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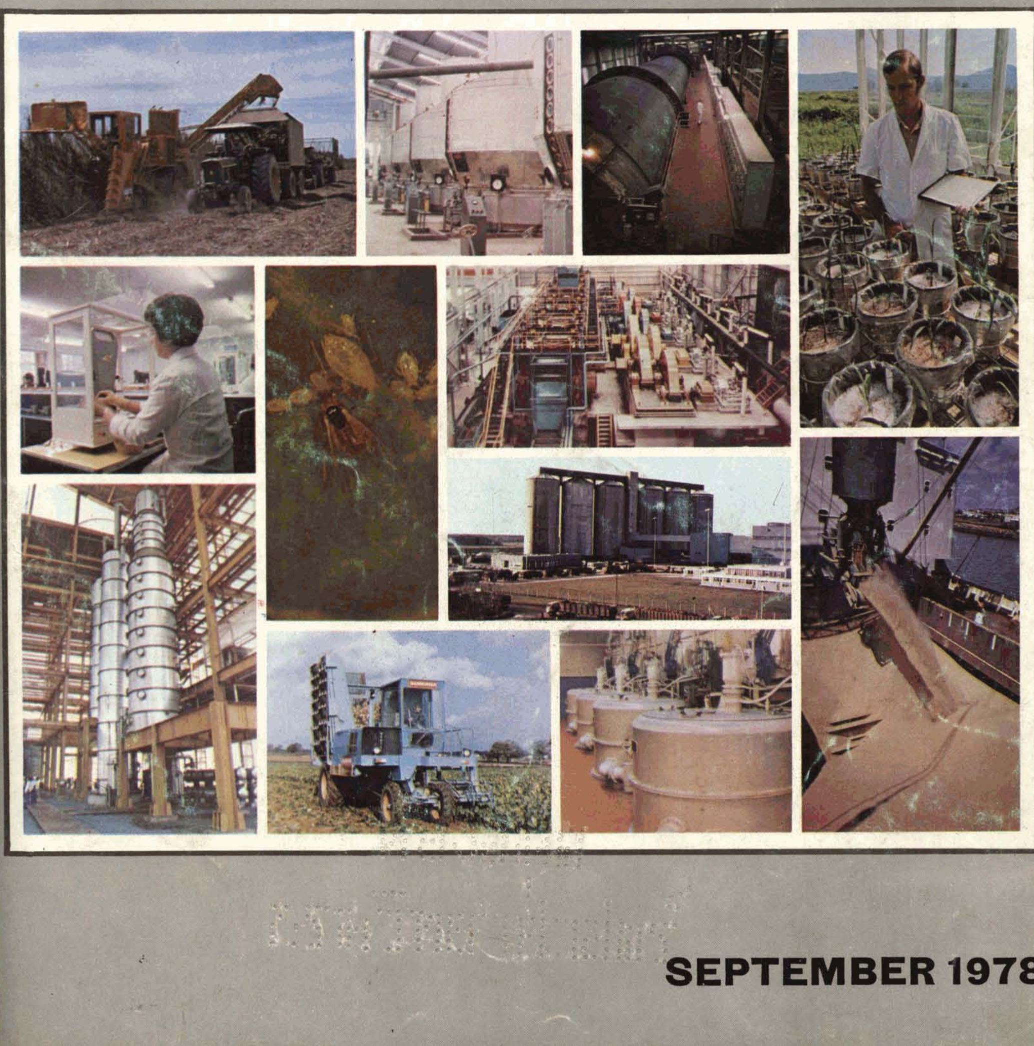

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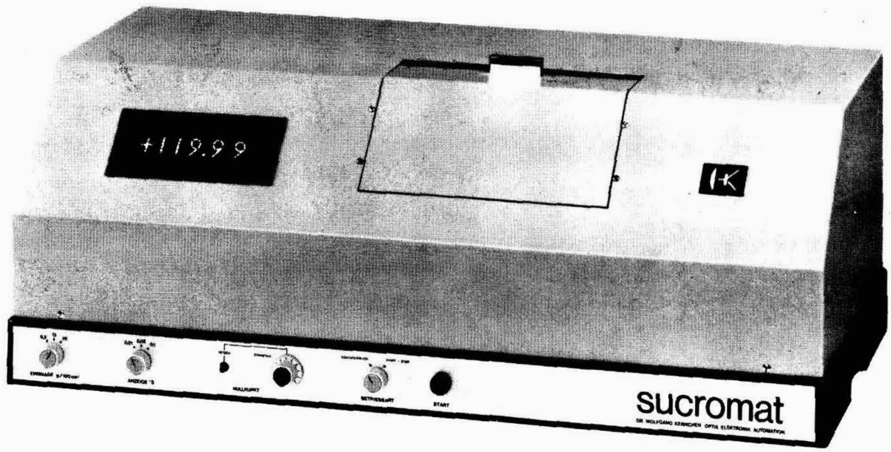
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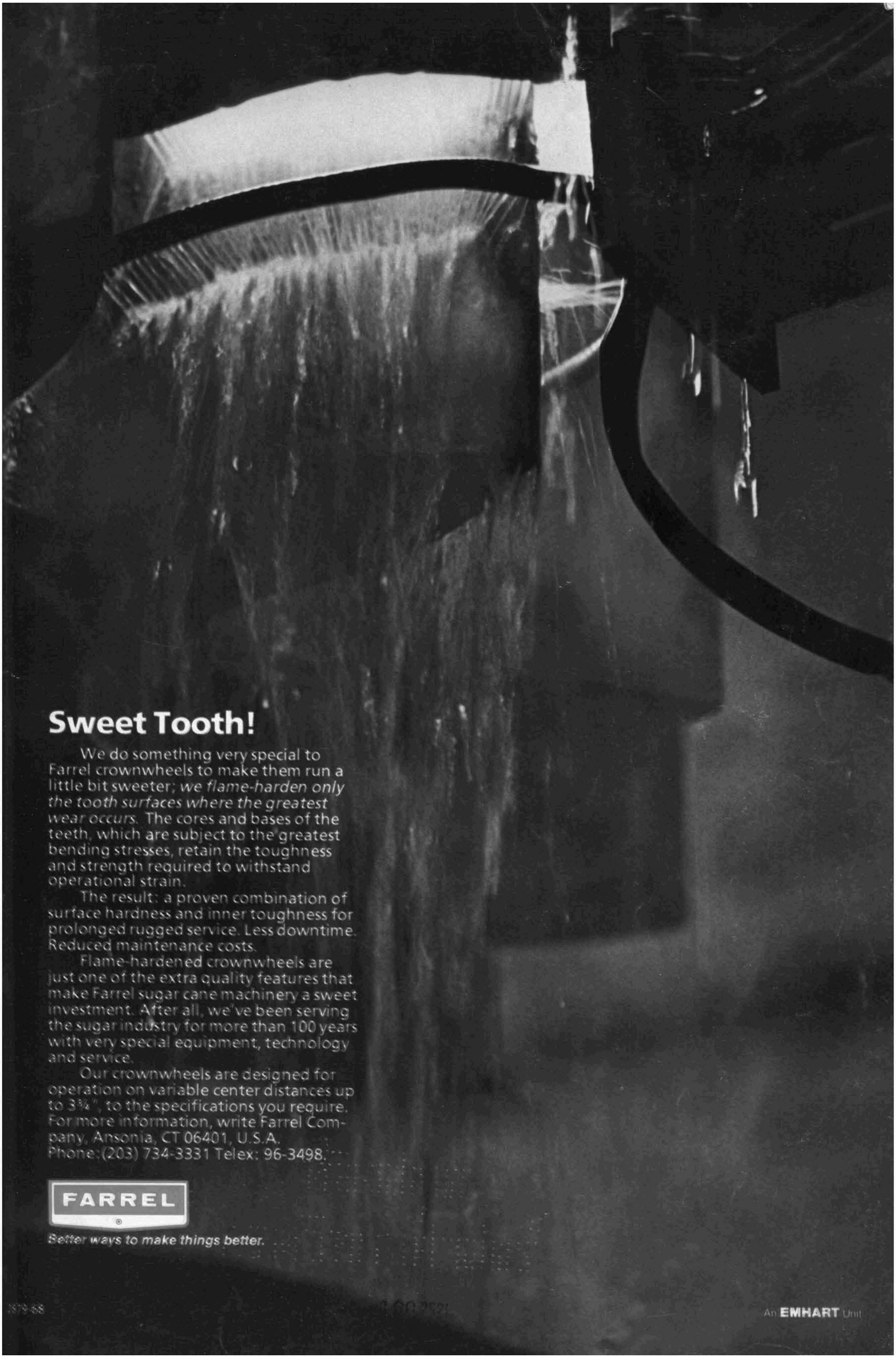

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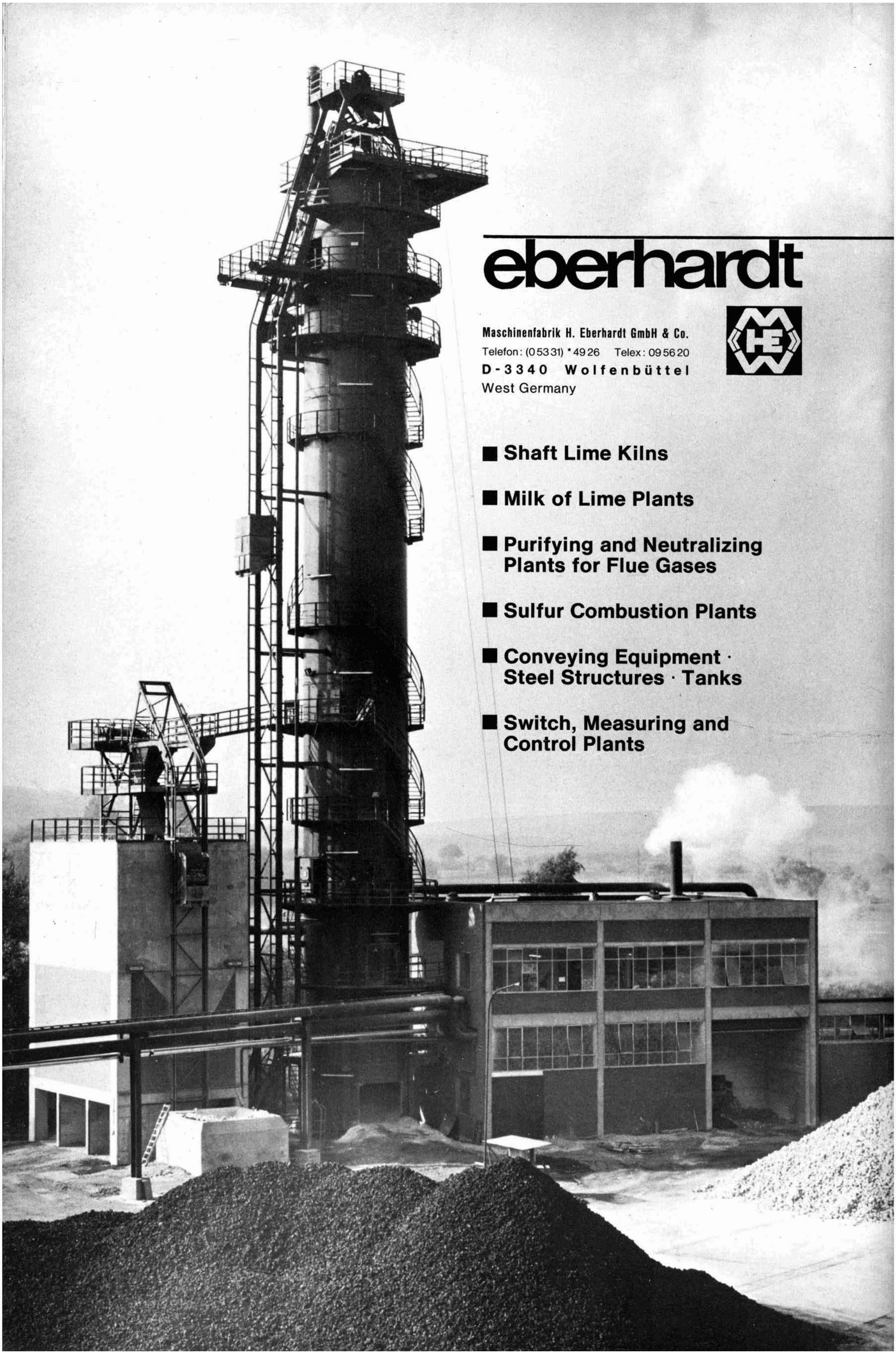
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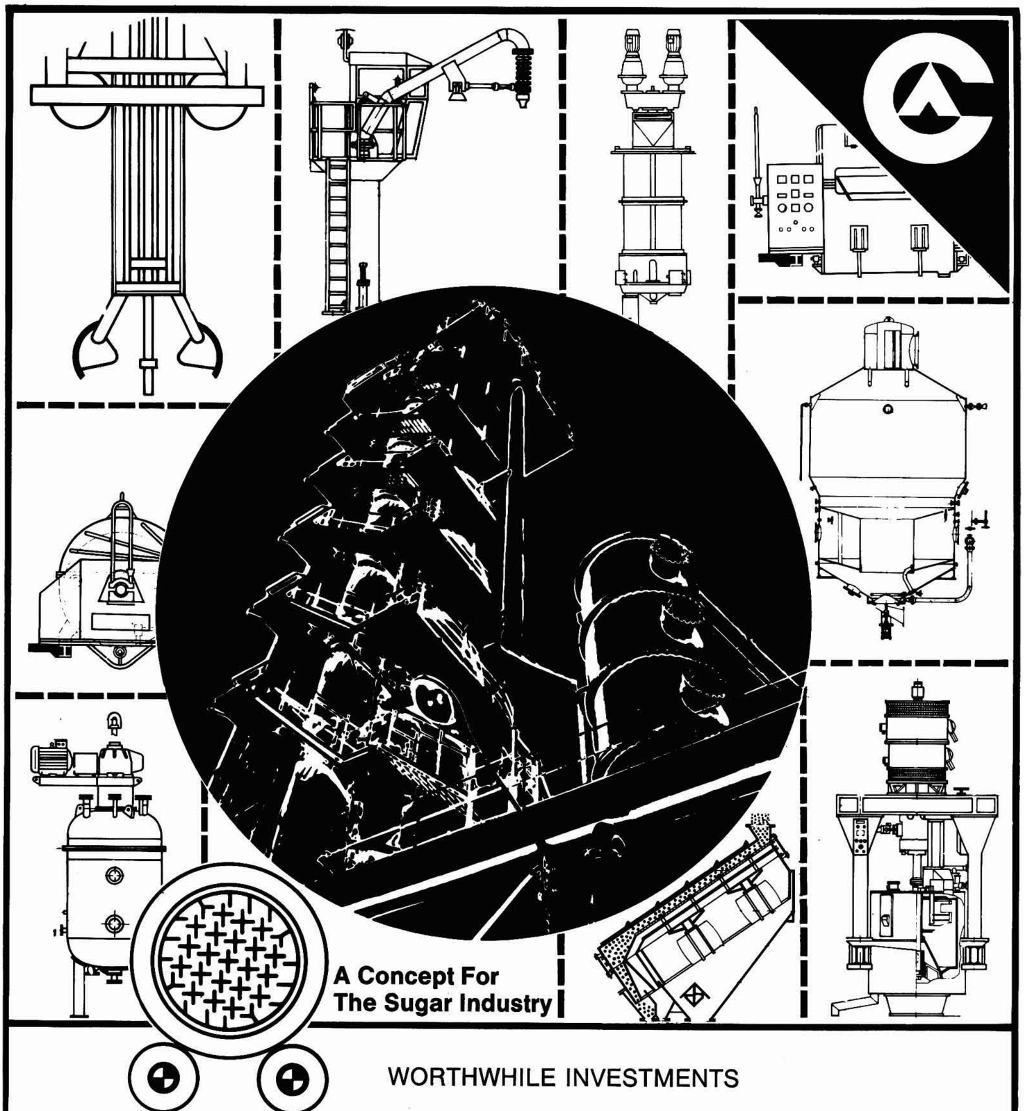
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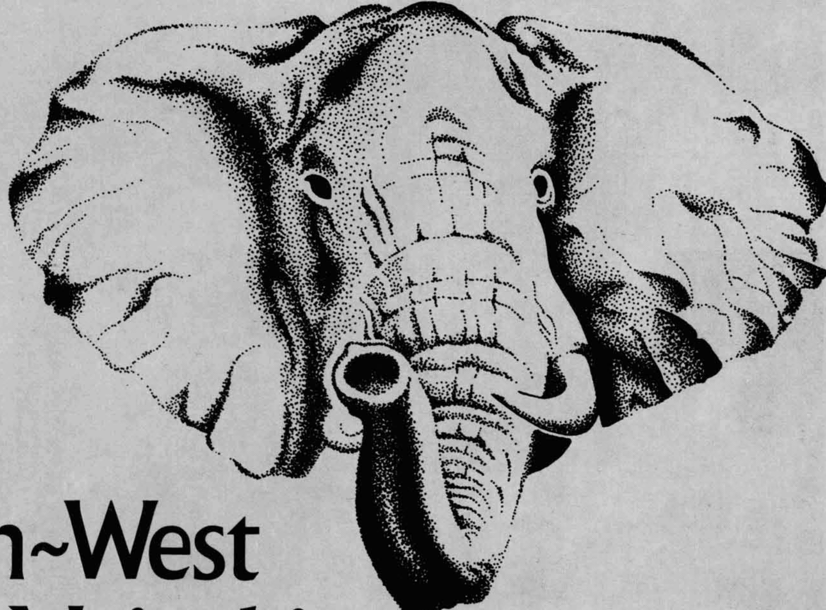

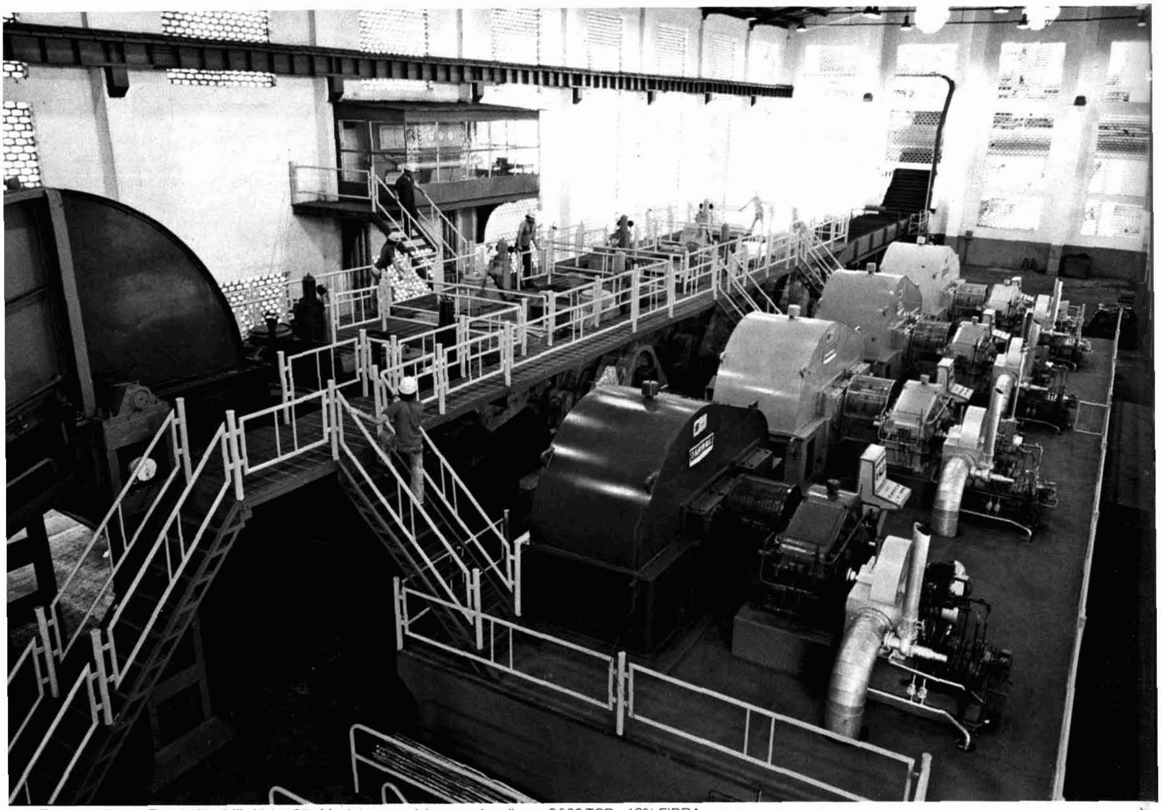

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NOTES AND COMMENTS

International Sugar Organization

The sixth meeting of the Executive Committee was held on 28th July, 1978 under the chairmanship of Mr. B. Dowling of Fiji, the Chairman of the Committee for 1978. The Executive Committee gave special consideration to the problems being faced in the market in securing the full and effective operation of the Agreement; observers from the EEC, at the invitation of the Committee, attended these discussions.

