particular publications are his own or not—objectivity is all-important in such a work as this. From this viewpoint, it is probably better, as with multilingual dictionaries, to have a number of compilers (this would certainly make for completeness) rather than one author, or to restrict the work to listing publications without attempting to evaluate them, as there is always danger of exaggerating the importance of any one publication. However, in all, the work is a valiant attempt to fill a gap in sugar literature and will probably be considered a worthwhile acquisition by institutes and libraries as well as the more progressive technologists who wish to know how to obtain more information than is merely available locally.

* * *

Brechungsindex von Saccharoselösungen (Refractive index of sucrose solutions). K. ROSENHAUER, F. SCHNEIDER and A. EMMERICH. 27 pp.; $6\frac{1}{4} \times 9$ in. (Institut für landwirtschaftliche Technologie und Zuckerindustrie, 33 Braunschweig, Langer Kamp 5, Germany.) 1970.

Two sets of tables are presented showing the refractive indices for yellow sodium light (589 nm) and green mercury light (546 nm) of sucrose solutions in the approximate concentration range 0–84% by weight. They are based on measurements made by the Institut für landwirtschaftliche Technologie und Zuckerindustrie in collaboration with the Physikalisch-Technische Bundesanstalt, and were adopted by the 14th Session of ICUMSA in 1966. The values refer to air at 760 torr, 20°C and 50% relative humidity. For concentrations in the range 0–65% the values have an accuracy equivalent to a concentration error of $\pm$ 0·001–0·002%. In all cases the concentration is calculated to 3 decimal places. Compensating polynomials have been used in the calculations, the values beyond 65% concentration being extrapolated. For ease of interpolation a column is given showing the difference between the last two concentrations ($\Delta P.100$, where P = concentration).

* * *

CSR—100 years a sugar miller. 9 pp.; $7 \times 9\frac{1}{2}$ in. (The Colonial Sugar Refining Co. Ltd., 1–7 O'Connell Street, Sydney, N.S.W., Australia.) 1970.

This is a brief but highly interesting story of the establishment in 1870 of a raw sugar manufacturing industry by the CSR Company which until then had been concerned only with sugar refining. It tells of the setbacks encountered in the operation of the original mills at Southgate, Chatsworth and Darkwater, none of which survived, but also tells of the valuable experience gained from the venture. This experience enabled the company to develop its raw sugar operations so that it now has the capacity to produce nearly a million tons of raw sugar in a season, operating three mills in New South Wales, four in Queensland and four in Fiji, the last operated by South Pacific Sugar Mills Ltd., a CSR subsidiary. Some early photographs of historical interest are reproduced.

I.S.J.

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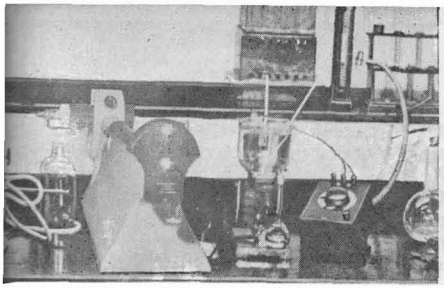

Laboratory methods & Chemical reports

Experiments on sugar beet lipids. III. Composition and distribution of lipids in the sugar beet. U. BEISS. *Zucker*, 1969, **22**, 701–706.—Details are given of paper chromatographic determination of beet lipids, of which 28 were found, including 13 phospholipids, 11 glycolipids and 4 unknown lipids. Chromatograms and R_f values are given as well as the lipid content in various parts of the beet and the phosphatide distribution in 12 different beet sections. The lipid content in beet molasses was found to be very low (0·05% on dry solids).

* * *

Thermography and kinetics of sugar crystallization. A. V. ZUBCHENKO and V. P. CHERPAKOV. *Sakhar. Prom.*, 1969, **43**, (12), 43–45.—Tests with refined sugar solution demonstrated the validity of a method for determining crystallization velocity from the adiabatic temperature difference. For this, a differential thermocouple connected through a ballast resistance to a reflecting galvanometer measures the temperature difference with time between the test solution (supersaturated) and a standard sample, the adiabatic temperature difference being obtained by calculation from the resultant thermogram.

* * *

Relationships between beet analysis and beet processing value. L. WIENINGER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968–69, 74.—Modification of the STANĚK & PAVLAS method for the "blue number" determination permitted its use for α-amino N determination in routine analysis of beet brei and slices; the results agreed with values obtained with the MOORE & STEIN method. Good correlation was found between beet K, Na and α-N contents on the one hand and thick juice purity and pH fall between thin and thick juice on the other.

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Comparison of a laboratory standard juice purification scheme with various factory units. L. WIENINGER and N. KUBADINOW. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968–69, 75–76.—Comparison between factory juice purity, alkalinity, lime salts content, invert sugar content, total N content, etc. and the same factors for laboratory juices showed good agreement where a standard carbonatation scheme was used in the laboratory and the factory results represented three different schemes. However, factory thin juice colour, expressed in °St, was about 23% greater than the laboratory values and, expressed as the extinction coefficient at 420 nm, was about 70% greater. On the other hand, the minimum colour contents found for the factory juices were about 30% lower at 560 nm and 23% lower at 420 nm than the minimum found in the laboratory.

* * *

Determination of beet α-amino nitrogen. N. KUBADINOW and L. WIENINGER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 77–79.—With the aim of establishing a semi-automatic method for amino-N determination in beet which would be suitable for tarehouse analysis, a modification of the STANĚK & PAVLAS method (in which the pH is maintained at 6·0 and the amount of reagent used increased from 10% v/v to 20% v/v) was compared with the MOORE & STEIN method. With 47 samples in which the α-amino N content ranged from 96 to 500 mg/100 pol, the mean values obtained with the two methods differed by 4·7 mg/100 pol, which is not significant statistically, so that a very close correlation exists between them.