The Committee considered that the recent developments were due to market fundamentals aggravated, on the one hand, by delays in the ratification of the Agreement by the United States and, on the other hand, by the fact that the EEC was not yet a Party to the Agreement with the resulting uncertainties regarding the supplies likely to be put on the free market by the EEC. The Committee expressed its confidence that the United States will have ratified and implemented the provisions of the Agreement by 1st October 1978.

The Committee also noted that provision had been made for a meeting of the ad hoc Group on Accessions to meet representatives of the EEC early in October to consider the modalities of EEC participation in the Agreement. It urged the EEC, pending accession, to conduct its sugar marketing in a way consistent with the objectives of the Agreement.

The Committee urged all its exporting Members which do not expect to use their quotas in effect for 1978 in full to make appropriate shortfall declarations as soon as possible before 30th September 1978.

The Committee agreed on the conditions of accession to be recommended to the Council in respect of Ghana and the United Republic of Tanzania, which have recently applied for membership under article 76 of the Agreement.

The Committee noted that 130,000 tonnes of sugar remained for allocation from the Hardship Reserve in 1978. In view of the present market situation, however, the Committee decided that of this quantity no more than 48,000 tonnes should be allocated for this year and that none of this allocation should be offered for sale before 1st October 1978.

C. Czarnikow Ltd. note[1]: "Fundamentally the world market price is governed by supply and demand and it is well known that there is a substantial quantity of sugar at present available which is surplus to requirements. A considerable proportion of this originates from countries which are not members of the ISA; consequently there is very little which can be done by Agreement members to adjust the statistical position, even if this were permitted by the ISA or, indeed, practicable. Nevertheless, the decision to allocate only 48,000 tonnes from the balance of the Hardship Reserve of 130,000 tonnes indicates that the Committee was conscious of the need to limit additional supplies of sugar which will become marketable this year.

"Steps taken in Washington at the beginning of August indicate that some degree of compromise may be in the process of being worked out over US sugar legislation. It may, therefore, be appropriate for the Executive Committee to express confidence that the USA will ratify the ISA and pass enabling legislation by 1st October. Nevertheless, the market may be forgiven if it continues to adopt a cautious attitude in this respect, bearing in mind that similar enthusiasm has been shown in the past and that earlier target dates have not been attained.

"Reference to discussions with the EEC do not, of course, indicate any likelihood that the Community will shortly be adhering to the ISA. Certainly discussions between the two parties may bring about a better understanding of points of view and might, indeed, influence EEC marketing arrangements, but it would seem that the first priority so far as the Community is concerned will be to establish its own fresh procedures to be adopted from 1980 onwards before adhering to the ISA".

World sugar balance, 1977/78

F. O. Licht GmbH have recently published[2] their second estimate of the world sugar balance for the crop year September 1977/August 1978 and this is reproduced below with corresponding figures for the two previous crop years.

	1977/78	1976/77	1975/76
	tonnes, raw value		
Initial stocks	25,470,000	20,705,000	17,501,000
Production	92,626,000	88,412,000	82,811,000
Imports	26,445,000	27,316,000	23,897,000
	144,541,000	136,433,000	124,209,000
Exports	26,909,000	27,783,000	23,373,000
Consumption	86,652,000	83,180,000	80,131,000
Final stocks	30,980,000	25,470,000	20,705,000
Production increase	4,214,000	5,601,000	3,211,000
" " %	4·77	6·76	4·03
Consumption increase	3,472,000	3,049,000	2,561,000
" " %	4·17	3·81	3·30
Final stocks % consumption	35·75	30·62	25·84

The latest balance includes the latest official country-by-country figures obtained by Licht, some of them a year or more late and affecting the other years as well as 1977/78. As a consequence initial stocks for the latest crop year were lower than thought earlier but production is now expected to have been greater as a consequence of higher than previously anticipated crops in Cuba and India. Consumption is now expected to be a million tons more, mainly through increased offtake in Brazil and India, with the net effect of a final stock figure for August 1978 some 300,000 tonnes less than anticipated in February last.

E. D. & F. Man, commenting on the future crop year[3], write: "There can be no doubt that the 1978/79 season, starting In 1st September, will be substantially better in

[1] *Sugar Review*, 1978, (1399), 143.
[2] *International Sugar Rpt.*, 1978, **110**, (21), 1–5.
[3] *The Sugar Situation*, 1978, (326).

supply/demand balance terms than in the 1977/78 season which is now finishing. Consumption in many areas is improving in response to lower world prices and particularly important because of the scale of their consumption is the improvement being seen in Japan and the EEC where the last three years have been stagnant. We see consumption in 1978/79 reaching 90,000,000 tonnes, raw value, and, when taken together with production falls expected in Brazil, Australia and probably in Western Europe, the sugar market has the possibility of seeing the first year of balance/deficit since the 1973/74 season".

US sugar legislation

The stalemate referred to in our last issue continued through July although there were meetings between Administration and representatives of sugar users, consumers and producers groups in order to try to work out a sugar programme which would be acceptable to all.

The Agriculture Committee of the House of Representatives completed work on a bill at the beginning of August which includes a range of amendments submitted by Representative de la Garza, the most important of which is a reduction in the support level from 17 to 16 cents/lb, which compares with the level of 14·65 cents favoured by the Administration. The President's views on it have not been made known, although it was said that he would veto the original 17 cents/lb bill and a compromise bill is expected to be put forward by the White House. Time is getting short, however, since whatever bill is to become law must pass through both houses of Congress and receive the President's signature. Ratification of ISA membership must wait for passage of domestic legislation, moreover, and although the time available for ratification has been extended to 1st October, Congress adjourns on 7th October and there will be a 7–10 day recess before then for Labor Day.

In the meantime the USDA has been working out proposals which it was to present to Mr. Carter by 1st August on whether to raise the import fee or impose quotas on sugar entering the US in face of declines in world market prices which had now made it possible to make available raw sugar to final buyers at levels below the current support levels in spite of the 5·51 cents/lb combined import fee and duty.

US import levy on EEC sugar

As reported earlier[1], sugar producers in the USA complained that EEC sugar was being "dumped" and the Treasury Department issued a preliminary determination on 28th June that the EEC was subsidizing exports of sugar. It initiated a formal investigation under the Countervailing Duty Law and on the 25th July announced that from the 28th it would impose a duty of 10·80 cents per pound on all EEC sugar entering the USA.

Dumping implies subsidization of exports to the US so that sales may be effected at a price lower than that applying in the country of origin; this must apply to virtually every country selling sugar at world market prices to the US and EEC officials consider the duty to be unjustified. They say that the subsidized prices do not undercut present low world prices which, under GATT rules, is the only justification for countervailing duties. Further, the subsidies are to private traders to permit them to sell in the world market to any destination and is not a special subsidy for sales to the US market. Reference has also been made to the fact that the sugar is partly available as a result of the manufacture of alternative sweeteners derived from maize (corn) imported from the USA.

On the other hand, the Community operates its own import levy system which effectively precludes importation of world market sugar, so that it can hardly complain of unfair protection of domestic producers by the USA when it practises the same.

World sugar prices

The world market prices of sugar fell steadily during July, the LDP reaching a low of £81 per ton on the 26th from £93 at the beginning of the month and the LDP(W) a low of £94 from £104. The fall reflected the statistical position but there was also the effect of pessimism over the failure of the ISA at present to bring about a recovery (although in the absence of an Agreement prices might well have been considerably lower than they are) and the lack of positive action by the USA. The condition of the European beet crop is also looking good and production could well be reasonably high.

Towards the end of July, however, news of several buying tenders improved the market tone, as did reports of purchases by China. There also seemed to be greater confidence in ratification of the ISA by the United States, and a LDP level of £89 had been reached by the 31st July, with the LDP(W) at £100.

Brazilian sugar production plan, 1978/79

The production plan for the Brazilian crop year June 1978/May 1979 has been published and calls for 120 million 60-kg bags, tel quel, against the previous year's 135 million bags. Of the total, 92 million bags is intended for domestic consumption (93 million in 1977/78) and 28,000,000 bags (1,680,000 tonnes) for export, against 42 million bags (2,520,000 tonnes) in 1977/78. Consumption has been running at a level of about 82 million bags, white value, and provision under the plan may be excessive. The export provision is less than Brazil's quota in effect but stocks are sufficient to ensure that this will be met.

The plan also envisages a remarkable expansion of the production of alcohol from cane; against the equivalent of 900,000 tonnes of sugar in 1977/78, alcohol will be produced equivalent to 2,100,000 tonnes of sugar in 1978/79. Considerable investments have been made in establishment of distilleries, autonomous and as ancillaries to sugar factories, with use of both molasses and cane juice as raw material for fermentation.

The Brazilian industry is in a financial crisis, however, because of the decline in sugar prices; the Instituto do Açúcar e do Alcool spent about $250 million equivalent in 1977 to meet the difference between what it paid to sugar producers and what it earned from world market sales[2]. It is not only the IAA which is in trouble, moreover, since mill owners in the north-east are in debt to the tune of about $500 million, half of which is scheduled for repayment this year and next.

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[1] *I.S.J.*, 1978, **80**, 225.
[2] *Latin America Commodity Report*, 12th May 1978.

Some problems and consequences of the evaluation of the transfer efficiency of cane diffusers

By G. V. GENIE

Consultant, Chaumont-Gistoux, Belgium

Paper presented to the 16th Congress ISSCT, 1977

Introduction

A GENERAL method for the evaluation of the transfer efficiency of diffusers, which is valid for both cane and beet diffusers, has been published recently[1,2,3]. It relies on the comparison of a practical diffuser with a theoretical countercurrent batch extractor of which the number of stages is adjusted in order to produce the same juice from the same material with equal losses. The number of stages then corresponds to the number of transfer units of the practical diffuser in analogy with the number of theoretical plates of a distillation column. This provides a common scale by which the transfer efficiency of different diffusers can be rated. Other practical factors such as cost, building space, steam requirements, etc. can of course influence the choice of a particular type of diffuser, but it should first be ascertained that its transfer efficiency meets the requirements set by the local operating conditions.

For several reasons, which are hereafter enumerated, the application of this method is more delicate for cane diffusers than it is for beet diffusers. First, the bagasse is much more heterogeneous than beet cossettes (for which an equivalent thickness can be defined and measured) and there is no direct relation between the preparation index and the extractability of the material. Second, the fibre content of cane is three to five times higher and much more variable than the marc content of beet. This requires corrections to be made at all steps of the calculation for fibre and hydration (so-called "Brix-free") water, while for beet the effect of the marc is merely neglected. A third reason is that, owing to the fibrous structure of the bagasse, it is difficult to trace the boundary between the fixed liquid phase and the percolating extracting juice and to define the true volume occupied by the bagasse. Moreover, modern cane diffusers now include pressing drums which reduce this volume before the bagasse leaves the diffuser and cause an internal recirculation of press juice distinct from the external one. But the worst difficulty is by far the lack of laboratory data specific to the diffuser. To evaluate its transfer efficiency it is of course required to know the amount and the polarization of bagasses and juices entering and leaving the diffuser and these data are rarely determined in a cane mill. Starting from the figures available in the daily or weekly report, a considerable amount of oblique calculation is required, which makes the result much less reliable than a direct determination. The first object of this communication is to discuss some of these difficulties specific to cane diffusers. The second one is to draw important conclusions concerning the dimensioning of cane diffusers.

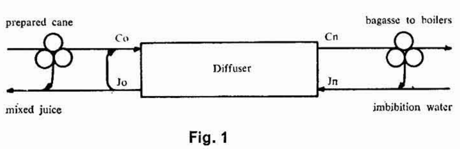

Fig. 1

Evaluation of concentrations

A scheme of the milling-diffusion process is shown in Fig. 1. For simplicity only one dewatering mill is represented, but the dewatering system is usually more complex and the imbibition water is fed between the dewatering devices rather than directly to the diffuser as shown. C_o, J_o, C_n, J_n represent respectively the concentration of the juice contained in the bagasse and the extracting juice entering and leaving the diffuser. This concentration may be expressed either in Brix or in polarization, but the latter is to be preferred because it is, of course, the extraction of sugar rather than dry matter in which we are interested. Assuming that there is no change of volume in the diffuser, the transfer efficiency of the diffuser expressed in transfer units is

$$n = \frac{\log(C_o - J_o) - \log(C_n - J_n)}{\log(C_o - C_n) - \log(J_o - J_n)} \quad \text{.....................(1)}$$

If data are available for C_o, J_o, C_n and J_n the method is quite simple. Let us examine these factors successively. To avoid unnecessary complication, the difference of density between the various juices is hereafter neglected. If required, appropriate corrections should be made in practical instances.

Bagasse juice concentration C_o

Only the liquid phase is concerned in the extraction process and the concentration which should be used is not the apparent concentration of the prepared cane or bagasse, but the concentration *of the juice* contained in it. For straight cane diffusers, the gross polarization of the cane P_c should be corrected for the fraction of weight corresponding to the hydrated fibre. Assuming 30% Brix-free water on dry fibre we have:

$$C_o = \frac{100\,P_c}{100 - 1{\cdot}3\,F_c} \quad \text{...(2)}$$

For bagasse diffusers, the problem is more complicated and the effect of the first mill should first be discussed. As explained in a previous communication[1], a mill has no transfer efficiency because its action is only a separation one. The subsequent imbibition however has some because the mean concentration of the liquid phase decreases when it mixes with more dilute juice, which in this instance is a part of the diffusion juice recirculated to the diffuser with the bagasse. Assuming that the original volume of the cane is restored, one may thus consider that the net effect of the first mill is to replace the first expressed juice by an equivalent amount of diffusion juice. Calling P_l and P_d the polarization of, respectively, the first expressed juice and the diffusion juice and V_l the first expressed juice % cane, we have:

$$C_o = \frac{100\,P_c - V_l\,(P_l - P_d)}{100 - 1{\cdot}3\,F_c} \quad \text{.............................(3)}$$

Without this correction the diffuser would be unduly credited for a transfer efficiency linked with the operation

[1] Genie: *S. African Sugar J.*, 1973, **57**, 601, 603, 605–607.
[2] *Idem*: *Zeitsch. Zuckerind.*, 1974, **99**, 473–477.
[3] *Idem*: *ibid.*, 1976, **101**, 317–322.

of the first mill. The mixed juice is the sum of the first expressed juice and the diffusion juice. If P_m and V_m represent respectively the polarization of mixed juice and mixed juice % cane, we have:

$$V_m P_m = V_l P_l + (V_m - V_l) P_d \quad \text{.......................} (4)$$

or

$$V_l (P_l - P_d) = V_m (P_m - P_d) \quad \text{.......................} (5)$$

Introducing this in (3):

$$C_o = \frac{100 P_c - V_m (P_m - P_d)}{100 - 1{\cdot}3 F_c} \quad \text{.......................} (6)$$

Equation (6) is equivalent to equation (3), but more convenient because the mixed juice % cane is readily available in factory reports.

Diffusion juice concentration J_o

The concentration of the diffusion juice does no always appear in daily reports and must sometimes be calculated from the first mill extraction E_l when the latter is stated. By definition.:

$$E_l = \frac{V_l P_l}{100 P_c} \times 100 \quad \text{.......................} (7)$$

Similarly for the mixed juice:

$$E_m = \frac{V_m P_m}{P_c} \quad \text{.......................} (8)$$

Using equation (4) we have:

$$E_m - E_l = (V_m - V_l) \frac{P_d}{P_c} = \left(\frac{E_m}{P_m} - \frac{E_l}{P_l}\right) P_d \quad \text{............} (9)$$

and

$$J_o = P_d = \frac{E_m - E_l}{\dfrac{E_m}{P_m} - \dfrac{E_l}{P_l}} \quad \text{.......................} (10)$$

Exhausted bagasse concentration C_n

At the water end of the diffuser, the sugar content may be assumed to be homogeneous in the bagasse with the possible exception of unruptured cells when the cane preparation is not adequate. This condition may be checked by comparing the apparent concentration which is equal to the last expressed juice (or the "first" last expressed juice when several dewatering devices are operating in series) and the concentration of the residual juice which is computed from the final bagasse. Let P_b be the polarization of the bagasse, W_b its moisture and p the purity quotient of the last expressed juice. Then the soluble solids are assumed to be P_b/p and the dry fibre content F_b is $(100 - W_b - P_b/p)$. The hydration water is then $0{\cdot}3\ F_b$, the water available for dissolving the soluble solids $W_b - 0{\cdot}3\ F_b$ and the weight of the solution $P_b/p + W_b - 0{\cdot}3F_b$. From this we derive the mean concentration of the residual juice in the final bagasse:

$$C_n = \frac{100 P_b}{1{\cdot}3 \left(W_b + \dfrac{P_b}{p}\right) - 30} \quad \text{.......................} (11)$$

These values are often close to each other, but we sometimes observed large differences denoting a non-homogeneous extraction, which may be caused by the presence of unruptured cells, "hard to extract" juice or possibly by preferential channelling in the diffuser. (The validity of this comparison is however impaired when several dewatering devices are operating in series with imbibition water fed between them.) Which value should be used in equation (1)? The answer is not simple. If the apparent concentration (i.e. the concentration of the last expressed juice) is used, the extraction is implicitly assumed homogeneous and the resulting transfer efficiency may be somewhat optimistic. On the other hand, if the concentration of the residual juice is used, the effect of a non-homogeneous extraction is overestimated and the diffuser held fully responsible for it, which is not always true. However, as a rule, we use the value shown in equation (11) because all figures are readily available in a cane mill, but a composite value would certainly be closer to the actual situation.