* * *

Juice colour change as a function of pH. N. KUBADINOW. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 79–80.—Tests with factory carbonatation juices showed that generally increase in the pH in the range 7–12 caused reversible changes to occur in the ultra-violet region of the spectrum. A band appeared with a maximum at 262 nm, a band occurring at 265 nm gradually extending to the 290–310 nm range, and at 340 nm a strong band occurred. However, no pH-dependent bands were found with laboratory carbonatation juice.

* * *

Determination of iron in sugar factory juices by means of atomic absorption spectroscopy. G. FORSTER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 80–81.—Inorganic matter in model solutions had little effect on iron determination by absorption spectroscopy, whereas organic matter, particularly sugar and various albumins, had a considerably greater effect. The absorption was reduced by the higher viscosity of the solutions compared with that of standard iron solutions, and the determined value was up to 27% lower than the actual content. Addition of methanol to reduce viscosity was not effective. Tests with thin juices showed that the reduction in apparent iron content was approximately the same as in sucrose solutions of identical viscosity, so that it would be possible to introduce a correction and express the iron content as a relative percentage.

Iron determination in thin and thick juice. W. WRUSS. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 81.—Reference is made to two analytical methods which use α,α'-dipyridyl and "Ferron", respectively, and are undergoing tests in cooperation with the Institute for Chemical Technology of Inorganic Matter at the Vienna Technical University and with a number of sugar factory laboratories.

* * *

Formaldehyde determination in diffusion juices. F. HOLLAUS and G. POLLACH. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 81–82.—The method of BIDAN *et al.*[1] for determination of formalin using chromotropic acid has been modified to permit rapid determination (45 min) in a greater number of samples. All inaccuracies with the modified method are attributed to error in the steam distillation used. Scatter in the values given by the colorimetric determination is not considered significant. Formalin concentrations greater than 0·1% may also be determined by a simple iodometric titration method which takes only 15 min.

* * *

The behaviour of browning products ("colorants") from sugar manufacture on ion exchangers. E. STEINECK. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 82–83.—Ion exchange treatment of thin juice removed only a portion of the low molecular browning products, whereas the same treatment was much more effective with thick juice, in which the browning products have undergone concentration. Gel filtration of molasses solutions showed that spectral maxima occurring in the ultra-violet were caused by both high-molecular and low-molecular browning products. Melanoidins isolated by gel filtration had a maximum at 325 nm in the ultra-violet and were formed from peptides and sucrose decomposition products. Juice colour formation in evaporation is attributed mostly to concentration of the browning products already present in the thin juice, while increase in the browning products by further sucrose decomposition is only very slight. Tests were conducted to find suitable resins for adsorption of particular components of the browning products.

* * *

The melanoidin problem in the sugar industry. G. PETERSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 83–84.—Reaction products having a spectral maximum in the ultra-violet at 330 nm (recognized as typical for melanoidins) have been identified as substituted 1-carboxymethyl-1,2-dihydro-2-ketopyrazines formed by condensation of 1 mole of an α-dicarbonyl compound with 1 mole of peptide. Determination of the extinction coefficients of eight ketopyrazines in the U.V. has permitted quantitative analysis methods to be developed for determining peptides, two of which are suitable for use with factory juices. The possibility of using them to compare carbonatation schemes is suggested.

The effect of non-sugars on sucrose crystallization rate. B. SHAMIRIAN. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 86–87.—Studies of model solutions showed that invert sugar, trioses (methylglyoxal) and thermal decomposition products did not reduce the crystallization rate, while alkaline decomposition products had only a slight reducing effect. On the other hand, a considerable fall in the crystallization rate was caused by reaction products from equimolar quantities of peptides and trioses, while products formed by reaction of peptides with excess trioses also caused a reduction. Reaction products formed from amino-acids and trioses affected crystallization only with a 20-fold excess of amino-acid. Parallel studies with factory juices and sugar samples showed that the methods used in the investigation were valid. In tests to establish the effect of surface-active agents, in only one case was the crystallization rate increased.

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Investigations on crystallization of sugar solutions. W. SZOKOL. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 87–89.—Boiling point elevation studies showed considerable differences between the values obtained (for 67–83°Bx sucrose solutions) and data from the literature. Further tests demonstrated the suitability of using b.p.e. for boiling control. In tests with a model solution, massecuite viscosity was found to be mainly dependent on crystal content and less so on crystal shape. Viscosity is considered a good control parameter during the later stages of boiling. The seed content of a slurry was determined during laboratory boiling tests and agreed well with the figure of $5{\cdot}5 \times 10^9$ per gram as measured by direct counting of the crystals using photomicrography. The maximum on the particle size distribution curve lay at 2·5μ, although particles of 20μ diameter were found. During massecuite cooling the curve was found to extend even more without new grain being formed. Direct measurement of crystal photographs gave somewhat larger crystal diameters than did sieve analysis.

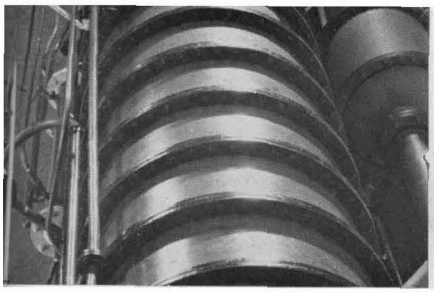
* * *

Corrosion tests. W. BRAUNSTEINER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968/69, 89.—The effects of betaine, glutamine, glutamic acid and lactic acid at pH 7–11 (measured at 20°C) and 100°C on iron samples were investigated. Betaine had a much smaller corrosive effect than did the other three, the corrosive effects of which increased considerably with fall in pH. Increase in sucrose concentration reduced the corrosive effects of the non-sugars.

* * *

Continuous culture of aerobic and anaerobic bacteria. G. POLLACH. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1968–69, 89–90.—A method for continuous culture of aerobic and anaerobic bacteria has been devised which is of considerable use in studies of the sugar decomposition capacity of the micro-organisms.

[1] *Ind. Alim. Agric.*, 1965, **82**, 699–708.



By-products

The use of sugar factory muds as soil conditioner in beet cultivation. P. BOGDANOVA, E. MANOV and P. MILANOV. *Ind. Alim. Agric.*, 1969, **86**, 945–948.—The use of beet sugar factory muds as fertilizer and soil conditioner has been tested and found to result in increased yields of beet and sugar per ha and of wheat planted after the beet.

* * *

Different levels of high-test and final molasses for layers. R. PEREZ. *Rev. Cubana Cienc. Agric.*, 1968, **2**, 269–271.—Although replacement of cereal with molasses in poultry diet tests caused a drop in the number of saleable eggs, an increase in egg breakages and poorer feed conversion, the economic advantages of using molasses in Cuba, where imported grain costs five times as much as molasses, are considerable. Details are given of the test results.

* * *

Recent advances in the utilization of sugar cane bagasse. V. T. XUAN and R. SAMANIEGO. *Proc. 16th Conv. Philippines Sugar Tech.*, 1968, 326–339.—This survey covers a number of aspects of bagasse utilization, including storage and preparation, depithing, pulping and the various uses to which bagasse and its pith can be put. Mention is also made of bagassosis, a pulmonary disease associated with the handling of dry bagasse, and 127 references are given to the literature.

* * *

A conceptual report on the production of sucro-chemicals from sugar cane juice. A. DIOKNO. *Proc. 16th Conv. Philippines Sugar Tech.*, 1968, 340–346.—A survey is presented of the by-products obtainable from mixed juice, and the basic chemical reactions involved are listed.

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Bagasse structural board—our hope? M. F. GLORIA. *Proc. 16th Conv. Philippines Sugar Tech.*, 1968, 347–352.—The advantages of using bagasse for structural board manufacture in the face of dwindling timber reserves in the Philippines are discussed and the physical properties of bagasse board compared with those of boards from selected woods. Details are given of the bagasse board manufacturing process and of possible applications for the board.

* * *

Molasses as raw material for industry. R. A. CRUZ. *Proc. 16th Conv. Philippines Sugar Tech.*, 1968, 353–356.—The various by-products obtainable from cane molasses are listed and the Philippine imports of petroleum products in 1965 (quantities and costs) are tabulated to show why it would be advantageous to produce alcohol from molasses and blend this with gasoline for use as automotive fuel. Other factors must be balanced against the credit side, it is emphasized, and a thorough economic study of the problem is needed.

* * *

The rôle of molasses in the manufacture of monosodium glutamate. R. Y. CHUA. *Proc. 16th Conv. Philippines Sugar Tech.*, 1968, 357–360.—Reference is made to the production of monosodium glutamate, using cane molasses as carbohydrate source, by the Philippine Fermentation Industrial Corp. Reasons for the use of molasses are listed, but a warning is given that a fall in quality beyond the standard requirement which has occurred plus the fluctuation in molasses prices will cause molasses users, particularly Japan, to look to other suppliers.

* * *

A complete ration composed of concentrates and sugar cane bagasse *vs.* a conventional ration of Pangola grass and supplemental concentrates for milk production. P. F. RANDEL, M. SOLDEVILA and B. SALAS. *J. Agric.* (Univ. Puerto Rico), 1969, **53**, 167–176.—In previous experiments ground sugar cane bagasse was found to be an excellent source of fibre in complete rations for dairy cows. The present experiments was conducted to compare a bagasse-concentrates ration and a conventional system of Pangola grass grazing plus supplemental concentrates for milk production. Results are discussed in detail. On balance satisfactory results were obtained in regard to average milk yield, butter fat, etc. with bagasse treatment. However, results emphasized the indispensability of obtaining high average milk production (at least 40 lb per cow daily) in order to make the complete ration economically competitive.

* * *

Filter cake as a source of fats. D. A. NAVIA M. *Bol. Ofic. A.T.A.C.*, 1969, **24**, 150–163.—In a study of the contribution which can be made to the growing need for fats in Cuba, the author has reviewed the literature on the constitution of cane wax extracted from filter cake, the various processes for extraction of fats from the crude wax and their yields, fractionation of the fats and identification of the constituents of the saponificable and unsaponificable fractions. The prospects for such fats is discussed with a brief note on the economics of their extraction, and it is pointed out that by-products would be the refined hard wax and resin which would also be of value.

Patents

UNITED STATES

Cane harvester. A. K. VYAZNIKOV, A. I. DAVYDOV, V. P. EGOROV, N. N. MELNIKOV, B. A. POPOV, E. I. KHOKHLOV and N. F. CHARYKOV. **3,472,299.** 1st March 1967; 14th October 1969.

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Electrodialysis of sugar phosphorylation reaction solutions. R. G. CAMPBELL and C. C. OLDENBURG, *assrs.* COLONIAL SUGAR REFINING CO. LTD., of Sydney, NSW, Australia. **3,472,750.** 2nd February 1967; 14th October 1969.—$CaCl_2$ is removed from a sugar phosphorylation reaction mixture (see USP 3,437,652[1]) by maintaining in an electrodialysis zone and maintaining a D.C. (pulsed) voltage so that the Ca^+ and Cl^- ions are transported through the (ion exchange membrane) boundaries while the sugar phosphates are kept within the zone.

* * *

Cane harvester reversible topper. J. J. ZAGORSKI and E. W. WRIGHT, *assrs.* MASSEY-FERGUSON (AUSTRALIA) LTD., of Sunshine, Va., Australia. **3,473,308.** 1st June 1967; 21st October 1969.

* * *

Cane diffuser. W. KAETHER and W. DIETZEL, *assrs.* BRAUNSCHWEIGISCHE MASCHINENBAUANSTALT, of Braunschweig, Germany. **3,475,214.** 14th October 1966; 28th October 1969.—See UKP 1,145,784[2].

* * *

Cane harvesting method. C. W. HART, of Hilo, Hawaii, USA, *assr.* C. BREWER & CO. LTD. **3,475,886.** 21st June 1967; 4th November 1969.