Feed juice concentration, J_n

In the simple dewatering system shown on Fig. 1, where the concentration of the last expressed juice is assumed to be equal to the concentration C_n of the juice contained in the bagasse, if k represents the fraction of the last expressed juice in the total feed, we have:

$$J_n = k\ C_n \quad \text{.......................} (12)$$

Only the imbibition water is metered and the weight of the last expressed juice must be estimated indirectly. Let F_n be the fibre content of the wet bagasse and F_b the fibre content of the final bagasse produced from it. From the original amount of (juice + hydration water) in the bagasse $(100 - F_n)$ the quantity retained in the pressed bagasse is $(100 - F_b)\ F_n/F_b$ and the quantity removed by the last mill is $100\ (1 - F_n/F_b)$. From this we derive the value of k when I represents the imbibition water % cane:

$$k = \frac{100\left(1 - \dfrac{F_n}{F_b}\right)}{100\left(1 - \dfrac{F_n}{F_b}\right) + I} \quad \text{.......................} (13)$$

As said previously, it is difficult to estimate the volume of the wet bagasse but its moisture is about 80-85% and one can assume without a considerable error that the weight of the bagasse leaving the diffuser corresponds to the weight of the processed cane. F_n then corresponds to the fibre content of the cane F_c and this leads to a simplification of equation (13) because F_c is often determined indirectly as the product of the fibre in the bagasse by the relative weight of bagasse. Let B be the percent of final bagasse on cane, then:

$$F_c = F_b \times \frac{B}{100} \quad \text{.......................} (14)$$

which combined with (13) gives, when M represents the weight of mixed juice % cane:

$$k = \frac{100 - B}{100 - B + I} = \frac{100 - B}{M} = \frac{M - I}{M} = 1 - I/M \quad (15)$$

and

$$J_n = \frac{100 - B}{M} C_n \quad \text{.......................} (16)$$

When the same method is applied to a dewatering system more complex than the one shown in Fig. 1, the overall efficiency found includes the efficiency of the imbibition between mills and should be corrected in a way analogous to the one shown above for the first mill. Each case should however be studied separately with consideration of the local flowsheet, which may also include the feeding of the imbibition water at two distinct places.

Let us now show a practical example of calculation of the transfer efficiency of a BMA bagasse diffuser installed in a South African sugar factory. The mean results during the week preceding our visit were the following, as quoted from the laboratory report:


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cane	pol	11·79
	fibre	10·99
first expressed juice	pol	15·44
mixed juice	pol	12·15
	% cane	92·97
last expressed (residual) juice	purity	49·0
bagasse	pol	1·94
	moisture	52·91
	% cane	25·48
imbibition	% cane	18·45
extraction		95·80
first mill extraction		50·82

Applying successively equations (10), (6), (11) and (16) we have:

$$J_o = P_d = \frac{95{\cdot}80 - 50{\cdot}82}{\dfrac{95{\cdot}80}{12{\cdot}15} - \dfrac{50{\cdot}82}{15{\cdot}44}} = 9{\cdot}79$$

$$C_o = \frac{100 \times 11{\cdot}79 - 92{\cdot}97\,(12{\cdot}15 - 9{\cdot}79)}{100 - 1{\cdot}3 \times 10{\cdot}99} = 11{\cdot}20$$

$$C_n = \frac{100 \times 1{\cdot}94}{1{\cdot}3\,(52{\cdot}91 + \dfrac{1{\cdot}94}{0{\cdot}49}) - 30} = 4{\cdot}42$$

$$J_n = \frac{100 - 25{\cdot}48}{92{\cdot}97} \times 4{\cdot}42 = 3{\cdot}54$$

The transfer efficiency is then according to equation (1):

$$n = \frac{\log(11{\cdot}20 - 9{\cdot}79) - \log(4{\cdot}42 - 3{\cdot}54)}{\log(11{\cdot}20 - 4{\cdot}42) - \log(9{\cdot}79 - 3{\cdot}54)} = 5{\cdot}8 \text{ transfer units}$$

When the concentration is expressed in Brix instead of polarization, a lower value is found which reflects the fact that comparatively less non-sugar than sucrose is extracted. The method outlined allows approximate calculation of the transfer efficiency of a diffuser from routine analyses in the cane industry but actual figures for C_o, J_c, C_n and J_n should of course be preferred whenever possible. This requires however many repetitive analyses because instantaneous values do not necessarily reflect the true situation owing to the fundamental instability of diffusers under normal operation and the difficulty of bagasse sampling. Let us also mention that analogous calculations were conducted through a long and tedious method by Buchanan[4], working on a hypothetical case rather than actual factory data, in order to prove that diffusion is the controlling mechanism of extraction. The efficiency values he obtains seem however quite low.

Stage efficiency

Apart from allowing a comparison between diffusers of different design or in different sites working under different conditions, the efficiency figure is also useful for monitoring the mixing and channelling effects in the diffusers, especially those which are physically divided into sections. The stage efficiency is defined as the quotient of the number of perfect theoretical stages, i.e. number of transfer units, divided by the actual number of diffuser sections. For instance, the moving-bed diffuser in the above example has eleven troughs and the stage efficiency consequently is 5·8/11 = 0·53. Assuming a molecular diffusion mechanism, Buchanan[4] endeavoured to compute the stage efficiency from physico-chemical considerations and found a lower value, 0·34. We believe, however, that too many factors are involved in bagasse extraction to allow a purely theoretical treatment, which is only possible with a more homogeneous material like beet cossettes. Furthermore it is not sure that the extraction is a molecular diffusion, although the diffusion laws may be widely applied to it because these laws are a particular aspect of the more general transfer law ruling any random dispersion of particles, whether material or immaterial (for instance calories). The mechanism of bagasse extraction has been discussed at length by many authors and some of them developed mathematical models to support their views. Rein[5,6] considers two first-order relations in parallel with a mass transfer coefficient for easily removed juice and another for tightly held juice. This is however an approximation because it is unlikely that a definite gap exists between easily removed and tightly held juice. Whatever the actual extraction mechanism may be, looking at the problem from the practical side, the process inside each stage is an attempted equalization of the concentrations of the juice contained in the bagasse and the moving extraction juice. Juice by-passed by channelling or insufficient contact time in case of molecular or quasi-molecular diffusion prevents this equalization being complete. If the equilibrium could be reached, i.e. if the concentration of the percolating juice and the juice left in the bagasse could be made equal, the efficiency of the stage would be *one* by definition. A higher efficiency is only possible for a plug-like displacement, in which case the polarization of the juice left in the bagasse would be lower than that of the collected juice. Although such effect is conceivable for a superficial rinsing, there is no indication that it has a considerable extent in bagasse extraction. At the most, it could explain the difference between the practical efficiency and the theoretical efficiency for molecular diffusion computed by Buchanan. Anyway there is no record of the juice left in the bagasse having a lower concentration than the percolating juice and we can accept an efficiency of unity as the maximum figure.

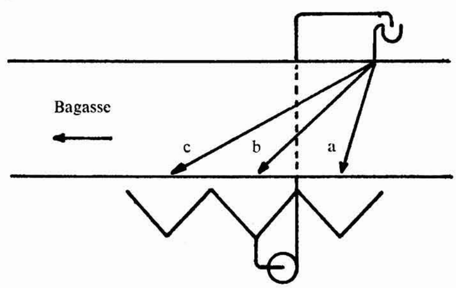

Fig 2

Another effect that reduces the efficiency of a diffuser is backmixing of juice and/or bagasse. Except for the DDS diffuser, the moving-bed design of most cane diffusers precludes any mixing of bagasse. Juice backmixing occurs when it moves in the wrong direction, i.e. is carried down by the bagasse. For a normal percolation velocity, this effect is corrected by shifting up the juice sprayers in order to collect the percolating juice in the following trough (Fig. 2, a). However, if the permeability of the bed decreases, a sizable part of the juice returns to the trough from which it was pumped (b), which effect corresponds to a juice recirculation,

[4] *Proc. 42nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1968, 65–73 (Appendix 2).

[5] *Proc. 14th Congr. ISSCT*, 1971, 1254–1266.

[6] *Proc. 15th Congr. ISSCT*, 1974, 1523–1537.

or even to the preceding one (c). It should be noted that the slowest percolating juice, which is the richest, is carried the farthest backward while the chanelling juice, which is the poorest, is delivered to the front trough, i.e. exactly opposite to what it should be. This effect tends to reduce the difference of concentration between the successive troughs and results in a loss of efficiency compared to the theoretical model of extraction, which assumes a perfect separation of juice and bagasse between stages. It is interesting to have a closer look at the recirculation of juice from and to the same trough because this effect is deliberately sought in the new FS-Van Hengel diffuser[7]. This provides a longer contact time between the extracting juice and the bagasse and a better equalization of the concentrations, which is of course favourable. It should however be noted that the possible benefit of a superficial rinsing explained above is lost because the rich juice displaced by a plug-like mechanism is mixed again with the low-concentration juice which displaced it. Under no circumstance can the efficiency of a diffuser stage based on juice recirculation exceed one transfer unit. A final type of juice mixing which should be mentioned is forward mixing, i.e. overflow in the correct direction between two adjacent troughs, which is also a characteristic of the FS diffuser[8]. It has no adverse consequence on extraction, but nevertheless represents a loss of efficiency because the juice should not flow idly toward the sugar end of the diffuser, but should flow *through the bed of bagasse.*

It is now time to consider the difference between cane and bagasse diffusion. Assuming that the preparation would be adequate for straight diffusion, we may compute how many transfer units would be required in the above example to get the same mixed juice with the same losses from a cane diffuser. C_n and J_n remain of course the same and we would further have:

$$C_o = \frac{100 \times 11{\cdot}79}{100 - 1{\cdot}3 \times 10{\cdot}99} = 13{\cdot}76 \qquad J_o = 12{\cdot}15$$

$$n = \frac{\log(13{\cdot}76 - 12{\cdot}15) - \log(4{\cdot}42 - 3{\cdot}54)}{\log(13{\cdot}76 - 4{\cdot}42) - \log(12{\cdot}15 - 3{\cdot}54)} = 7{\cdot}4 \text{ transfer units}$$

As explained elsewhere[9], the help provided by the first mill to the process is quite small and corresponds to a diffuser of only 1·6 transfer units in spite of the large amount of sugar extracted. The reason is that the extraction of one pound of sugar is much easier at the sugar end than at the water end. The consequence is that an increase of only 30% in the length of the diffuser allows complete discarding of the first mill if the preparation of the cane is suitable for straight diffusion. Assuming the same stage efficiency as in the bagasse diffuser, the minimum number of troughs required is then 7·4/0·53 = 14. As a matter of fact, actual BMA cane diffusers have fifteen or sixteen troughs[10]. Considering now the FS-Van Hengel diffuser, which originally had five stages, in spite of the increase in the stage efficiency from 0·53 to nearly 1·0, it could of course not exceed the maximum figure of five transfer units and the reason why a sixth unit and more recently a seventh proved unavoidable appears obvious from the theory outlined here. Similarly, if this diffuser were to be operated as a cane diffuser with the same imbibition as contemplated[11], two more units would be required. The question of course is whether these two units would be cheaper than a mill.

To conclude, it should be stressed that the same extraction or even better can be obtained from a smaller diffuser with fewer transfer units if higher imbibition is acceptable, because the extraction figure used in the cane industry considers only the final result and disregards the imbibition and consequently the amount of mixed juice. The breakeven point between the cost of a larger evaporator and the cost of a better diffuser is to be determined in each particular case. On the other hand, in the beet industry, where an expensive fuel is used, it is probably more critical than in the cane industry, which uses bagasse as fuel. Nevertheless, we believe that the efficiency of diffusers expressed in transfer units aids the choice of an appropriate diffuser and is a useful tool to making money-saving decisions.

Nomenclature

- B — % final bagasse on cane
- C — polarization of the juice contained in the prepared cane or bagasse
- E — extraction
- F — fibre content
- I — imbibition water % cane
- J — polarization of the extracting juice
- k — fraction of last expressed juice in the total water fed to the diffuser
- M — mixed juice % cane
- n — transfer efficiency
- p — purity quotient of last expressed juice
- P — polarization
- V — % juice on cane
- W — moisture

Subscripts

- o — refers to the input of the diffuser
- l — „ „ first mill juice
- b — „ „ bagasse
- c — „ „ cane
- d — „ „ diffusion juice
- m — „ „ mixed juice
- n — „ „ output of the diffuser

Summary

An indirect method for calculating approximately the efficiency of diffusers in transfer units from figures readily available in a cane sugar factory is outlined for use where no direct measurement of the sugar balance in the diffuser is made. The stage efficiency is defined as the quotient of the efficiency of the diffuser divided by the actual number of sections of the diffuser. The effect of juice mixing on the efficiency is discussed and the minimum required number of stages is evaluated for BMA and FS-Van Hengel cane diffusers.

Quelques problèmes et conséquences de l'évaluation de l'efficacité de transfert des diffuseurs de canne

Une méthode indirecte pour le calcul approximatif de l'efficacité des diffuseurs exprimée en unités de transfert à partir de données facilement disponibles dans une sucrerie de cannes est décrite pour être employée lorsqu'on ne dispose pas d'un bilan sucre du diffuseur

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[7] *I.S.J.*, 1978, **80**, 3–9.
[8] Anon.: *S. African Sugar J.*, 1975, **59**, 511, 515, 517, 519.
[9] Genie: *I.S.J.*, 1976, **78**, 269.
[10] Delavier: *Zeitsch. Zuckerind.*, 1976, **101**, 138–141.
[11] Matic: *S. African Sugar J.*, 1974, **58**, 235. 237, 239, 241.

mesuré directement. L'efficacité totale du diffuseur par étage est définie comme le quotient de l'efficacité totale du diffuseur divisée par le nombre de sections du diffuseur. L'effet du mélange des jus sur l'efficacité est examiné et le nombre minimum d'étages est évalué pour les diffuseurs de cannes BMA et FS-Van Hengel.

Einige Probleme und Konsequenzen der Bewertung des Austauschwirkungsgrades von Rohrextraktionsapparaten

Eine indirekte Methode zur Näherungsbewertung des Wirkungsgrades von Extraktionsapparaten wird beschrieben. Sie bezieht sich auf die Zahl der Austauscheinheiten, die aus in einer Rohrzuckerfabrik leicht erhaltbaren Werten berechnet wird, und wird angewandt wo man die Zuckerbilanz im Extraktor nicht direkt misst. Der Stufenwirkungsgrad wird als Quotient des Extraktorwirkungsgrades, dividiert durch die tatsächliche Zahl von Extraktorsektionen, bestimmt. Der Verfasser diskutiert den Einfluss der Saftmischung, und berechnet

die wenigste Zahl von Stufen, die für BMA- und FS-Van Hengel-Rohrextraktoren notwendig ist.

Algunas problemas y consecuencias en el avaluo del traspaso de la eficiencia por los difusores para caña

Se esboza un método indirecto para calcular aproximadamente la eficiencia de los difusores, basado en unidades de transferencia y según cifras obtenibles fácilmente en una fábrica de azúcar de caña. El propósito es utilizarlo donde no se hace una medida directa del balance de azúcares en el difusor. El grado de eficiencia en las etapas se define como el cociente de la eficiencia del difusor por el número existente de secciones en el difusor. El trabajo trata sobre los efectos de la mezcla del jugo sobre la eficiencia; y hace el avalúo del número mínimo de etapas necesario en los difusores para caña BMA y FS-Van Hengel. □

Inhibitory effect of some heteropolyanions on sugar cane mosaic virus

By KALAWATI SHUKLA
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THE biological roles of heteropolyanions in modifying the cell membrane and affecting the adsorption and penetration of viruses is very well known[1–4]. The antiviral activity of silicotungstate and its *in vitro* inhibitory action on marine lucamia, sarcoma virus[5,6] and other mononeogenic viruses have earlier been reported[7,8]. Silicotungstate has also been found to inhibit *Escherichia coli* DNA and RNA polymerase and DNA polymerase extracted from mouse $3T_3$ cells[6]. However, nucleases and proteases were not inhibited by high concentration of silicotungstate. The heteropolyanions tungsto-2-antimonate protected mice against plasma variant-induced leukemias[10]. However, it had no effect on grafted leukemia.

Although plant virus inhibition has much earlier been reported[11,12], the effects of high-molecular inorganic mineral heteropolyanions have not been paid considerable attention. The present report deals with the effect on sugar cane mosaic virus (SCMV) of four such heteropolyanions, those of arsenomolybdic acid (AMA) phosphotungstic acid (PTA), arsenovanadotungstic acid (AVTA) and tungstosilicic acid (TSA).

The heteropolyanions were prepared by a method described earlier[13]. A pure culture of SCMV was maintained on *Zea mays* cv. Ganga safed. Infected leaves were crushed and sap was filtered through a double layer of muslin cloth. The stock solutions of 1 $mg.cm^{-3}$ of all the heteropolyanions were prepared and were further diluted when needed. One-cm^3 aliquots of virus extract were mixed with 1 cm^3 of these diluted solutions and were left for about 10 minutes. Inoculations were made with an inoculum-wet forefinger on healthy seedlings of maize (at the two-leaf stage) previously dusted with carborundum powder (600 mesh). One cm^3 of infective sap mixed with 1 cm^3 of distilled water served as the control. The results are given in Table I.