* * *

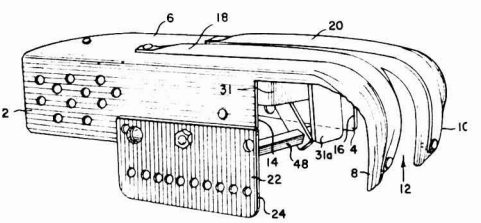
Purifying, decolorizing and clarifying raw sugar juices and raw sugar solutions. F. G. LIPPE and F. SUPPAN, of Cologne, Germany. **3,476,597.** 10th February 1966; 4th November 1969.—To the juice, at room temperature and pH about 7, is added a 1% solution of an extract of an umbelliferous plant (*Levisticum officinale*) and the treated juice subjected to ion exchange or dialysis, filtered on polyamides, and subjected to the action of metal oxides or hydroxides to render impurities present into filtrable compounds, after which it is treated with ferric ions and subjected to a counter-current of ozone-carrying air.

Sucrose-based surfactants as aids in sugar refining and sugar crystallization processes. H. L. SANDERS, of Skokie, Ill., USA, *assr.* VARNEY CHEMICAL CORPORATION. **3,476,598.** 10th May 1966; 4th November 1969.—Massecuite viscosity is reduced by adding [0·01 — 1% (0·03–0·5%) of] a sucrose [fatty acid (dioleate)] ester, ether or ether-ester surfactant or a mixture of these (lauryl sucrose ethers, lauroyl esters of sucrose polypropoxypropanol).

* * *

Shield for protecting the hand and holding the stalk during cane cutting. F. J. CASTRO, of San Juan, Puerto Rico. **3,477,756.** 19th February 1968; 11th November 1969.

The shield, made of metal or other material, comprises a rigid U-shaped section having a back wall 6 and side walls 2, 4 sufficiently long to cover beyond the fingertips and the back of the forearm. To provide additional protection for the thumb (of the left hand in the diagram) is a plate 22 attached to one side wall 2. The back wall 6 is turned inwardly beyond the edge of the fingertips and bifurcated to form two parts 8, 10 which are reinforced by ribs 18, 20 also of metal or other material.



Underneath the shield and across from one side wall to the other is a fixed bar while a similar bar 48 connects two levers which are parallel with the side walls and are connected to them at fixed pivot points. At the other end of the levers are pivots by which they are linked to arms which slide along in the direction of and underneath the back wall 6, carrying with them the transverse arm 31 which joins their outermost ends and the plate 31a which is fastened to the arm. A spring connects the arm 31

[1] *I.S.J.*, 1970, **72**, 123.
[2] *ibid.*, 59.

Copies of Specifications of United Kingdom Patents can be obtained on application to The Patent Office, Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent (price 5s 0d. each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C. 20231 U.S.A. (price 50 cents each).

to the wrist end of the back wall 6 so that it is held back within the shield while the bar 48 is held forward. When the user's grip is tightened on the fixed bar and bar 48 the latter is drawn toward the rear of the shield and the plate 31a is thrust forward so that a cane stalk can be gripped between it and the curved parts 8, 10 for cutting by a knife or machete held in the other hand.

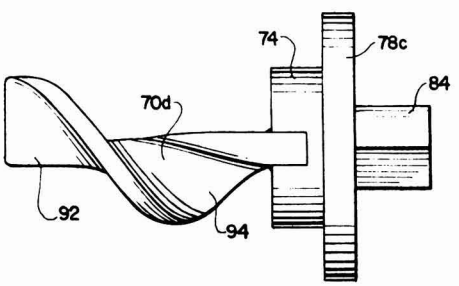
* * *

Sugar beet processing. L. M. KOELSCH, of Pittsfield, Mass., USA, *assr.* BELOIT CORPORATION. **3,477,873.** 3rd October 1966; 11th November 1969.—Whole beets are cut into thin chips and these passed into a defibrator in a disc attrition mill to produce fibrils. These are successively passed through a screw press to remove their juice content, to a leaching tank where water is added to dilute the residual juice, and through another press to remove the sweet water. The beet juice is purified and its sugar content crystallized.

* * *

Beet pulp press. H. M. BAUSERMAN, of Littleton, Colo., USA, *assr.* STEARNS-ROGER CORPORATION. **3,478,679.** 24th May 1967; 18th November 1969.

The press comprises a vertical cylinder within which rotates a driven spindle which is narrow at the upper feed end and wide at the lower discharge end so that the volume available for the pulp is reduced as it passes downwards. This passage is induced by an interrupted scroll on the spindle, stationary bars protruding inwardly from the wall of the cylinder and into the gaps between the scroll sections. The spindle is perforated so that water expressed from the pulp pass through to its interior from which it is withdrawn at the bottom of the press.



In order to achieve more efficient and flexible operation, to suit pulp of varying characteristics, the stationary bars are designed to do more than prevent rotation of the pulp with the spindle; they are made rotatable so that they offer more or less resistance to the pulp movement and thus can bring about an increase or decrease in the flow rate of pulp. In addition, they are provided with plough-share or helical shapes, as in the illustration, so that they cause mixing of the pulp, which improves water removal, while retaining the ability to govern flow rate fairly precisely.

Sugar (juice) purification. F. C. BUHL, R. D. LEES and D. J. MONAGLE, *assrs.* HERCULES INC., of Wilmington, Del., USA. **3,479,221.** 15th November 1966; 18th November 1969.—An aqueous sugar slurry (juice containing insoluble fibre and mud particles) is purified by stirring with 0·1–10 p.p.m. (0·5–5 p.p.m.) on total slurry weight [0·1–100 p.p.m. (1–40 p.p.m.) on insoluble solids weight] of a copolymer formed from 99–20% [97–50% (95–60%)] of acrylamide and the remainder β-methacrylyloxyethyltrimethylammonium methyl sulphate. This increases the rate of flocculation and the amount of solids settling out of the slurry. The mud is removed, treated again with the copolymer and then dewatered.