Table I. Inhibitory effect of heteropolyanions on sugar cane mosaic virus

Heteropolyanions	*Dilutions* $\mu g.cm^{-3}$	% *inhibition*	*Incubation period* (*days*)
Arsenomolybdic acid (*AMA*)	1000	60	7
	100	50	7
	10	40	6
	1	40	6
Phosphotungstic acid (*PTA*)	1000	80	7
	100	60	7
	10	50	7
	1	30	6
Tungstosilicic acid (*TSA*)	1000	90	7
	100	70	7
	10	50	7
	1	50	7
Arsenovanadotungstic acid (*AVTA*)	1000	20	5
	100	20	5
	10	20	5
	1	10	5
Control		0	5

The results presented in the table show that maximum inhibition of 90% was noted with TSA, followed by 80% with PTA. The least inhibition (20%) was noted with

1 Regelson: *Proc. Int. Symp. on reticuloendothelial system and arterioscleroses*, Italy, 1966.
2 Solomon, Glatt & Okazaki: *J. Bact.*, 1966, **92**, 1855.
3 Toyoshimak & Vogt: *Virology*, 1969, **38**, 414.
4 Voheri: *Acta Path. Microbiol. Scand. Suppl.*, 1964, 171.
5 Raynaud *et al.*: *C. R. Acad. Sci. Paris Serv. D.*, 1971, **272**, 347–348.
6 Haapala *et al.*: *Biomed. Express*, 1973, **19**, 7.
7 Jasmin, Rayband & Cherman: *Ital. Biomedicine.*, 1973, **18**, 319.
8 Bonissote, Konap & Cherman: *C. R. Acad. Sci. Paris Serv. D*, 1972, **274**, 3030–3033.
9 Rabaud *et al.*: *Eur. J. Chin. Biol. Res.*, 1972, **17**, 295.
10 Jasmin *et al.*: *J. National Cancer Inst.*, 1974, **53**, 269.
11 Allard: *U.S. Dept. Agric. Bull.*, 1914, **40**, 33.
12 Bawden: *Adv. Virus Res.*, 1954, **2**, 31–57.
13 Braner: "Handbook of preparative inorganic chemistry" (Academic Press, London), 1965.

AVTA. The inhibitory effects thus follow the order TSA>PTA>AMA>AVTA.

Incubation periods vary from 5 to 7 days.

Acknowledgments

The author is grateful to Prof. K. S. Bhargava for his valuable guidance and to C.S.I.R., New Delhi, for financial assistance.

Summary

The inhibitory effect of four heteropolyanionic acids on sugar cane mosaic virus was studied. The greatest effect was observed with tungstosilicic acid (90% inhibition with a solution of 1 mg.cm^{-3}) followed by phosphotungstic acid (80% inhibition).

L'effet inhibiteur de quatre acides hétéropolyanioniques sur le virus de la mosaique de la canne à sucre

L'action inhibitrice de quatre acides hétéropolyanioniques sur le virus de la mosaique de la canne a été étudiée. L'effet le plus prononcé a été observé avec l'acide tungstosilicique (90% d'inhibition avec une solution à 1 mg.cm^{-3}) suivi par les acides phosphotungsténiques (80% d'inhibition).

Der Inhibitionseffekt von vier heteropolyanionischen Säuren auf den Zuckerrohr-Mosaikvirus

Die Inhibition von vier heteropolyanionischen Säuren auf den Zuckerrohr-Mosaikvirus wurde untersucht. Der grösste Effekt wurde mit Siliziumwolframsäure (90% Inhibition mit einer Lösung von 1 mg.cm^{-3}) gefolgt von Phosphorwolframsäure (80% Inhibition) erzielt.

Efecto inhibitório de algunos heteropolianiones sobre el virus de mosaico de caña de azúcar

El acción inhibitória de cuatro ácidos heteropolianiónicos sobre el virus de mosaico de caña de azúcar se ha estudiado. El efecto máximo se ha observado con ácido tungstosilícico (90% inhibición con una solución de 1 mg.cm^{-3}) y, en seguida, ácido fosfotúngstico (80% inhibición). □

Effects of irrigation level and trash management on sugar cane

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(Rhodesia Sugar Association Experiment Station, Chiredzi)

Paper presented to the 16th Congress, I.S.S.C.T., 1977.

PART I

Introduction

AVAILABILITY of water is a major constraint in the Rhodesian sugar industry; consequently it is important to obtain basic information required to improve the scheduling of irrigation and so to improve the efficiency of water utilization. Accordingly a trial was initiated in 1966 to investigate the effects of six irrigation levels on burnt and trashed cane. A comparison of two nitrogen carriers was also incorporated in the trial. In the selection of treatments, it was believed that the most practical approach was to compare a range of pan factors from 1·0 to 0·37.

The results of the first three crops were reported by Gosnell[1]; as treatment W3 was altered in 2nd ratoon, results are here presented from 2nd to 6th ratoons, during which period identical treatments were maintained (Experiment 1).

It was then decided to investigate the effect of severe water restrictions and this was carried out in 7th ratoon, following which the original treatments were re-imposed in 8th ratoon (Experiment 2).

TREATMENTS AND METHODS

Experiment 1

Six treatments were applied as shown in Table I. Evaporation was measured with a Class "A" Pan with the Central African modification of black matt-painted interior and 25 mm mesh screen over the pan. The resulting water applications and rainfall are also given in Table I.

* Now with Lonrho Sugar Corporation.
† Now with Huletts Sugar Ltd.

[1] *Proc. S. African Sugar Tech. Assoc.*, 1970, **44**, 121–130.

Table I. Treatments, irrigation applied and rainfall (mm)

		Treatments						Rainfall
		W1	W2	W3	W4	W5	W6	(mm)
Pan factor		1·0	0·84	0·84/0·60	0·68	0·53	0·37	—
Evaporation deficit, mm		51	60	60/85	74	96	135	—
Irrigation water applied, mm	2R	1473	1219	1118	914	660	457	452
	3R	1778	1524	1321	1219	914	610	380
	4R	1727	1372	1219	1067	813	508	434
	5R	1224	1020	867	714	510	306	597
	6R	1581	1275	1173	1020	714	459	417
	Mean	1557	1282	1140	987	722	468	456

Overhead irrigation was used; in order to obtain nett irrigations of 50·8 mm, gross applications of 59·6 mm were made. This represented 85% efficiency, and to check the output of nozzles at the termination of the trial two tests were conducted. It was found that nozzle output had increased from the 11·4 gallons.min^{-1} given in the sprinkler data sheet, to 12·2 gallons.min^{-1} which in theory represents an increase in application from 59·6 to 63·8 mm. However, when tins were put out to measure the water actually applied (using oil to prevent evaporation), the application rate in the net plot was found to be 7·3 mm.hr^{-1}. As the design figure used was also 7·3 mm.hr^{-1} it is believed that the figures in this trial are reliable.

Immediately after harvest, two applications of 50·8 mm were made to all plots to eliminate differences in soil profile moisture from the previous crop. Thereafter, allowances were made for lower water requirements of the young crop. From 0 to $\frac{1}{4}$-canopy, pan factors were multiplied by 0·5; from $\frac{1}{4}$- to $\frac{1}{2}$-canopy by 0·75 and after $\frac{1}{2}$-canopy the full pan factors were applied, canopy figures being determined in treatment W1.

The main plots of 15 m × 36 m were irrigation treatments and were split into 4 sub-plots of 15 m × 9 m gross or 10 m × 6 m nett each. Sub-plot treatments consisted of trashing *vs.* burning and urea *vs.* ammonium nitrate. There were 4 replications, making a total of 96 sub-plots.

The soil was a PE1 sandy clay loam. The water-holding capacity on a site adjacent to the trial is given in Table II. Soil chemical analysis was done on virgin soil before the trial was initiated and plots were analysed after 3rd and 6th ratoons. Foliar analyses were carried out in 3rd, 4th, 5th and 6th ratoons.

Table II. Water-holding capacity of soil

Depth, cm	*Available moisture* mm/15 cm	*Available moisture* Cumulative, mm
0 –15·2	23·2	23
15·2–30·5	23·3	46
30·5–45·7	20·9	67
45·7–61·0	18·2	86
61·0–76·2	18·1	104
76·2–91·4	12·4	116

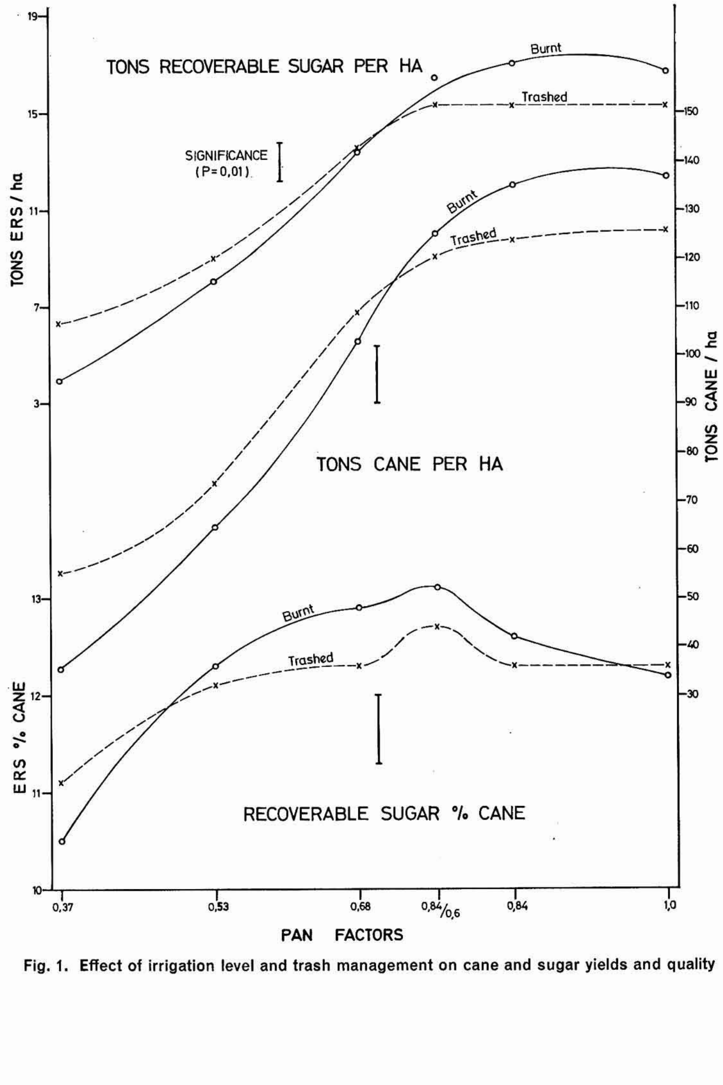


Fig. 1. Effect of irrigation level and trash management on cane and sugar yields and quality

After each crop the plots were top-dressed with 84 kg.ha^{-1} P_2O_5 as single superphosphate and 179 kg.ha^{-1} N as urea or ammonium nitrate (treatment). The variety was N:Co 376 and was harvested at approximately 12 monthly intervals from November 1969 (2nd ratoon) to November 1973 (6th ratoon).

Cane quality was determined on a bulk sample of 8 tops, 8 middles and 8 bottoms from 24 canes per sub-plot. Direct analysis of cane was employed, using the Jeffco cutter-grinder and Alfa Laval cold extractors. Estimated recoverable sugar % cane was calculated as follows.

e.r.s. % cane $= S - 0{\cdot}451\,(B - S) - 0{\cdot}077F$

where S = sucrose % cane, B = Brix % cane and F = fibre % cane.

Experiment 2

After 6th ratoon the sub-plot treatments were altered for a year: the burnt *vs.* trash and urea *vs.* ammonium nitrate treatments were scrapped and two water restriction treatments (*R*) were applied to sub-plots during 7th ratoon (no irrigations were made to "top up" the profile):—

R0 — no irrigation

R1 — irrigated at 0·37 of pan.

No treatments were applied to the previous whole plot treatments W1 — W6, but they were harvested separately to determine whether there were residual main effects or interactions with R treatments.

In 8th ratoon the original whole-plot irrigation treatments (W1—W6) were re-applied on the same plots; no restriction treatments or other sub-plot treatments were applied.

Sub-plots were 18 m × 15 m gross and 12 m × 10 m nett. All trash remaining on the trashed sub-plots after the 6th ratoon was burnt and the only form of nitrogen applied was ammonium nitrate at the same rate as in Experiment 1.

RESULTS

Experiment 1

Burning vs. *Trashing*

There was a very marked interaction between irrigation level and burning *vs.* trashing. At normal levels of irrigation (0·84 to 1·0 × Pan) burning produced higher cane and sugar yields per hectare than did trashing; where the cane was subject to severe moisture stress, however, (0·37 to 0·53 × Pan), trash conservation resulted in higher yields than burning. Burning and trashing produced similar yields at an irrigation level causing moderate stress (0·68 × Pan). These results were consistent and significant over all five ratoons and the mean results are shown in Fig. 1, which also shows the effects on e.r.s. % cane. At all intermediate irrigation levels (0·84 to 0·53× Pan) burning resulted in higher quality than trashing. In the wettest treatment (1·0 × Pan) trashing and burning produced similar cane quality, but in the driest treatment, trashing was substantially better.

Where water is more of a limiting factor than land, it is of interest to examine the water use efficiency (kg sugar produced per m^3 irrigation water applied) rather than yield per hectare. This is done in Fig. 2, which shows completely different trends for burning and trashing. While the curve for burnt cane is similar to that of tons sugar per ha in Fig. 1 (but with a peak at 0·84/0·6 × Pan), the dominant effect of a trash blanket on moisture conservation has resulted in fairly uniform water use efficiencies at all irrigation levels from 0·37 to 0·84 with a slight peak at 0·68. The wettest treatment (1·0 × Pan) showed a marked fall-off in water use efficiency.

Part of the cause of higher cane yields with burning at high irrigation levels may be found in the stalk counts (Fig. 3) which were substantially higher in burnt than trashed cane with all the wetter treatments because the trash blanket reduced tillering. There was a marked reduction in stalk counts with drier treatments in burnt cane, but little with trashed cane; this resulted in essentially the same population with burnt and trashed cane at the lowest irrigation level. Fig. 3 also shows that trashed cane had thicker stalks than burnt cane; the difference was greater at low levels of irrigation than at high levels.

The effect of trash management on sucrose % cane, Brix and purity was similar to that of e.r.s. (Fig. 1). There was a marked effect on fibre % cane, with burnt cane averaging over 1% higher than trashed cane (Table III).

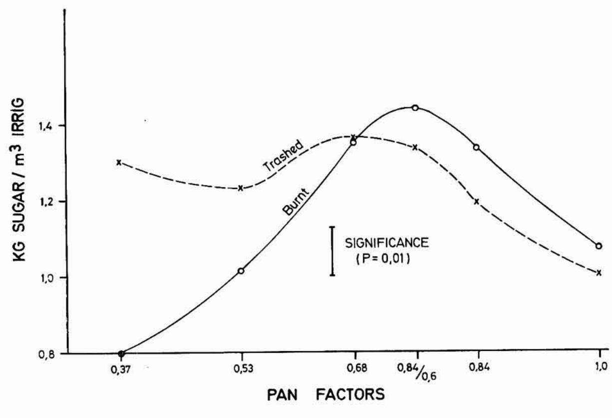


Fig. 2. Effect of irrigation level and trash management on water use efficiency

Table III. Effect of trash management at different irrigation levels on cane quality

		W1	W2	W3	W4	W5	W6	*Mean*
Sucrose % cane	Burnt	14·6	15·0	15·5	15·2	14·7	13·0	14·7
	Trashed	14·4	14·7	15·0	14·5	14·5	13·5	14·4
Fibre % cane	Burnt	13·6	13·1	13·0	12·8	12·9	12·5	13·0
	Trashed	12·6	12·2	12·1	11·6	11·5	11·1	11·9
Brix % cane	Burnt	17·4	17·9	18·5	18·4	17·7	16·3	17·7
	Trashed	17·3	17·7	17·9	17·4	17·9	17·0	17·5
Purity	Burnt	82·7	83·8	84·0	84·3	83·1	79·6	83·0
	Trashed	83·7	83·2	84·2	83·5	81·7	80·0	82·9

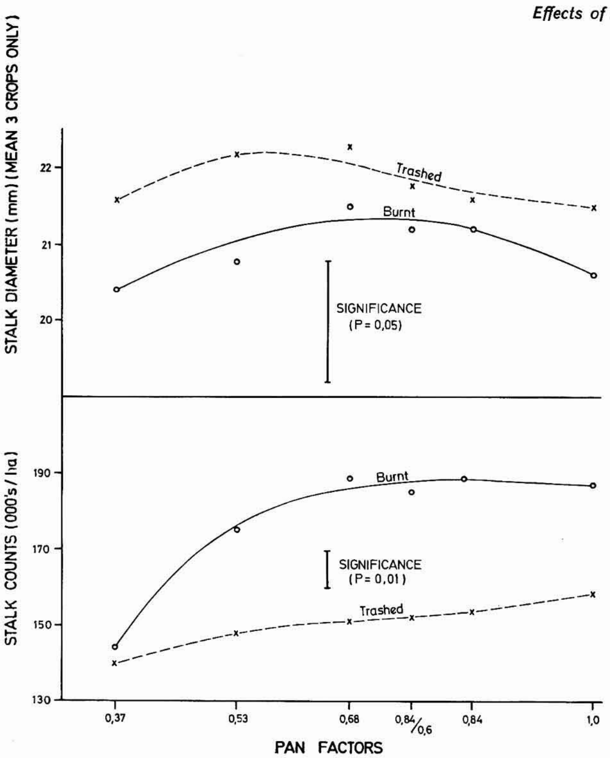


Fig. 3. Effect of irrigation level and trash management on stalk population and diameter

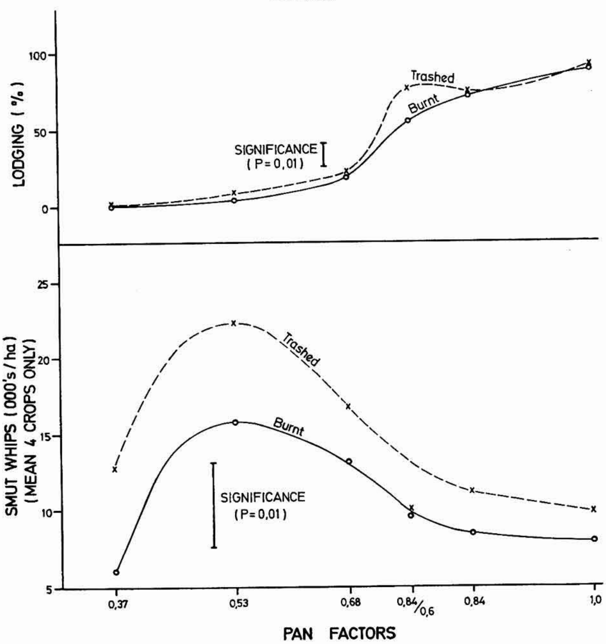


Fig. 4. Effect of irrigation level and trash management on smut and lodging

There was a fairly marked increase in smut infection in trashed cane, with counts some 5000 whips per ha more than in burnt cane (Fig. 4). Trashed cane resulted in somewhat more lodging than burnt cane.