* * *

Solubilizing the hemicellulose of vegetable materials (bagasse) and recovering the sugars from them. L. NOBILE, of Milan, Italy. *assr.* LEDOGA S.p.A. **3,479,248.** 7th October 1965; 18th November 1969. The ligno-cellulose material (containing 20–65% water) is subjected to thermal treatment (with steam) at 150°–180°C for 1–30 minutes (130°C for 5 minutes) at pH 3·2 (thereafter mixing with water to give a pH of 4·4–4·9) and the resultant pulp dewatered. The liquid is concentrated to 10–15% sugars, defecated with a flocculating agent [$Al_2(SO_4)_3$] at pH 4–5, passed over a strongly acid cation exchange resin (so reducing the pH to below 1·5), heat treated at a pH less than 2 (preferably between 0·5 and 0·8), and the treated liquor passed over a strongly basic resin giving a pH of about 7), concentrated to 70–85% solids, the syrup crystallized with gentle stirring and gradual cooling, and the crystallized pentoses (mainly xylose) separated from the residual syrup which contains pentoses and hexoses.

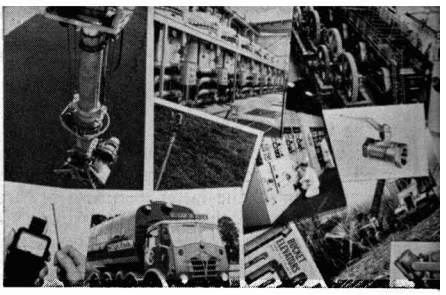
* * *

Control system for sugar inversion process. [R. E. ABBOTT, of San Francisco, Calif., USA, *assr.* BAILEY METER CO. **3,480,476.** 17th October 1966; 25th November 1969.—Inversion of sugar (for use in canning) is an exothermic process and the heat generated is directly related to the degree of inversion. The system described compensates for the effect of initial ambient temperature and for heat loss from the inversion vessel to the ambient environment during the inversion.

* * *

Molasses purification. [H. J. VON DER LINDE and W. HABERICH, *assrs.* BRAUNSCHWEIGISCHE MASCHINENBAUANSTALT, of Braunschweig, Germany. **3,481,783.** 24th August 1967; 2nd December 1969.—Liquid sugar of high purity and of low colour is produced by diluting cane molasses to 35°Bx, removing insolubles and defeco-saturating at $\geq$45°C with lime and CO_2 at pH 10–12, using 30–60% CaO on molasses non-sugars, filtering and re-subjecting to defeco-saturation at pH 8–8·5 using 3–6% of CaO on the original non-sugars, filtering and treating with cation and anion exchangers.

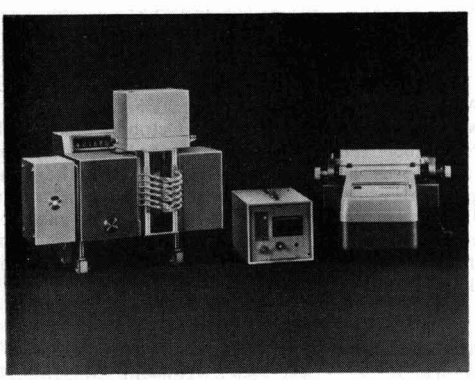
Trade notices



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

O.L.D. digital polarimeter. Carl Zeiss, 7082 Oberkochen, Postfach 35/36, West Germany.

In order to minimize the time between sampling and reading of the polarization values, the polarimeter should be installed near the sampling point and not in the factory laboratory. The instrument must be proof against moisture and vibration, should be able to measure continuously the polarization of intermediate products without need for preparation of the sample, record the results automatically and transmit these results directly to the production control via the corresponding control units. It must be able to provide sufficiently accurate measurements of dark samples at short path lengths, have an unlimited measuring range for samples of very high concentration, operate with analogue and digital output, and be able to operate without attention for at least one campaign.

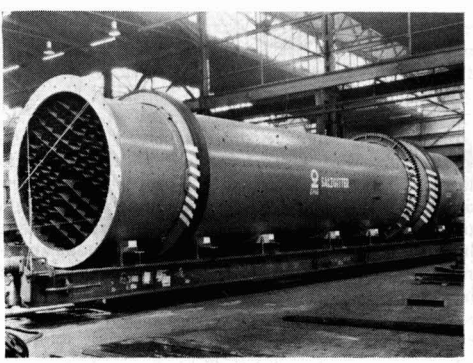


These demands are met by the Zeiss O.L.D. digital polarimeter which uses the green mercury light standardized by ICUMSA in 1966. The result is displayed numerically in °S (O.L.D.3) or in angular degrees (O.L.D.4) as 5-digit numbers (0·01°S or 0·001°) with automatic change of sign. A printer or computer can be connected to the digital output and a recorder or analogue computer for continuous control connected to the analogue output. The polarimeter housing is of stainless steel and hermetically sealed. All that the operator has to do at the start of the campaign is switch on and adjust the polarimeter to zero. With a sensitivity of $\pm 0{\cdot}001°$ and path lengths of up to 100 mm, the instrument can determine the polarization to within an accuracy of 0·01% even at low concentrations.

Among possible uses of the instrument are determination of the juice sugar content at various stages in tower diffusion and automatic determination of the purity of intermediate beet factory products, for which methods have been developed in collaboration with Süddeutsche Zucker AG. For control of tower diffusion, samples of the press water and of juice from the middle of the tower and from the raw juice discharge point are taken and transferred to an automatic cell changer in the O.L.D. digital polarimeter after a patented continuous method has been used to remove albumin and other turbid matter. For determination of the purity of intermediate products, the O.L.D. digital polarimeter is used in conjunction with a fully-automatic "Refractograph 2" refractometer. The quotient of the sucrose content and Brix is calculated by analogue computer and recorded. The method, which is independent of sample concentration, is automatically compensated for temperature within a range of $\pm 5°$ of the nominal temperature, giving a purity accuracy of within 0·2% of the maximum value.