Trash management had some slight effects on soil analysis: trashing tended to decrease pH, conductivity and exchangeable K and Ca. Exchangeable Mg tended to increase with trashing, while Na remained unchanged (Table IV).

Trash management had relatively little effect on foliar analysis. Table V shows that there were no apparent differences between burning and trashing except in K and Ca. Burnt cane had slightly lower K and slightly higher Ca foliar content than trashed cane. Although these effects were not marked, they were consistent over all four ratoons.

Table V. Effect of trash management on foliar analysis

	N	*P*	*K*	*Ca*	*Mg*
Burnt	1·85	0·22	1·40	0·28	0·18
Trashed	1·84	0·22	1·44	0·26	0·19

Irrigation levels

In comparing the effects of irrigation levels, the average of the trash and burnt treatments would not be meaningful where there was a major interaction (see above). Since all cane is burnt in the Rhodesian Lowland, the remainder of this paper deals with results of burnt cane only, except where otherwise stated.

Increasing pan factors from 0·37 to 0·84 resulted in a linear increase in yield of cane per ha but over 0·84 the response tailed off (Fig. 1). The drying-off treatment (0·84/0·6 × Pan), which produced the highest recoverable sugar content, yielded significantly less cane than the two wettest treatments (Table VI). This was most marked in the 3rd and 6th ratoons which were the two driest seasons.

The yield of the 0·84 and 0·84/0·60 treatments declined with each successive crop after 3rd ratoon, a decline which was not as well defined in the wettest treatment.

Fig. 1 also shows that the highest e.r.s. % cane was obtained with the drying-off treatment (0·84/0·60) followed by the other intermediate treatments 0·68 and 0·84 × Pan. Both wetter and drier treatments resulted in lower e.r.s. content, this being particularly marked with the driest treatment (0·37 × Pan), which produced some extremely low values (Table VII).

The highest yields of sugar per ha were obtained with the 0·84 × Pan treatment, with both 1·0 × Pan and 0·84/0·60 × Pan treatments giving very similar yields. As shown in Table VIII, in three of the crops, the latter treatment outyielded the former.

Fig. 2 shows that the highest crop water use efficiency (kg sugar per m³ water applied) was obtained from treatment 0·84/0·60 × Pan, with both 0·68 and 0·84 giving almost as good results. The poorest efficiency was obtained with the lowest irrigation level. Table IX shows that there is a large variation from season to season in crop water use efficiency, owing to rainfall fluctuation.

The effect of pan factors on sucrose and Brix % cane was similar to that of recoverable sugar. It was sur-

Table IV. Effect of trash management and irrigation level on soil analysis (6th ratoon)

			Pan factors (Mean burnt and trashed)					
	Burnt	*Trashed*	1·0	0·84	0·84/0·60	0·68	0·53	0·37
pH	5·5	5·3	5·6	5·2	5·5	5·7	5·3	5·2
Conductivity, mmho.cm^{-1}	218	186	212	202	182	242	175	195
Ex. K meq %	0·88	0·78	0·80	0·72	0·74	0·94	0·80	0·98
Ex. Ca meq %	8·5	8·1	7·6	8·2	8·5	9·1	8·1	8·2
Ex. Mg meq %	2·7	3·2	2·9	3·1	2·3	2·9	3·6	3·0
Ex. Na meq %	0·48	0·48	0·52	0·46	0·45	0·44	0·44	0·55

Table VI. Effect of irrigation level on yield of burnt cane (tons per hectare)

	Treatment						L.S.D.		C.V.
Crop	W1	W2	W3	W4	W5	W6	5%	1%	%
2R	141·7	138·8	134·5	118·6	83·6	43·5	5·95	8·23	10·5
3R	152·9	148·6	134·5	109·4	61·2	29·1	5·31	7·34	9·0
4R	130·8	136·1	128·5	92·9	45·3	18·8	11·1	15·3	11·1
5R	126·9	129·7	118·1	113·4	89·7	62·7	7·5	10·3	6·0
6R	131·3	121·1	109·8	81·0	43·2	24·9	12·0	16·5	12·4
Mean	136·7	134·8	125·1	103·1	64·6	35·8	8·0	11·1	6·6

Table VII. Effect of irrigation level on e.r.s. % cane of burnt cane

	Treatment						L.S.D.		C.V.
Crop	W1	W2	W3	W4	W5	W6	5%	1%	%
2R	12·2	12·6	13·4	13·6	13·2	12·2	0·9	1·2	5·6
3R	12·6	13·2	13·8	13·7	12·7	11·4	0·6	0·9	4·5
4R	11·4	12·0	12·6	12·7	10·9	8·8	0·9	1·2	5·4
5R	11·6	11·9	13·0	12·8	13·1	10·8	1·0	1·4	7·1
6R	13·3	13·4	12·9	11·7	11·6	9·3	1·2	1·7	8·4
Mean	12·21	12·63	13·15	12·92	12·31	10·49	0·5	0·7	3·5

Table VIII. Effect of irrigation level on tonnes e.r.s/hectare of burnt cane

	Treatment						L.S.D.		C.V.
Crop	W1	W2	W3	W4	W5	W6	5%	1%	%
2R	17·15	17·33	18·00	16·01	11·08	5·27	0·82	1·13	11·8
3R	19·28	19·66	18·61	14·95	7·80	3·30	0·68	0·94	9·5
4R	14·89	16·41	16·13	11·84	4·90	1·65	1·60	2·22	12·8
5R	14·85	15·38	15·37	14·50	11·70	6·77	1·28	1·78	8·3
6R	17·46	16·19	14·13	9·59	5·05	2·35	1·91	2·64	16·0
Mean	16·70	17·00	16·43	13·30	7·95	3·75	1·08	1·49	6·8

Table IX. Effect of irrigation level on kg sugar per m³ water in burnt cane

	Treatment						L.S.D.		C.V.
Crop	W1	W2	W3	W4	W5	W6	5%	1%	%
2R	1·16	1·42	1·61	1·75	1·68	1·15	—	—	—
3R	1·08	1·29	1·41	1·23	0·85	0·54	—	—	—
4R	0·86	1·20	1·32	1·11	0·60	0·32	0·13	0·17	13·9
5R	1·21	1·51	1·77	2·03	2·29	2·21	0·16	0·21	8·8
6R	1·10	1·27	1·20	0·94	0·71	0·51	—	—	—
Mean	1·07	1·33	1·44	1·35	1·10	0·80	0·13	0·18	7·8

Table X. Dry matter content (burnt cane)

Treatment	W1	W2	W3	W4	W5	W6
Pan factor	1·0	0·84	0·84/0·60	0·68	0·53	0·37
Moisture % cane	69·0	69·0	68·5	68·8	69·4	71·2
Sucrose % dry matter	47·1	48·4	49·2	48·7	48·0	45·1
Fibre % dry matter	43·9	42·2	41·4	41·1	42·1	43·3
Non-sucrose Brix % dry matter	9·0	9·4	9·4	10·2	9·9	11·6

Table XII. Effect of severe water restriction (7th ratoon)

	Restriction			Irrigation treatments to previous crop						L.S.D.(W)		C.V.
	R0	R1	*Signif.*	W1	W2	W3	W4	W5	W6	5%	1%	%
Pan factor	0·0	0·37		1·0	0·84	0·84/0·60	0·68	0·53	0·37			
Irrigation, mm	0·0	318		Treatments not applied this crop								
Irrigation and rainfall, mm	811	1129										
Tons cane/hectare	43·5	64·8	***	59·5	60·5	50·3	52·0	49·8	52·6	7·83	10·83	27·2
Estimated recoverable sugar % cane	9·07	11·11	***	10·16	10·79	9·62	10·02	10·64	9·31	1·44	1·99	14·2
Tons estimated recoverable sugar per hectare	4·02	7·22	***	6·17	6·81	5·07	5·34	5·35	4·97	1·13	1·56	20·6
Stalk counts (000's hectare)	148·1	173·6	***	137·4	166·7	163·4	154·9	182·4	160·1	19·3	26·73	14·7
Sucrose % cane	11·64	13·19	***	12·53	13·06	12·02	12·40	12·86	11·63	1·29	1·79	9·8
Brix % cane	15·2	15·6		15·7	15·8	15·0	15·4	15·5	14·7	1·04	1·43	5·2
Fibre % cane	13·0	13·0		12·3	13·1	13·7	13·2	13·5	12·0	1·26	1·75	4·9
Purity %	76·6	84·7	***	79·9	82·1	79·9	80·4	83·0	78·8	4·02	5·56	6·5

prising, but consistent, that fibre % cane declined steadily with decreasing pan factors. Juice purity declined rapidly below 0·68 × Pan (Table III). Stalk counts declined significantly below 0·68 × Pan, and lodging below 0·75 × Pan (Fig. 3). The incidence of smut was highest at 0·53 × Pan (Fig. 4).

A remarkable feature of the results is the tendency for moisture % cane to increase as water stress increased (Table X). It is also interesting to note that low irrigation levels decreased sucrose because a greater proportion of the dry matter was in the form of non-sucrose Brix, while above 0·75 × Pan the sucrose declined because a greater proportion of dry matter was in the form of fibre.

Nitrogen carrier

There were effectively no differences between urea and ammonium nitrate in relation to responses to pan factors; results of the two carriers have accordingly been averaged throughout.

Soil analysis

There was quite a marked drop in soil pH over the 7 years of irrigation on a virgin soil; exchangeable Na and conductivity also decreased, presumably owing to leaching. There were no other clear differences (Table XI).

Conductivity appeared to decline and exchangeable K, Ca and Mg to increase as the pan factor declined. Exchangeable Na and pH appeared to be unaffected (Table IV).

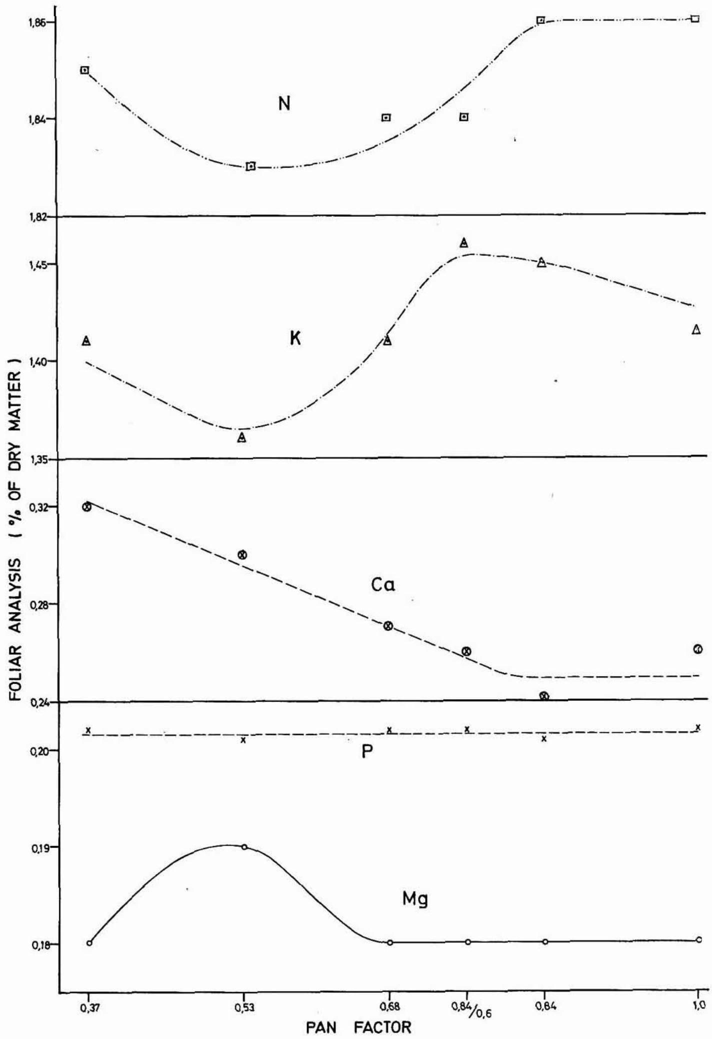


Fig. 5. Effect of irrigation level on leaf N, P, K, Ca and Mg

Foliar analysis

The effects of irrigation level on the major nutrients is shown in Fig. 5. These data are the averages for 3rd to 6th ratoon inclusive and of burnt and trashed plots. The data show that with both N and K there is a reduction with decreasing levels of irrigation with an unexpected rise at the driest treatment (see Discussion). There was a marked and consistent rise in Ca content with reduced levels of irrigation. P and Mg contents appeared to be unaffected by irrigation level with the exception of an unexplained rise in Mg content at 0·53 × Pan.

Table XI. Soil analysis

	Virgin soil	3rd ratoon	6th ratoon
pH....................	6·4	5·5	5·4
Conductivity	—	284	201
Organic matter %	1·3	1·3	—
Ex. K. meq %......	0·85	0·90	0·83
Ex. Ca meq % ...	8·6	6·7	8·3
Ex. Mg meq % ...	3·1	2·3	3·0
Ex. Na meq % ...	—	0·76	0·48

Experiment 2

During the 7th ratoon, when only restriction treatments were applied, the 0·37 × Pan treatment was highly significantly better than no irrigation in terms of cane and sugar yield, recoverable sugar and sucrose % cane, and juice purity (Table XII).

The effect of irrigation treatments applied to the preceding crop was fairly marked, partly because of varying moisture in the soil at ratooning. The 0·84 × Pan treatment yielded significantly more cane and sugar, as well as producing a higher sugar content than the other treatments. The driest treatment, which was not irrigated for a prolonged period prior to ratooning, produced a significantly lower sucrose content.

(*To be continued*)

SUGAR CANE AGRONOMY

Soil cultivation: introduction and orientation. G. D. Thompson. *Sugarland* (Philippines), 1977, **14**, (2), 12-16. See *I.S.J.*, 1977, **79**, 137.

Rock and stone pickers. Anon. *Australian Sugar J.*, 1977, **69**, 249, 254.—Illustrations are given of two home-made rock and stone pickers. One picks up rocks from the soil surface in the inter-row space (it being assumed by the designer that cultivation will always bring more rocks to the surface); it operates along one row at a time and has means of removing rocks from among cane stools, the stones being swept into the centre of the inter-row where they are raked onto an elevator. The other stone picker removes all stones and rocks from the top eight inches of soil before planting; soil and stones are taken in through a 1-m wide scoop and elevated into a very large rotating auger surrounded by heavy-gauge mesh. The soil and very small stones drop through the mesh, while rocks and large stones eventually pass to a rear bin which can be raised to a sufficient height to allow the material to be tipped into a gravel truck.

The management of cane production and supplies in sugar cooperatives—an overview. S. N. G. Rao. *Maharashtra Sugar*, 1977, **2**, (11), 9-16.—Problems confronting the Maharashtra sugar industry, which produced more sugar in 1976-77 than any other state in India and contains 50 cooperative factories as opposed to only 10 private factories, are discussed. They centre on the need to maintain cane quality and quantity in order to reduce agricultural and processing costs. The author calls for a dynamic cane breeding programme (since at present the state depends mostly on only two varieties, Co 740 and Co 419) and the establishment of cane nurseries at factories, not only for varietal testing but also for growing of heat-treated seed cane which should replace all the cane in the area once every five years. Other aspects considered are irrigation, fertilization, ratooning, plant protection from pests and diseases, harvesting and transport, and cane maturity scheduling.

Zoning and management of cane supplies. B. M. Hajarnis. *Maharashtra Sugar*, 1977, **2**, (11), 17-23.—In the absence of statutory zoning of cane areas, there has been irrational supplying of cane in Maharashtra, with some factories suffering from cane deficiency. The author stresses the need for a zoning policy such as applies in other Indian states, so that factories can be sure of regular supplies from the adjacent area.

Maturity survey for harvesting of sugar cane in sugar factory areas. D. G. Dakshindas. *Maharashtra Sugar*, 1977, **2**, (11), 25-29.—Cane harvest scheduling on the basis of maturity is discussed, and the problems peculiar to Maharashtra indicated. The most suitable sampling method to use is discussed. Brix measurement by hand refractometer has been found to correlate closely with cane pol, so that laboratory analysis for pol, purity and estimated sugar recovery is unnecessary.

Water management for cane development. G. K. Zende. *Maharashtra Sugar*, 1977, **2**, (12), 15-21.—The water requirements of cane are discussed and factors affecting it examined. The mechanism of cane moisture absorption is described and irrigation methods and scheduling explained. The effects of flood irrigation are discussed, and mention made of trash mulching which, in trials over three seasons, did not prove beneficial (although the type of soil and the high water table during the period were regarded as possible reasons for this). Finally, the role of leaf sheath moisture in controlling cane yield is considered.