* * *

Beet pulp dryer.—The illustration shows a section of pulp dryer manufactured by Salzgitter Maschinen AG. It is mounted on a special flat-bed truck provided by German Railways for the journey by a special route from Salzgitter-Bad to the sugar factory at Vrbas in Yugoslavia.



World sugar production estimates, 1969/70[1]

BEET SUGAR	Campaign	Estimate 1969/70	1968/69
		(metric tons, raw value)	
EUROPE			
Belgium/Luxembourg	Sept./Jan.	690,000	583,791
France	,,	2 781,527	2,433,322
Germany, West	,,	2,114,212	2,021,412
Holland	,,	781,444	734,806
Italy	July/Oct.	1,415,554	1,316,665
Total E.E.C.		*7,782,737*	*7,089,996*
Austria	Sept./Jan.	357,162	299,234
Denmark	,,	304,097	347,777
Finland	,,	55,754	50,055
Greece	July/Oct.	149,422	97,919
Ireland	Sept./Jan.	149,848	162,001
Spain	July/March	770,876	707,929
Sweden	Sept./Jan.	210,600	303,551
Switzerland	,,	62,890	69,210
Turkey	Aug./Feb.	557,031	721,613
United Kingdom	Sept./Jan.	958,314	996,021
Yugoslavia	Aug./Jan.	533,332	398,631
Total West Europe		*11,892,072*	*11,243,937*
Albania	Aug./Jan.	16,000	16,000
Bulgaria	,,	220,000	168,889
Czechoslovakia	Sept./Jan.	731,500	880,000
Germany, East	,,	500,000	505,550
Hungary	,,	438,533	437,176
Poland	,,	1,527,000	1,706,000
Rumania	Aug./Feb.	438,037	416,163
USSR	Sept./Jan.	8,600,000	10,350,000
Total East Europe		*12,471,070*	*14,479,778*
Total Europe		24,363,142	25,723,715
OTHER CONTINENTS			
Afghanistan	Nov./Feb.	7,901	6,667
Algeria	June/Nov.*	8,000	7,556
Azores	June/March	10,000	9,000
Canada	Oct./Dec.*	138,321	135,326
Chile	April/June†	246,000	195,175
China	Jan./Dec.†	650,000	650,000
Iran	Oct./March	508,000	484,000
Iraq	,,	5,000	6,174
Israel	May/July†	32,222	25,556
Japan	Oct./Feb.	330,217	321,455
Lebanon	June/Nov.*	10,000	9,000
Morocco	May/Aug.†	45,000	120,000
Pakistan	June/April	28,000	20,941
Syria	May/June†	30,000	28,747
Tunisia	May/April	5,592	4,061
United States	July/June	3,100,000	3,184,202
Uruguay	May/April	37,000	55,481
Total Other Continents		*5,191,253*	*5,263,341*
TOTAL BEET SUGAR		29,554,395	30,987,056
CANE SUGAR			
EUROPE			
Spain	March/Sept.	49,000	49,423
NORTH AND CENTRAL AMERICA			
British Honduras	Dec./June	70,000	57,062
Costa Rica	,,	145,000	140,000
Cuba	Aug./July	8,529,000	4,700,000
Dominican Republic	Nov./Sept.	1,016,000	844,736
Guadeloupe	Jan./June†	185,000	161,615
Guatemala	Dec./June	194,000	179,467
Haiti	,,	65,000	58,946
Honduras	,,	70,000	57,062
Martinique	Jan./June†	45,000	34,101
Mexico	Nov./July	2,489,000	2,565,100
Nicaragua	Dec./June	142,000	127,000
Panama	,,	78,404	80,519
Puerto Rico	Jan./July†	453,600	438,183
Salvador	Nov./June	170,000	152,408
USA—Mainland	Oct./June	972,000	1,097,042
Hawaii	Jan./Dec.†	1,120,000	1,072,662
West Indies—Antigua‡	Jan./June†	10,000	0
Barbados	,,	156,000	141,688
Jamaica	,,	390,300	389,106
St. Kitts	Jan./June†	30,500	35,918
Trinidad	,,	220,600	242,034
Total North and Central America		*16,547,404*	*12,570,574*
SOUTH AMERICA			
Argentina	June/Dec.*	997,757	954,436
Bolivia	May/Sept.†	120,000	113,400
Brazil‡	June/May	4,400,000	4,111,827
Colombia	Jan./Dec.†	750,000	708,673
Ecuador	June/Jan.	270,000	215,000
Guyana‡	Oct./June	381,000	370,296
Paraguay	July/Nov.*	47,103	37,931
Peru‡	Jan./Dec.†	750,000	632,810
Surinam	Aug./May	17,000	14,554
Uruguay	May/April	10,000	7,866
Venezuela	Sept./Aug.	445,000	381,334
Total South America		*8,187,860*	*7,548,127*
AFRICA			
Angola‡	May/March	70,000	67,248
Cameroun		12,300	7,666
Congo (Brazzaville)	May/Nov.*	100,000	92,341
Congo (Kinshasa)	,,	45,000	42,558
Ethiopia	Nov./June	108,000	73,480
Ghana	April/Sept.	20,000	20,000
Kenya	July/June	140,000	113,521
Madeira	March/Sept.*	3,594	3,333
Malagasy	July/June	100,000	98,500
Malawi	May/Nov.*	25,000	22,271
Mauritius‡	July/Jan.	708,056	632,223
Mozambique‡	May/Nov.*	225,000	214,452
Nigeria	May/Nov.*	27,320	27,906
Réunion	July/Jan.	282,991	275,201
Rhodesia	May/Nov.*	120,000	120,000
Somalia	Dec./April	68,909	55,324
South Africa	May/April	1,653,791	§1,535,541
Sudan	Dec./June	100,000	91,213
Swaziland	May/Dec.*	156,613	161,829
Tanzania	July/June	100,000	92,465
Uganda	July/June	159,000	158,389
UAR (Egypt)	Dec./June	491,000	‡461,292
Zambia	May/Nov.*	37,000	33,767
Total Africa		*4,753,604*	*4,400,520*
ASIA			
Afghanistan	Oct./April	11,000	10,000
Burma	Nov./April	85,000	85,000
Ceylon	Nov./June	10,000	8,542
China	Jan./Dec.†	2,050,000	2,050,000
India, excl. khandsari	Oct./July	4,750,000	3,953,288
Indonesia	May/Dec.*	600,000	599,569
Iran	Oct./April	55,000	55,000
Japan & Ryukyu Is.	Nov./June	304,183	300,691
Nepal	Oct./April	10,000	10,000
Pakistan	Nov./May	621,000	441,904
Philippines	Nov./July	1,860,000‡	1,652,104
Taiwan	Nov./June	614,935	786,595
Thailand	Oct./April	467,000	388,889
Total Asia		*11,438,118*	*10,341,582*
OCEANIA			
Australia	May/Dec.*	2,275,000	2,846,000
Fiji	,,	322,000	422,000
Total Oceania		*2,597,000*	*3,268,000*
TOTAL CANE SUGAR		43,572,986	38,178,226
TOTAL BEET SUGAR		29,554,395	30,987,056
TOTAL SUGAR PRODUCTION		73,127,381	69,165,282