The Victorias experience. Anon. *Crystallizer*, 1977' **2**, (3), 7, 18-19.—Guidelines are given on ways in which the costs of cane production can be reduced on the basis of experience in the Victorias Milling Co. area of the Philippines. It is pointed out that 14% of the total direct cost is accounted for by land preparation for plant cane; since the work is fully mechanized, the need is to cut fuel consumption by eliminating unnecessary use of plough, harrow or subsoiler and restricting operations to the minimum required to give a good soil tilth. The soil should not be worked when too wet, as tractor slippage will increase fuel consumption without accomplishing much work, and compaction will be greater. A system is recommended in which trash is burnt, the field harrowed once for stubble control and a subsoiler passed along the interspace; the setts are then planted at a slight angle in the subsoil line. Costs can be reduced still further by omitting harrowing and removing the stubble later (although it can be uprooted by the subsoiler). Such a system can cut the cost of land preparation by 70%. Farmers in the Philippines, who use the system mainly during the rainy months, have found that cane yields are comparable to those with the conventional method of land preparation. Treatment of setts with fungicides immediately after cutting will protect them from rot-causing organisms such as the causal agent of pineapple disease and thus increase germination and reduce the need for replanting. Experience has shown 23% greater germination by comparison with untreated setts, while up to 13 days' delay in planting had no adverse effect on germination—in fact, delay even improved it. It is recommended to use undamaged setts having at least three viable eyebuds. Ratooning will also help cut costs, and it is considered that ratoon yields equal to those of plant cane are possible provided as much attention is given to ratoons as to plant cane. Manual weeding is cheaper than chemical control, although will be effective only if carried out as early as possible or when the weeds are still small. It should be supplemented with mechanical cultivation, although excessive ploughing should be avoided, since it adversely affects cane growth. Only 4-6 passes of a plough may be necessary for adequate weed control. If herbicides are used, application should be limited to just one spraying per crop, either as pre-emergence or early post-emergence treatment—this will give about a month's freedom from weeds, after which manual and mechanical treatment can be used for regrowth. The cost of fertilizers alone, even at their cheapest, constitutes 38% of the total direct cost of cane production. It is recommended to use the cheapest N-P-K combination, to apply the minimum required, to use soil analyiss to determine the requirement, to apply fertilizers correctly (top dressing without soil covering leads to nutrient loss, while fertilizers applied at planting should be placed about 4-5 cm to the side of the sett) and at the right time, to use fertilizer supplements such as filter cake whenever possible (the filter cake being allowed to decompose before application so as to avoid scorching of the plants), to ensure that the field is well drained, and to remember that yields do not continue to rise in direct proportion to the amount of fertilizer applied. The cane should be harvested at the right point of maturity, the stalk being cut at ground level to reduce sugar loss and cut the cost of stubble shaving. If stubble shaving is necessary, it should be carried out immediately after trash burning or harvesting so as to avoid reduction in sugar yield (found to be of the order of 16-44% when stubble shaving was delayed by 5-20 days).

A parametric approach to evaluation of soil productivity for land use planning and crop development. A. A. Tomaneng. *Crystallizer*, 1977, **2**, (3), 12, 16. Studies of agronomic factors affecting cane sugar yield showed that the most important were soil available P and K, followed by soil texture, effective soil depth, climate, soil organic matter, internal soil drainage and land slope. These parameters accounted for 60·7% of the variation in sugar yield. Cane yield was influenced by effective soil depth, available P and K, climate, soil texture, internal soil drainage, land slope and soil organic matter, in that order; these parameters accounted for 68% of the variation in cane yield. Cane juice quality was affected by soil pH, soil organic matter, soil texture, available P and K, effective soil depth, land slope, internal drainage and climate, in that order; these factors accounted for 74·4% of the variation in juice quality. Correlations between yield parameters and the factors mentioned above were not consistent, however, and, although certain tendencies were evident, it is concluded that accumulated data on most Philippine soils are still inadequate for land use evaluation and planting.

***In vivo* inhibition of sugar cane invertase.** J. D. Layoso. *Crystallizer*, 1977, **2**, (3), 20.—Post-harvest deterioration of cane and the action of invertase on sucrose are discussed. The need for rational short-term storage of cane at a time when there is prolonged delay between harvesting and processing (particularly as a result of delivery of considerable quantities of cane during the months of high cane purity) is stressed. Studies were conducted on inhibition of invertase activity by various chemicals applied to cane stored for 4 days. While MBR 1345-4S at 2% concentration increased gravity purity by comparison with the control, 5% sodium metasilicate and 10% CMA bactericide had no inhibitory effect on cane deterioration. "Tide" detergent at 2, 5 and 7% had a positive effect. Further investigations are to be conducted on the method of application, concentration and economics of the ripener used.

Field losses in sugar production through cane drying, burning and delayed harvest. M. Ilaga. *Crystallizer*, 1977, **2**, (3), 20-21.—The effects of moisture stress, burning and delayed harvesting were investigated. Results showed that severe moisture stress, causing all the leaves to become dry, caused nearly 35% fall in yield and 47% fall in sugar yield by comparison with cane having green leaves. Cane juice purity also fell markedly with leaf desiccation. Loss of calculated sugar yield in burnt standing cane was 14·45% after 1 week, 28·82% after 2 weeks and 43·10% after 3 weeks. By comparison, losses in burnt, cut cane were 1·83%, 17·24% and 42·71% after 1, 2 and 3 weeks, respectively. The values for unburnt, cut cane were 12·72%, 25·22% and 36·46%, respectively, and for unburnt cane left standing beyond the normal harvesting date 1·48%, 1·84% and 3·89%, respectively.

Test applications of siliceous materials to sugar cane at the Tarlac Development Corporation. M. T. Ilaga, J. M. Canlas, A. T. Valentino and N. B. Romero. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 20-33.—Two sources of silicon, quarry silica and "Sucromax" (a soluble silica), were tested for their effects on cane grown on low-Si soils. In preliminary trials, treatments with the equivalent of 4 and 6 tonnes.ha^{-1} of quarry silica showed marked improvement in sugar yield and cane sugar content, juice purity and Brix, while increasing doses of "Sucromax" at rates equivalent to between 0 and 8 tonnes.ha^{-1} also tended to improve stalk height and weight of seedbed cane. Large-scale applications of both materials were generally beneficial to cane and sugar yield in Si-deficient soils with increases averaging 12·42% and 8·52%, respectively, for quarry silica and 8·87% and 6·00% for "Sucromax".

Chemical methods of assessing available phosphorus from phosphate fertilizer materials. E. M. Tianco. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 34-43.—*I.S.J.*, 1978, **80**, 142.

A study on the application of infrared colour aerial photography in determining drainage conditions in sugar cane fields. R. C. Bruce. *Proc. 14th Ann. Conv. Philippines Sugar Tech.*, 1976, 54-66.—With infra-red colour film, cane leaves appear in various shades of red which are more easily distinguishable than corresponding shades of green with normal film. Leaves under stress through disease, pest attack, chemical excess or deficiency, moisture deficiency or poor drainage, etc., can be distinguished and identified. The condition can then be confirmed by ground observation and steps taken to remedy the situation. This has been applied in respect of soil drainage in the Biscom district of Binalbagan, Negros Occidental.

Broad spectrum weed control with "Asulox"/Actril DS" in sugar cane in the Philippines. R. W. E. Ball and M. J. Simmonds. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 77-85.—The title herbicide mixture was applied to 75 sites in commercial cane crops during 1974 and 1975 and gave very good control of most of the major grass weeds present, particularly *Echinochloa* spp., *Eleusine indica, Digitaria* spp. and *Rottboellia exaltata.* Control of *Paspalum* spp. was good in the young stages, but these weeds became resistant with age. Excellent control was obtained of a range of broadleaved weeds, including *Ipomoea* spp., *Physalis* spp., *Calopogonium moconoides* and *Amaranthus* spp. The growth of sedges (*Cyperus* spp.) was well controlled, but regrowth occurred within a few weeks. Slight phytotoxicity was noted at some sites, but this was normally quickly outgrown, with no adverse effect on either cane height or tiller numbers.

CANE PESTS AND DISEASES

A preliminary study on chemical control of the white grub, *Holotrichia serrata* F., damaging sugar cane. H. David and K. Ananthanarayana. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 25-Ag. 29.—*H. serrata* has been found to damage sugar cane, sometimes very seriously, in a few districts of Karnataka and Tamil Nadu states, and experiments on control of the pest were carried out in 1972-75. Of the various insecticides tested, "Fensulfothion G.5" at 2·5 kg a.i. per ha proved the most effective in terms of grub population reduction and cane yield. Application of half the full dose at planting followed by the other half 90 days later was better than a single application at planting.

Is it difficult to control the white grub (*Holotrichia serrata* F.) in sugar cane in Maharashtra state? P. R. Moholkar, S. J. Ranadive and B. S. Shewale. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 31-Ag. 37.—*H. serrata* has become a serious cane pest in districts of Maharashtra, and studies were made of its life cycle and possible control. The results are discussed and tabulated, showing that a number of insecticides, in powder or granular form, are effective against first instar larvae of the grub, best results being obtained by application in two half-doses, one at the opening of the furrows in the first week of July and the second at the time of cane planting, i.e. end of July to mid-August. The most effective treatment was "Carbaryl"+"Lindane" at 1·5 + 1·5 kg a.i. per ha; this reduces the percentage of dead cane shoots to 3·89% compared with 28·5% where no insecticide was applied.

A review on causes and remedies of iron chlorosis in sugar cane. A. K. Garg and K. D. Agarwal. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 43-Ag. 47.—Investigations into possible causes of iron deficiency in cane, resulting in chlorosis and possibly severe reductions in yield and quality, are reviewed. The disorder, which has been found to occur in many parts of India, is generally attributed to unavailability of soil iron to the cane plant. It can be cured by spraying with ferrous sulphate, which may also be mixed with manganese sulphate and urea to give even better results.

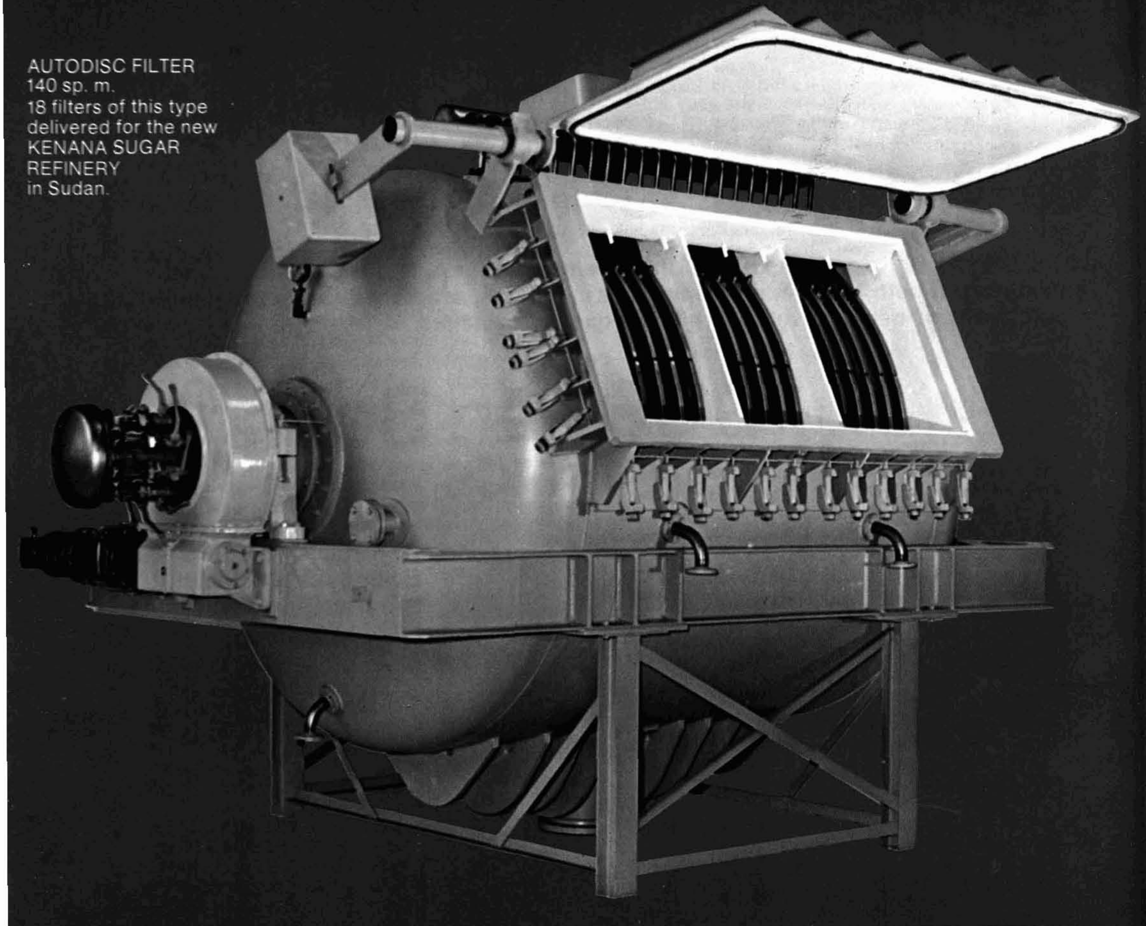
Pathogenic potential of wilt pathogens of sugar cane and their ecological relationship with *Colletotrichum falcatum*. R. P. Singh and K. Singh. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 69-Ag. 75.—Isolates of wilt fungi were taken from both apparently healthy cane (represented by seven varieties) and diseased cane. The former canes contained only *Fusarium moniliforme* which, however, did not cause any browning of vascular strands or other wilt symptoms and must therefore be regarded as non-virulent. The diseased canes yielded *F. moniliforme, Acremonium terricola* and *A. furcatum*; when tested using the plug method, all three fungi, either individually or together, produced typical wilt symptoms, even in the apparently healthy cane, from which it is concluded that a virulent form of *F. moniliforme* also exists. Only one variety, BO 32, was highly resistant to it and the other causal organisms. Combination of one or more of the wilt pathogens with the red rot pathogen, *C. falcatum*, did not reveal any synergism or antagonism, so that the wilt-causing fungi are considered to play no major role in triggering red rot outbreaks. When the wilt fungi were inoculated with *C. falcatum*, the wilt-affected internodes turned bright red or reddish-brown with formation of white spots at right angles to the cane axis, and it was very difficult to distinguish red rot-affected from wilt-affected strands.

Occurrence of black bug and its control in sugar cane. B. N. Pandey. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 25-Ag. 30.—Two species of lygaeid (black) bug, *Blissus jibbus* and *Cavelerius excavatus*, are commonly found in ratoon cane in western districts of Uttar Pradesh during hot weather, but indications are that the pest is now spreading to eastern parts of the state. Both nymphs and adults suck the sap, and the numbers per shoot can vary from a few to 200. Yield may fall by 1-5 tonnes per ha, depending on the degree of incidence and crop condition. After harvest, the over-wintered adults remain in the field under the debris and start breeding and feeding on the ratoon shoots, later migrating to plant cane. Trials were conducted on control of the bug. Best results (97·2% reduction) were obtained with "Endrin" at 0·2 kg a.i. per ha, although more than 90% reduction was also achieved with 0·15 $kg.ha^{-1}$ "Endrin", 0·20 $kg.ha^{-1}$ "Endosulfan", 0·25 $kg.ha^{-1}$ "Dichlorphos" and 0·2 $kg.ha^{-1}$ gamma-BHC. The performances of various spraying systems were also investigated. If trash cannot be burnt, it should be collected and dumped outside the ratoon crop area so as to expose the adults to the sun.

Effect of hot water treatment on germination, grassy shoot disease incidence and yield of sugar cane. A. O. Patil, M. B. Bachchhav and S. J. Ranadive. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 65-Ag. 66.—Hot water treatment for 2 hours at 50°C completely eliminated the disease from affected setts and, in the cases of both diseased and healthy setts, increased yield by comparison with untreated cane. Treatment slightly increased % germination of healthy cane, but reduced it in the case of diseased cane.

Pathogenic potential of wilt pathogen of sugar cane and its ecological relationship with the red rot pathogen. R. P. Singh and K. Singh. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 81-Ag. 86. See this page.

Factors affecting the severity of leaf scald disease of sugar cane in different countries. C. Ricaud. *Seminar, Sugar Tech. Assoc. India*, 1975, 8 pp.—Factors affecting the severity of leaf scald are discussed, including varietal susceptibility and the proportion of susceptible varieties grown in a given area, harbouring of the disease by tolerant varieties, virulence of the pathogen, and environmental factors (particularly weather) affecting spread and host-parasite interaction.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CANE BREEDING AND VARIETIES

Current status of the variety improvement programme of the Philippines Sugar Institute. L. T. Empig. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 351-361.—An account is given of the history of cane breeding in the Philippines. The current programme is intended to replace the smut- and downy mildew-susceptible varieties Phil 56226 and Phil 58260, to provide enough good varieties that no one is grown on more than 25% of any mill district, and to establish a network of certified sett growers for immediate multiplication and distribution of high-yielding varieties. This is to be achieved through a programme of nobilization, parental clone development, and breeding of commercial hybrids, and progress in this programme is summarized.

The performance of introduced varieties at Pongola. R. S. Bond. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 1–4.—Of some 350 different varieties tested annually at the Pongola Field Station, about 30 are introduced from other cane breeding countries, the remainder being second year selections from an original 45,000 single stools. An account is given of the results of trials from 1968 to 1975, with lists of the introduced varieties tested during the period. In general, locally-bred canes have performed better than the introduced varieties in which susceptibility to leaf scald has been a drawback in several cases.

Drought coefficient of cane and sugar yields in relation to drought resistance in sugar cane hybrids. S. Singh and M. S. Reddy. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), Ag. 13–Ag. 18.—Field experiments were carried out to assess the relative drought resistance of cane varieties on the basis of drought coefficients of cane yield, sucrose % juice and c.c.s. under moisture stress and optimum soil moisture conditions. Results are tabulated for six mid- and late-maturing varieties and three early-maturing varieties and are discussed. Early-maturing varieties were better than late-maturing varieties as regards drought tolerance, while the juice sucrose content coefficient was also higher in the early-maturing varieties. Varieties which perform better under natural dry conditions also showed greater drought coefficients for cane yields, juice sucrose content and c.c.s., indicating the possibility of using the c.c.s. coefficient (the product of cane yield and juice sucrose content) as a reliable criterion for drought resistance screening.

Evaluation of agronomic characters of sugar cane varieties under Tarai conditions in Uttar Pradesh. P. P. Singh and K. Kumar. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), Ag. 19–Ag. 24.—Varietal trials conducted at Pantnagar are reported in which setts of promising varieties were collected from a number of research stations in north India and compared with Co 1148 and Co 1136, standard varieties of the region. Results are tabulated and discussed.

Technological characteristics of some important sugar cane varieties in north India. S. P. Shukla and A. P. Gupta. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), Ag. 37–Ag. 46.—The quality of eight varieties (Co 527, Co 975, Co 1007, Co 1111, Co 1148, Co 1158, CoS 510 and BO 17) was determined in terms of amino-acids and phenols, organic acids, reducing sugars and ash, and raw and clarified juice colour. The trends in the contents of the various constituents with time were also established. Results are tabulated and presented in graph form.

B 37172—a foreign variety responds well to fertilizer application. B. S. Nadagoudar, K. Kenchaiah and G. K. Lokeshwarappa. *Indian Sugar*, 1977, **27**, 75–77. Two non-flowering varieties (B 37172 and KHS 2045) and two flowering varieties (Co 62175 and Co 419) were tested for their response to fertilizer application at five levels, viz. 0, 25%, 50%, 100% and 125% of the recommended dose of 250:100:125 kg $N:P_2O_5:K_2O$ per ha. Tabulated data show that there was progressive increase in yield at each increase in fertilization rate in the case of the two non-flowering varieties, while the yields of the flowering varieties reached a maximum at 50%, then fell at 100% but increased again at 125% of the recommended dosage; the imported variety B 37172 showed greatest yield increase, viz. 93·7% at the 125% rate by comparison with no fertilization. This variety also contained more sugar than the other three, but its final sugar yield per ha was second to that of Co 62175 (a flowering variety).