[1] F. O. Licht, *International Sugar Rpt.*, 1970, **102**, (20), 1–4.

* 1969, 1968

† 1970, 1969

‡ tel quel

§ excluding sugar equivalent of high test molasses, 108,520 tons, in 1968/69

Brevities

Sucrose extraction by cane diffusion in South Africa.—There are many in the cane sugar industry who doubt whether the diffusion process is more economical than the conventional milling method with respect to the obtainable total yield of sugar. It is of interest, in this connexion, to see figures recently obtained in South Africa and communicated to us by Braunschweigische Maschinenbauanstalt. In the crushing period up to 30th May 1970, the Dalton sugar factory of Union Co-operative Bark and Sugar Co. Ltd., which is equipped with a BMA cane diffuser (the Egyptian system), obtained a sucrose extraction of 98·23% as compared with an average of 94·90% for all the other sugar factories in South Africa. In the following period up to 27th June 1970, the extraction at Dalton was again far above the other South African factories at 98·34% as compared with 95·25%. As regards overall recovery, results obtained are even more favourable; the sugar yield at Dalton for the above periods was 86·93% and 87·98%, as against averages of 83·28% and 84·33% for all other sugar factories in South Africa.

* * *

The late Sir Peter Runge.—We regret to report the death on the 19th August 1970 of Sir Peter Runge, joint vice-chairman of Tate & Lyle Ltd., at the age of 61. A member of a family of sugar brokers, he was educated at Oxford where he took a degree in chemistry, then working in the Laboratory of the Syndicat National des Fabricants de Sucre in Paris. He joined Tate & Lyle Ltd. in 1931 at Allscott beet sugar factory (now part of the British Sugar Corporation), later transferring to Thames refinery in London, where he became Director-in-Charge in 1936. As a senior executive of the Tate & Lyle organization he was well-known throughout the sugar world and was almost equally well-known in other spheres as a result of his interests and activities outside sugar, one of the principal of these being the British National Export Council of which he had been chairman since 1968. He had also been President of the Federation of British Industries and Chairman of the Royal Society for the Blind.

* * *

US beet area, 1971[1].—The US Dept. of Agriculture announced on the 3rd September that there will be no area restrictions on the 1971 domestic beet crop. It will be recalled than an acreage limit was originally imposed upon the current crop but was later lifted in view of the poorer result of the previous campaign as against earlier forecasts. The arrangements within the present US Sugar Act ensure that, of any increases in the Overall Supply Quota over 10,400,000 tons, nearly half is supplied from the domestic beet crop. As consumption grows year by year this throws an increasing demand upon domestic agriculture. The USDA noted that 1970 beet plantings totalled about 1,445,000 acres which, based on average yields, would give a sugar production of about 3,300,000 short tons, raw value, or about 300,000 tons less than this year's domestic beet quota of 3,579,000 tons[2]. It is said that effective stocks at the beginning of next January were likely to be around 2,525,000 tons, well below the desirable level.

* * *

Argentina state intervention in the sugar industry[3].—Recent legislation provides for the formation of the Cía. Nacional Azucarera (Conasa), with majority state participation, to develop and operate the sugar industry and related activities in the Province of Tucumán. The legislation also authorizes the State to intervene in and expropriate the Cía. Azucarera Tucumana and the sugar mills of La Florida, La Trinidad and Santa Rosa.

Swaziland sugar production, 1969/70[4].—The Swaziland Sugar Association has announced that Swaziland's production of sugar in the 1969/70 season was a record with 172,637 short tons of sugar produced, compared with 169,296 tons in 1968/69. The cane area was 33,621 acres and the tonnage of cane 1,588,178. Molasses production amounted to 47,184 short tons. Local sugar sales reached 12,300 short tons while exports totalled 155,300 tons, of which the UK took 95,200 tons and Canada 34,331 tons.

* * *

Flood damage in Brazil[5].—Severe damage was done to the Pernambuco sugar cane crop by heavy rains which flooded rivers in the cane growing region of the state. In announcing this, the Export Director of the Brazilian Instituto do Açúcar e do Alcool said that there had also been heavy losses of sugar already produced owing to flooding of many factories and warehouses. The extent of the damage would only be known after men in the field had finished their inspection and reported back, he added.

* * *

South African sugar production, 1969/70[6].—Sugar production in South Africa for the 1969/70 season closed with 1,788,499 short tons made from 16,300,826 tons of cane. In the previous season, 1,659,399 tons of sugar was produced from 15,123,370 tons of cane. The current crop is undergoing considerable moisture stress because of low rainfall—the lowest in February and March for 44 years—and above-average sunshine leading to high evaporation rates.