Physiological approach to an ideotype of sugar cane—a case with non-arrowing canes (*Saccharum officinarum* L.). G. Hunsigi, C. Marigowda and C. Shankaraiah. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 63–Ag. 67.—The dependence of cane yield on physiological parameters has been well established. A number of field experiments were conducted with non-flowering varieties in 1969–73 to determine the relationships between certain parameters and yield. The parameters investigated were: leaf area, leaf area index, i.e. leaf area:ground area ratio, crop growth rate, relative growth rate and net assimilation rate. The observations were made during the maximum growth period of 90–140 days. Results showed that two genotypes, Co 62175 (a commercial flowering variety used as control) and B 37172, were the highest yielders, both also having the highest values of the various parameters. By contrast, H 2631 had the lowest parameter values and gave lowest yield. A regression equation is given which relates yield to stalk number, stalk length and cane weight. B 37172 is regarded as an ideal cane type.

Sugar cane varieties in eastern U.P. and their performances under various agronomic conditions. M. L. Agarwal, A. Nath, S. M. Singh and B. K. Mathur. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 13–Ag. 24.—Cane varietal trials carried out at three locations in Uttar Pradesh in 1966–72 are reported and results tabulated. Varieties suitable for spring and autumn planting and for growing under waterlogged conditions are indicated.

CANE SUGAR MANUFACTURE

An estimation of loss on account of agola (cane tops) supplied along with the cane. M. K. Sanghi, K. M. Gupta and K. P. Mittal. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 21-Ag. 24.—Of extraneous matter accompanying cane into the authors' factory, cane tops and dry leaves constituted the dominant forms, with roots and soil making up only a small percentage of delivered weight. Attempts were made to assess the factory losses resulting from the presence of cane tops, assuming 448 g per quintal of cane. From the calculations of bagasse and final molasses sugar attributed to the presence of the cane tops, a loss of Rs. 9·3 per 100 quintals of cane crushed was estimated.

A case of low speed of centrifugal machines. S. L. Kumar and -. Srinivasan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.1-E.4 (+ fig.).—Fluctuations in oil flow to a battery of semi-automatic centrifugals at the authors' factory caused reductions in speed of the machines, with a resultant drop in throughput. The fluctuations were smoothed out by recirculating some (not all, as previously) of the oil from the main feed line to the feed tank, and providing a valve to reduce or increase recirculation according to circumstances.

A simple method for determining optimum imbibition for lesser pol and moisture in bagasse. T. K. V. Rao. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.11-E.12 (+ figs.).—Last mill juice Brix and bagasse pol were determined at various maceration levels and constant crushing rate. A graph relating the two variables was then plotted, and the juice Brix found which corresponded to the minimum bagasse pol. Another graph was then plotted, of last mill juice Brix *vs.* maceration % cane, and the maceration level found at which the juice Brix corresponded to minimum bagasse pol in the first graph. The readings showed that 26·5% maceration was optimum.

A useful device for vacuum improvement in a central vacuum system. S. C. Sharma, B. C. Jain and S. N. S. Gupta. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.13-E.22 (+ figs.).—Details are given of an auxiliary condenser used to cool further the air extracted from a condenser before it is fed to a vacuum pump, the aim being to reduce the volume of air which must be extracted and hence increase vacuum. The resultant improvement was of the order of 25·4-35·5 mm at vacuum levels generally of 619-655 mm. Installation of a small condenser before the steam ejector of a vacuum pan was also found to increase efficiency, the ejector achieving 508-585 mm vacuum within 4-5 min.

Bagasse-fired lime kiln. A. C. Raha, R. B. Nigam, A. K. Agarwal and P. Sanyal. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.23-E.28 (+figs.). The possibility of using bagasse as lime kiln fuel is considered and design aspects of such a kiln examined. Calculations are made of important parameters, and it is deduced that the bagasse consumption would be about 11% of the total (assuming 20-25% on cane as bagasse) or 2·2% on cane, and its moisture content 40% to give a flue gas discharge temperature of 816°C.

Pre-drying of bagasse in a sugar factory and its impact on fuel and steam consumption. B. B. Paul. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.33-E.37.—Bagasse from a diffuser, even after passage through two dewatering mills, has a higher moisture content (e.g. 55-57%) and hence lower fuel value than bagasse from a conventional milling tandem. Use of screw presses to reduce the moisture value further involves high power consumption, while other types of presses are limited in their dewatering capacity to 45-48% bagasse moisture. Drying is more economical and practical; of two possible methods, blowing of boiler flue gas over the wet bagasse is less suitable, because of the corrosive nature and high moisture content of the gas, than treatment with dehumidified air heated by boiler flue gas. The latter process, carried out in a vertical tower, ensures efficient counter-current heat transfer; four types of air heaters are available, but the most suitable has proved to be a packed, finned tube type. Reduction of the bagasse moisture content from 50 to 35% by pre-drying would provide the same heat value from less bagasse, so permitting surplus bagasse to be used for pulp and paper production. Calculations are made for a factory of 3000 t.c.d. capacity.

Modifications made in the design of a vacuum filter and improvement achieved thereby in New Horizon Sugar Mills Private Ltd., Pondicherry, during the season 1974-75. II. L. C. Banerji. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.39-E.41.—After the reduction in filter cake pol obtained in the 1972-73 and 1973-74 seasons as a result of increasing the number of suction points[1], a further suction point was added for filtrate withdrawal, thus doubling the number of points in the original filter. As a result, the filter cake pol fell to 1·8-2·0 in contrast to 3·2 before any modifications were made.

Automatic signalling of leveller overloading in sugar factories. R. C. Sharma and R. P. Sharma. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.43-E.45 (+ figs.).—A warning system for cane leveller knives is described in which the leveller shaft drives a governor spindle through a pair of bevel gears. The governor sleeve is in contact with a lever which operates a mercury switch panel. At normal leveller speed the first of the four mercury switches operates a green light in the mill house; as soon as overloading starts and the leveller speed falls slightly, the second mercury switch operates a yellow light, an electric buzzer in the mill house and an electric bell in the cane cutter section. If the cane then clears automatically the yellow light is extinguished, but should overloading continue and the drive speed fall still further, the third switch operates a red light in addition to the yellow light and buzzer, at which point the green light operated by

[1] Banerji: *I.S.J.*, 1975, 77, 341.

the first switch goes out. Further overloading causes a bell alarm to be sounded, at which point the leveller stops if the cane carrier does not, and all the signals cease.

Increasing the capacity of a "RapiDorr" clarifier by adding one compartment. O. P. Bhargava. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.47–E.52 (+ figs.).—After a 4-compartment "RapiDorr" clarifier at the author's factory had proved inadequate to handle the juice from 1270 tonnes of cane daily (compared with 863 tonnes per day when it was first installed), an extra compartment was added. Despite lower lime and sulphur consumption for juice treatment and a higher crushing rate, in 1973–74 the extended clarifier gave 27·55% less mud by comparison with the original model in the previous season. Purity rise from mixed to clear juice was greater and syrup Brix was higher, while filter cake and final molasses losses were lower as were undetermined losses. Sugar quality also rose. (Modifications to a continuous sulphiter also contributed to the reduction in sulphur consumption in sulphitation.)

Improved drainage without cush cush fall. B. M. Tiwari. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.53–E.55.—A diagram is presented of a grooved trash plate designed by the author for use with cane rollers provided with Messchaert grooves with the aim of reducing the amount of bagacillo falling into the extracted juice. Tabulated data for 1974–75 (when the trash plate was first used) and for 1973–74 demonstrate the improved milling extraction and reduced losses.

Studies on cane juice characteristics responsible for the production of deep red coloured syrups in some sugar factories and remedial measures. N. A. Ramaiah, S. K. D. Agarwal, P. C. Johary and L. P. Tewari. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.1–M.16 (+ fig.).—At Gola and Palia sugar factories in Uttar Pradesh, melanoidins formed during clarification have led to deep red syrups and sugar of high colour. Analysis of the juices showed a phosphate level which, at 150–200 mg.litre^{-1}, was lower than the average range of values (350–550 mg.litre^{-1}) in north India. Moreover, the levels of reducing sugars, organic acids, potassium and amino-acids in the juices at Gola and Palia were excessive. Formation of normal colouring matter together with the melanoidins necessitated considerable SO_2 consumption in sulphitation. Remedial measures included adding triple superphosphate to the juice, increasing the amount of lime added to reduce the K content, and preliming to reduce the amino-acid content.

Factory trial of a newly developed continuous carbonatation process for making plantation white sugar from cane juice. S. L. Sang, C. H. Chen and J. F. Tong. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.17–M.21 (+ figs.).—See *I.S.J.*, 1976, **78**, 309.

Working difficulties of a lime kiln and their remedies. V. P. Yadav. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.23–M.25.—Problems which can arise in lime kiln operation are described and their causes and remedial measures given. Included are: discharge of unburnt lime; reduction of the cooling zone, resulting in discharge of very hot lime; over-burning of lime to form an impermeable black layer which is difficult to slake; formation of scaffolding (a fused mass which at times is so large that movement of air and lime in the kiln is prevented); and the presence of excessive quantities of carbon monoxide and oxygen and the possible presence of SO_2 and H_2S in the kiln gas.

A new process—the substitution of double sulphitation and double carbonatation-double sulphitation in the plantation white sugar industry. B. B. Paul. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.27–M.30.—The advantages and disadvantages of double sulphitation and double carbonatation-double sulphitation processes are discussed and descriptions given of the HVA-International and Tate & Lyle defeco-melt phosphatation processes for plantation white sugar manufacture, with discussion of their advantages over the conventional processes.

Studies in primary extraction. A. C. Chatterjee and S. S. Thakur. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.31–M.34.—Primary juice extraction e_1 (sugar in primary juice % sugar in cane) and factors affecting it, particularly cane fibre content, are discussed. It is shown, by means of calculated data using the Deerr formula for reduced primary extraction, that in the fibre content range of 10–16% on cane, there is almost constant change in the value of Q, the primary juice sugar content per unit sugar in mixed juice, with 1% change in the fibre content. Since $e_1 = Q.e$, where e is the total extraction of the tandem, calculation of the reduced primary extraction requires a correction of $\pm$0·026 for each unit % fibre content above or below 12·5%.

Effective utilization of continuous cooling of A, B and C massecuites in crystallizers. M. Anand, V. B. Bagal and S. K. Kulkarni. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.35–M.42 (+ figs.).—At the authors' sugar factory, *A*- and *B*-massecuites are dropped to their respective air-cooled receiving troughs and finally treated in water-cooled crystallizers. *C*-massecuite is also first cooled by air and then transferred to four water-cooled crystallizers arranged for continuous operation. Tabulated data are given showing the results obtained with all three massecuites, particularly low-grade massecuite. The advantages of continuous crystallization of *C*-massecuite are given as higher molasses exhaustion, better curing and the possibility of handling massecuites of higher Brix and crystal content than with batch crystallization.

Basic boiling house recovery with ideal clarification factor. H. T. Patel. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.43–M.46.—Various methods of calculating boiling house performance are examined. The basic boiling house recovery (BBHR) is defined as the recovery obtainable at a juice purity of 85 and a molasses purity of 28·57, assuming no other losses, and is given by $1 - k\left(\frac{m}{100 - m}\right)\left(\frac{100 - j}{j}\right)$, where k is the clarification factor (non-sugar in clarified juice per unit non-sugar in raw juice), m is final molasses gravity purity and j is raw juice gravity purity. However, use of true values of k is of disadvantage in that the effect of clarification on boiling house performance is removed, and comparison between factories is not possible. Values have been suggested by S. N. G. Rao for *k* under three different process conditions, viz. 0·70 for the double carbonatation-double sulphitation process, 0·90 for the sulphitation process, and 1·00 where defecation is used. Substituting these values in the above formula and calculating boiling house performance by the Rao formula will permit comparison between factories, irrespective of the process used and juice purity.

The performance of "Wal-Konti 8/34°" continuous machines on curing of low-grade massecuite. N. N. Joshi, G. G. Singh and P. K. Aren. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.47–M.64.—Details are given of the performances of two "Wal-Konti" centrifugals in trials carried out in 1973/74 and 1974/75, and comparison is made with results obtained with batch machines. It was found possible to reduce molasses purity by 0·5–0·8 units in the continuous machines by comparison with the batch centrifugals, provided massecuite purity was 56–58, crystal size 0·20–0·25 mm, crystal content and Brix as high as practical and reheating to saturation temperature carried out before curing. Reheating plus judicious water washing at up to 70 litres.hr^{-1} increased the capacity of the machines by varying degrees relative to that without heating and water addition. Sugar purity was about 6 units higher than from batch centrifugals.

C-massecuite boiling, conditioning and curing. I. B. L. Mittal. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.65–M.72.—Means of improving the boiling of *C*-massecuite and conditioning of molasses used as pan feed are examined against the background of techniques applied in Indian sugar factories. Aspects discussed include the purity of the graining material, graining techniques, conditioning equipment and methods, types of vacuum pan, steam pressure, vacuum fluctuations, and the apparent massecuite crystal content and its determination, as well as calculation of expected molasses purity.

Drop in purity from mixed juice to clear juice in sulphitation sugar factories. S. C. Sharma, S. S. Sharma and P. V. L. Narsimham. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.87–M.92 (+ figs.). A drop in purity from mixed to clear juice of 0·8–2·0 units was investigated and found to be partly due to tray deformations in the "RapiDorr" clarifier first installed in 1964–65. Modifications were made to the clarifier so as to reduce retention time, to permit juice withdrawal from the maximum number of peripheral points, and to release a maximum of gas in order to prevent turbulence. Operation of the modified clarifier in 1973–74 showed improvement, the average purity drop being 0·63 unit. Further investigations revealed a noticeable drop in mixed juice purity when filtrate from a rotary vacuum filter was added. Reasons for this are examined.

How to control the inventory of stores and spares in the sugar industry. R. L. Srivastava. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.37–G.41. Efficient maintenance of stocks of consumable items as well as spares in a sugar factory is discussed.

Enzymatic removal of starch from sugar house products. S. Mukherjee, S. Bose, K. C. Gupta and L. Singh. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.51–G.58.—After alpha-amylase had proved highly effective in reducing the starch content in sucrose solutions to which known amounts of starch had been added, attempts were made to prepare the enzyme from barley seeds (since the pure enzyme is considered too expensive and is usually imported into India). Details are given of the procedure used, and trials on starch removal with the enzyme obtained are reported. Tabulated data showed that maximum starch removal from a sucrose solution (10 g sucrose dissolved in 10 cm^3 water) to which 585 ppm starch had been added was 91·1%; this was obtained after 30 min at 70°C by adding 3 cm^3 of the enzyme preparation. A maximum of 44·2% reduction to 232 ppm in the starch content of raw sugar solution (10 g sugar in 10 cm^3 water) was achieved with 1 cm^3 preparation, while 77% reduction from 175 ppm starch was obtained with 3 cm^3 preparation added at the rate of 1 cm^3 per 10 g of cane juice. Results are also given for sorghum syrup treatment.

Towards a better quality of sugar—a challenge to be met. B. N. Rao and K. S. R. Rao. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.109–G.113. Means of improving the quality of sugar produced by Indian factories are examined, covering clarification, boiling, low-grade massecuite curing (for which continuous centrifugals are recommended), the use of pan stirrers, gravity feed of massecuite to centrifugals, sugar washing and drying, and use of magnetic separators.

Studies on production of bold grain and good quality white sugar in sulphitation factories. D. P. Kulkarni, A. V. Deshpande and V. A. Ketkar. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), M.1–M.12.—The practices used at Phaltan Sugar Works Ltd. in the manufacture of *B* and *C* sugars are described and details given of the special precautions taken in the boiling of bold grain, particularly as regards colour. The composition of commercial white sugar samples produced during the three seasons 1971–75 is reported and Indian standards for sugar colour are discussed. Difficulties facing sugar manufacturers in endeavouring to meet the requirements are noted.

Some observations on "difficult mud settling" in the Kolhapur Cane Sugar Works Ltd. during the season 1974-75. S. A. Savanur, S. B. Pendse, E. V. Jagtap and S. G. Zadbuke. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), M.13–M.16.—Mud settling difficulties occurred at the start of the 1974–75 crushing season; main causes were considered to be poor lime quality, lack of equipment to remove sand and soil particles adhering to the cane (so that the extraneous matter was able to accumulate in the clarifiers and increase the bacterial content), and insufficient retention of juice in the liming and sulphitation tanks. Pre-sulphitation, addition of flocculants and triple superphosphate and dilution of mixed juice to a required Brix provided only a partial solution.

Continuous pans. E. Hugot. *Seminar, Sugar Tech. Assoc. India*, 1975, 16 pp.—Descriptions are given of the Fives Cail-Babcock and Langreney continuous vacuum pans and their performances.

BEET SUGAR MANUFACTURE

Industrial tests on a DS-17 diffuser. A. K. Buryma, V. N. Borzdaya, V. G. Yarmilko, N. D. Khomenko and D. E. Nikitovich. *Sakhar. Prom.*, 1977, (10), 55-61 (*Russian*). The DS-17 is a larger form of the DS-12, both of which are made in Poland under licence from DDS. The DS-17, having a rated throughput of 4200 tonnes per day, was tested at Lokhvitsk factory in 1973/74 and 1974/75, and details of the tests are reported. The data from the latest test period (November 27th-December 5th 1974) showed a throughput of 4314 tonnes per day, a juice draft of 116·4% and sugar losses in exhausted cossettes of 0·47% on weight of beet.

Boiling point elevation of supersaturated beet sugar solutions. V. I. Tuzhilkin, E. B. Skhirtladze, M. I. Vasin and A. F. Epikhin. *Sakhar. Prom.*, 1977, (10), 61-65 (*Russian*).—Investigations were made of changes in the BPE of saturated and supersaturated sugar solutions using a specially developed and patented ebulliometer designed for studies on highly concentrated, highly foaming solutions. Graphs were drawn of BPE *vs.* supersaturation coefficient, temperature and purity; from these, a mathematical expression was derived by computer which defined BPE in terms of the three parameters. While the relationships between the three parameters and between them and BPE do not conform to a distinct pattern as their values alter, it was decided to study the effect on BPE of unit change in each parameter. The factors affecting each were investigated, and it was decided that since purity, exerting greatest influence on BPE, could not be held constant, a correction would have to be made for this in automatic control of BPE. Moreover, in view of the non-linear interrelationships between purity, temperature and supersaturation, it was considered better to express them in relative rather than absolute terms. By this means, automatic boiling control on the basis of BPE is possible.