* * *

Verenigde HVA-Maatschappijen N.V. 1969 report.—In the 1968/69 season cane from 3500 hectares was milled to produce 66,200 metric tons of sugar, almost the same as in the previous season (67,753 tons). The season was again interrupted by a strike but this is not expected to occur in future seasons when new labour regulations come into force in Ethiopia. The new Metahara sugar factory started operations in November 1969, and after completion of some minor extensions will be in a position to produce some 65,000 tons of sugar annually. The Tanzanian Government has purchased all the shares of the Kilombero Sugar Co. Ltd. but HVA management is to continue to the end of April 1973. Production in 1969/70 amounted to the record 36,040 metric tons and plans are being made to increase the milling capacity from 1750 to 2600 t.c.h. which will raise annual outturn to some 46,500 tons.

* * *

Zambia sugar refinery expansion.—In addition to the expansion of the cane area serving the Nakambala sugar factory[7], in order to reach its maximum present annual capacity of 45,000 tons of raw sugar by 1971, rapidly growing consumption of sugar is likely to ensure the continuing need for imports[8]. To keep pace with the growing demand for sugar, now estimated at 20 lb per head as compared with 6½ lb in 1960, the capacity of the Ndola refinery is to be raised from 40,000 to 50,000 tons/year.

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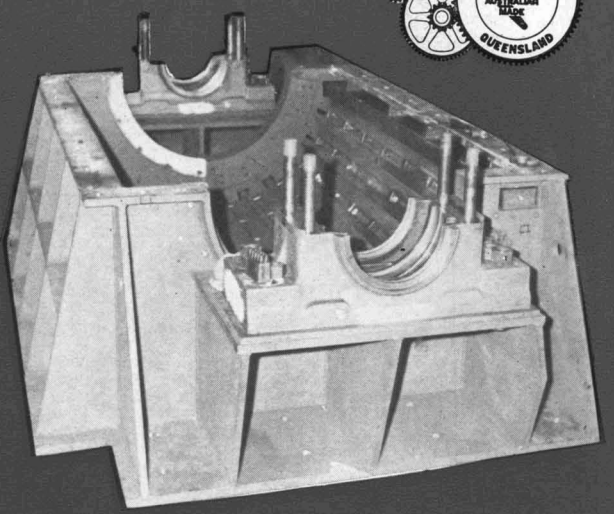
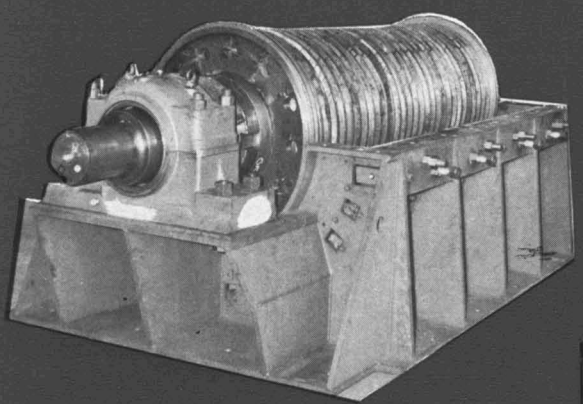
[1] C. Czarnikow Ltd., *Sugar Review*, 1970, (987), 156.
[2] *Public Ledger*, 5th September 1970.
[3] *Bank of London & S. America Review*, 1970, **4**, 384.
[4] *Standard Bank Review*, July 1970, p. 33.
[5] *Public Ledger*, 25th July 1970.
[6] F. O. Licht, *International Sugar Rpt.*, 1970, **102**, (12), 6.
[7] *I.S.J.*, 1970, **72**, 159.
[8] *Standard Bank Review*, July 1970, p. 31.

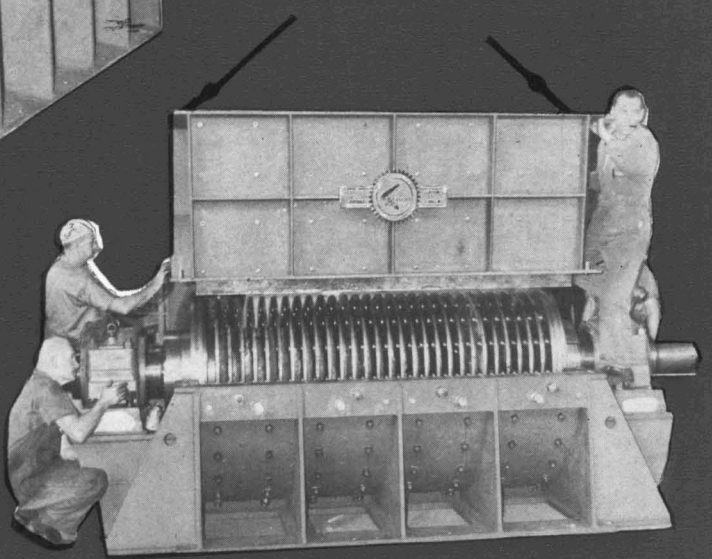
CANE PREPARATION BY SHREDDING

HIGH EXTRACTION AT HIGH RATES IN MILLS OR DIFFUSERS REQUIRES THE ULTIMATE IN CANE PREPARATION. PRELIMINARY KNIFE PREPARATION FOLLOWED BY SHREDDING PROVIDES THE SOLUTION.
TECHNICAL KNOW-HOW AND THE UNSURPASSED SKILL OF THEIR TRADESMEN GIVE **WALKERS LTD.** AN INTERNATIONAL LEAD AS DESIGNERS AND MANUFACTURERS OF SWING-HAMMER SHREDDERS.





STAGES IN THE SHOP ASSEMBLY OF AN 84" HEAVY DUTY CANE SHREDDER



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SPHERICAL ROLLER BEARINGS.
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