Development and testing of a sectioned raw juice heater. Yu. S. Razladin, A. A. Ivashkevich and N. G. Solovov. *Sakhar. Prom.*, 1977, (10), 68-72 (*Russian*).—A Soviet-designed raw juice heater, comprising six vertical sections, was tested. Each section contained 33/30 mm steel tubes 5 m long, the total heating surface being 47·5 m^2. Provision was made for removal of individual tubes and complete tube bundles. The sections can be linked in parallel in a number of different ways, according to conditions in the sugar factory, and further sections added to increase the total h.s. In the layout tested, the tubes were linked alternately by top and bottom U-bends, creating a "snaked" system. Full details are given of the performance in the trials, in which a 0·1-0·2 mm layer of scale caused a drop in the heat transfer coefficient K from 3000 $W.m^{-2}.°C^{-1}$ initially to 1750-2000 $W.m^{-2}.°C^{-1}$ within 3-4 days, after which the value of K remained practically constant. The initial fall was attributed to the absence of automatic heating control. Steam blowing of the tubes for 15 min permitted the scale to be easily removed with a fast-flowing stream of juice. At a flow of 3·03-3·47 $m.sec^{-1}$, juice temperature was raised from 55-75° to 80-90°C at a heating steam temperature of 102-108°C and 0·17-0·22 MPa hydraulic resistance. The daily throughput corresponded to a beet slice of 2500-2700 $tonnes.day^{-1}$. The performance of the heater compared favourably with that of a conventional juice heater.

A new continuous Steffen process. K. W. R. Schoenrock. *J. Amer. Soc. Sugar Beet Tech.*, 1977, **19**, 192-206. The author stresses the need to minimize the quantity of non-sugars recycled to carbonatation with saccharate cake from a Steffen house; such non-sugars considerably increase juice colour and lime salts and are eliminated only to a limited degree in carbonatation. While very little is known of the true reaction which takes place in the Steffen process, there is substantial evidence of a two-stage reaction; for the first phase, any type of lime is suitable provided it is active, and no insoluble calcium oxide-saccharate complex is produced in the cold, whereas the second phase is critical for the Steffen process and requires a properly burned, finely ground lime in order to precipitate an insoluble complex in the cold. The CaO-saccharate complex has been found to carry the bound non-sugars primarily as their calcium salts. Carbonatation in the presence of saccharate cake was found to remove more non-sugars than carbonatation in a factory not using the Steffen process, provided the degree of non-sugars removal was determined by treating the cake with ammonium carbonate; if gassing with CO_2 was the method used for determination, the reverse was true. In a laboratory test, raw juice was purified under "straight house" and "Steffen house" conditions to give thin juices having the same CaO:raw juice non-sugars ratio. An aliquot from the saccharate cake sample used for carbonatation was also treated with ammonium carbonate, and the final filtrate (after steam distillation) added to straight house thin juice to represent the same available CaO:raw juice non-sugars ratio. Results indicated that there seemed to be no difference in the purities of Steffen thin juice, whether obtained by cake treatment with CO_2 in the presence of raw juice or whether by treatment with ammonium carbonate and addition of the filtrate to thin juice obtained by conventional means. However, the CO_2 treatment in the presence of raw juice did give a lower colour than the artificial Steffen thin juice, although both colour and lime salts content of normal Steffen thin juice are much higher than in normal straight house thin juice. It was assumed that the affinity between the lime salts and saccharate would lead to their surface adsorption on the CaO-saccharate complex when functioning as a substrate, with surface area the controlling factor; while surface area and, hence, surface adsorption would decrease with increasing particle size, it was assumed that reduced shear and agitation would favour the formation of larger particles, which would lead to better filtration and washing. While instantaneous intimate contact between powdered lime and diluted molasses without agitation was impossible, a suitable alternative to powdered lime was considered to be a ground lime paste in an inert liquid carrier, instantaneous in-line mixing with a static mixer then being possible. Tests indicated the suitability of isopropanol as a carrier; although this forms an azeotrope with water, Steffen lime was found to have sufficient affinity for water to break the azeotrope. A continuous saccharate process was tested on a laboratory and pilot plant scale, in which milk-of-lime was added to the molasses dilution tank at a rate of 30% CaO on sugar, the molasses being diluted to 6–20% sugar. An isopropanol-lime slurry of 0·67 ratio was injected into the molasses stream at 50% CaO on molasses sugar and passed through a Kenics static mixer at an optimum flow of about 4 litres.min^{-1}. On discharge from the mixer (in which cooling took place), the solution had a temperature of 15°C; wash water application in the subsequent filtration gave a cake purity of 92·5 at 50% water on solution or 96·6 (maybe even better) at 100% water on solution. Water-immiscible liquids such as mineral oil are released by cake treatment with thin juice or sweet water at a 1:1 ratio. The liquid carrier can be recycled to the wet lime grinding process after decantation and centrifuging of the supernatant.

Evolution in the design of beet sugar factories. Compact and expandable factories. M. Barre, H. Duret and B. Aubain. *Ind. Alim. Agric.*, 1977, **94**, 681–684 (*French*).—It is pointed out that, since the factory management has no control over quality of the beet harvest, price of the beet or price at which its sugar is sold, the only way in which it can fight the rising costs of production (particularly those of fuel and labour) is to raise processing efficiency. Given the most efficient equipment, this involves reductions in: sugar loss by shortening the routes followed by the juice and other liquids; heat and energy losses by minimizing the lengths of the steam and power feed-lines; building costs by providing the maximum number of outdoor plants compatible with operation requirements and climatic conditions; operation costs while improving working conditions through grouping of workshops around individual control rooms which are in turn linked to a central information and control room; water consumption and the quantity of effluent. To achieve these ends, the authors propose a compact factory where the main process building (in which take place the main processes from carbonatation to sugar drying) is a square, single-storey block to which are linked the boiler house and power plant surrounded by three main "satellites": (i) the washer, beet slicer and diffuser unit, (ii) plant for water separation, and for storage, conditioning and despatch of the dried products, and (iii) plant for storage, conditioning and despatch of sugar. The rest of the plant and buildings would be sited around the factory according to land form and relief and wind direction. Requirements of an efficiently operated beet yard are listed, and the advantages and disadvantages of fluming as opposed to dry reclamation of the beet from the storage piles are examined. The beet washer is considered one of the most difficult pieces of equipment to design and operate, since the beet must be handled in the minimum of time and with the minimum damage, despite the heterogeneity of the material passing through (beet, soil, stones, weeds and rootlets); since it is relatively independent of the rest of the factory, it can be placed out of doors and thus reduce investment costs as well as the complexity of control, involving use of closed-circuit television. The beet screens and slicers can be housed in an umbrella-type building, i.e. without walls but protected by a roof, while both diffuser and pulp press and dryer can be sited in the open. Advice is given on plant arrangement in the main process building, on sugar and pulp silo proximity to dryers, and on the various outbuildings.

A new beet reclaimer in a dry sugar factory beet yard. L. Vassal. *Ind. Alim. Agric.*, 1977, **94**, 687–689 (*French*).—At Abbeville sugar factory, beets unloaded from road trucks but not immediately required for processing are stored in a polar silo 100 m in diameter, around which are six chutes, three leading directly to the factory and three leading to the beet pile. The beets are reclaimed by means of a radial beam, extending from the centre of the pile to the perimeter, at the end of which is a trolley; as the beam travels around the pile, an inclined disc component transfers the beets to a belt conveyor, while two other lateral discs facilitate reclamation and penetration into the pile. The unit is completely automatic and stops only when a level probe in the central chute is reached, after which it resumes operations when the beet level has fallen sufficiently. The system, manufactured by F. Moret, operated satisfactorily (despite some teething troubles) in 1976–77, delivering 4500 tonnes of beet daily at a tare in the range 25–45%. Variations of the arrangement are envisaged, viz. for a rectangular beet yard and support of the radial beam on a cushion of air.

Determination of sugar losses in beet yards and beet washers. R. Chablay, J. Y. Guyot, G. Mesnard and M. Ribeille. *Ind. Alim. Agric.*, 1977, **94**, 691, 693–694 (*French*).—A method for determining losses in fluming and washing is described. Using a large-pan sampler, 10–12 samples of beet, making a total of 500 kg, are taken from the load dropped from a road truck onto a concrete area. More samples, again totalling 500 kg, are collected from the beets between the washer and slicer, while samples of extraneous matter are taken at all points where separation takes place, e.g. stone collector, trash remover and water separator, and the amount of beet "flesh" in these determined. The beet samples taken in the yard and after the washer are divided into eight categories, three of scalped whole beets weighing 0–299, 300–599 and 600 g or more, and five of beet pieces (small ones without crowns, large ones without crowns and those with crowns which are sub-divided into the weight categories as for whole beets mentioned above). In each category, the average weight and sugar content are determined; for the whole beets and pieces with crowns, the individual weighments are also noted. The extraneous matter samples are sorted for extraction of beet "flesh" which is weighed and the sugar content determined; if the samples are of too great a volume, representative sub-sampling is used. From the analyses, the loss of sugar by lixiviation as a percentage of that entering the yard is calculated as $\frac{R_{EC} - R_{SC}}{R_{EC}} \times 100$, where R_{EC} is the average sugar content of the composite sample taken in the yard and R_{SC} is the average sugar content of the composite sample taken after the washer plus that of the beet pieces in the extraneous matter. The method permits approximation to within ±0·1% of the true losses with a probability of 95%, using about 50 samples in the yard and after the washer and about 20 samples of extraneous matter. Each test takes about 15 days. (Another method must be used to establish storage losses.) Results from three campaigns show that in two conventional factories, where the beets are reclaimed by water jet and flumed and paddle-type washers are used, average losses were 3·15%; by contrast, they averaged 1·21% in three modern factories where dry reclamation is used and washing takes place in a drum or under pressure.

Development of a single-line juice purification station capable of handling (juice from) 12,000 tonnes of beet a day. J. Genotelle, R. Michel, J. Bourdin and A. Molé. *Ind. Alim. Agric.*, 1977, **94**, 697-699, 692 (*French*).—When the factory at Roye doubled its daily slicing capacity from 6000 to 12,000 tonnes of beet, it was decided to design a single-line juice purification station capable of handling all the juice rather than install a second station operating in parallel with the original one and handling only half of the total juice. Details are given of the new station, which includes 15 minutes' preliming in a Naveau vertical tank at 72-74°C (instead of 30 min at 30°C previously), two-stage liming (addition of lime followed by heating to 85-87°C and 12 min retention in a contact vessel in contrast to the previous 45 min at 30°C), 1st carbonatation in a SERG recirculation vessel, clarification in a Dorr 4-tray clarifier (preferred to a rapid clarifier but still designed for a relatively short retention period of 30 min to permit a reduction in the construction costs and able to handle juice from 15,000 tonnes of beet daily in the event of further expansion). Flocculant is added to the 1st carbonatation juice before the clarifier, from which some mud is recycled to preliming; the remainder of the mud is treated by three Gaudfrin rotary filters. Only one 2nd carbonatation vessel is used, and the juice treated by Grand Pont filters; the clear juice is delimed in a 3-unit battery and sulphitated before evaporation. Intermediate tanks in the station have been kept to a minimum capacity, except the 2nd carbonatation muddy juice and the pre-evaporation buffer tank (for 12 and 25 minutes' retention, respectively). Operation and automatic control of the line are as easy as for a factory of 3000 tonnes/day beet slice, and losses in mud have averaged 0·03% on beet at a lime consumption equivalent to 0·8 parts CaO to 1 part non-sugars in raw juice and a total dilution less than 2% between diffusion and evaporation. Thin juice quality is satisfactory and the colour very low.

Development of an evaporation station in a factory slicing 12,000 tonnes of beet a day and storing 60% of the thick juice produced in a campaign. R. Michel, P. Ternynck and P. Bonnenfant. *Ind. Alim. Agric.*, 1977, **94**, 701-705 (*French*).—Details are given of the quintuple-effect evaporator installed at Roye where thick juice from 7000 tonnes of beet a day is stored for post-campaign processing. Vapour is bled from the 4th and 5th effects to diffusion and juice purification, and from the 1st, 2nd and 3rd effects to the pan station (where a 2-strike system is used) and juice reheating before evaporation. The 1st effect comprises two vessels in series, each of 4000 m^2 heating surface; the 2nd effect is a single 4000-m^2 vessel; the 3rd effect is a 3600-m^2 vessel; the 4th effect is of 3300 m^2 h.s. and includes three vessels, and the 5th effect is of 2500 m^2 h.s. and consists of two vessels. A number of features specially incorporated in the otherwise conventional evaporator are described, and information is given on its control and operation. At a Brix increase from 14·1° to 73°, fuel consumption during two campaigns was 19-20 kg per tonne of beet; this low level of consumption is attributed not only to thick juice storage and low vapour requirements for pan boiling, but also to the small amount of vapour passing to the condenser as a result of considerable recompression, while total factory power consumption has also been low and generator efficiency high.

Volatile alkalinity in the sugar factory. P. Devillers, R. Detavernier, R. Gontier and M. Groult. *Ind. Alim. Agric.*, 1977, **94**, 707-714 (*French*).—Volatile alkalinity is the combination of light amines and ammonia formed by alkaline hydrolysis of amides in beet (the ammonia in water recycled to diffusion not passing into the juice). The two methods described earlier[1] were used to determine volatile alkalinity in diffusion juice, cossettes, pulp and diffusion water, and in juice at various stages in purification and during deliming as well as before and after evaporation. The values, given in tabular form (in the case of deliming, in the form of a time plot), are discussed. Failure to control volatile alkalinity leads to a sharp fall in pH and possible evaporator corrosion. On the other hand, there is need to avoid excessive soda addition to compensate for the pH drop, since this will cause increased molasses sugar. Possible means of overcoming the problems posed by volatile alkalinity are briefly examined for diffusion, liming, carbonatation and deliming. In the case of evaporation, two methods of thick juice pH control based on soda addition are described: (1) very rapid concentration of a pre-evaporation juice sample in a mini-evaporator to cause a drop in alkalinity which is sensed by a pH meter (a closed-loop regulation system linked to the pH meter controls the soda addition until the desired pH is reached), and (2) use of a specific electrode which is linked to a regulation system. Both methods have shown promise, with adequate maintenance of constant pH and alkalinity values.

Application of continuous boiling to different strikes in a beet sugar factory. P. Pithois and P. Benoit. *Ind. Alim. Agric.*, 1977, **94**, 717-722 (*French*).—The history of the development of the Fives-Cail Babcock continuous vacuum pan is described and the advantages of continuous boiling briefly discussed. Application of the system to 3-massecuite boiling, with and without remelting of *B*-sugar, is explained, and the economics of continuous and batch boiling compared.

New deliming process for sugar juices without chemical regenerant or effluent. Y. le Henaff and D. Hervé. *Ind. Alim. Agric.*, 1977, **94**, 725-729 (*French*). Details are given of laboratory and industrial tests on the beet juice deliming process, developed by Gryllus[1], which involves treatment with an ion exchange resin in Na^+ form and regeneration with 60° Bx molasses (in preference to thick juice as in the original process). The diluted molasses has a high content of alkaline ions which replace the Ca^{++} ions in the resin after juice treatment, thus adequately replacing NaCl as a regenerant and avoiding increased molasses yield as well as column effluent. Average results of factory tests with Applexion XA 300 macroreticular resin having high resistance to osmotic shocks showed an 84·3% reduction in lime content (from 136·5 to 21·5 mg CaO/100 Bx). Quantities involved in the process are tabulated to show the benefit that a factory slicing 6000 tonnes of beet daily would derive by using the process.

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[1] Devillers *et al.*: *I.S.J.*, 1977, **79**, 263.
[1] *ibid.*, 1976, **78**, 185, 187; 1978, **80**, 84.

SUGAR REFINING

Experiment on the use of AG-3 carbon at Odessa sugar refinery. Ya. O. Kravets, M. V. Dvornichenko, G. P. Pustokhod, M. L. Ryushenkova, L. G. Kuts, S. A. Gurova, V. D. Petrunyak and B. T. Tverezovskii. *Sakhar. Prom.*, 1977, (8), 31–34 (*Russian*).—AGS-4 is a granular active carbon, with magnesite powder added to stabilize the pH of solutions undergoing treatment, which was specially produced for use in sugar refining. Another carbon, AG-3, was found, in tests conducted some years ago, to be unsuitable in refining because of high liquor concentrations (up to 70% dry solids) and its lack of pH stabilizer, so that the pH fell and sucrose inversion took place. Odessa refinery now handles cane raw sugar, however, so that the liquors are of lower concentration, and the purification scheme used allows pH to be regulated. Tests were therefore carried out to see if AG-3 could be used instead of AGS-4 carbon. Results indicated that the degree of decolorization was in fact generally greater when AG-3 carbon was used, and that its adsorptive properties were much greater after regeneration than were those of AGS-4 carbon. On the other hand, the decolorizing efficiency of a 1:1 mixture of the two carbons was greater than of AG-3 alone. On the basis of the findings, AG-3 is recommended where cane raw sugar is being processed; where beet sugar is being refined, a 1:4 or 1:5 mixture of AG-3: AGS-4 carbon is recommended.

Purification of low-grade yellow sugar in a centrifugal force field. A. P. Kozyavkin, N. I. Odorod'ko and L. S. Taranenko. *Sakhar. Prom.*, 1977, (9), 17–20 (*Russian*). Affination of low-grade sugar with *A*-molasses in mixers yields a high-purity affined sugar (96–97) which, however, still carries a film of molasses non-sugars on the crystals. Tests on affination in centrifugals are described, in which a final sugar purity of 98–99 was obtained by washing the low-grade crystals for 6–8 min with *A*-molasses of 80 purity at 50°C. The resultant sugar contained less colour, lime salts, ash and reducing matter than did sugar obtained by the earlier affination method. The fall in the various impurities contents was linear up to 99 sugar purity with molasses usage in the range 0·5–0·9% on weight of beet, and better results were obtained with molasses of 65% concentration than 67·5% or 72·3%. The amount of saturated molasses solution used was considerably less than with the conventional means. The purification efficiency rose with crystal size up to 0·30 mm, after which it was constant. Molasses purity increased only very slightly as a result of the affination. The affination time could be reduced when molasses viscosity was lower.

Prolonged storage of liquid sugar intended for industrial processing at sugar refineries. S. A. Brenman, N. S. Ivolga, V. Z. Nakhodkina, A. U. Dmitrenko and A. G. Antonenko. *Sakhar. Prom.*, 1977, (9), 20–24 (*Russian*).—A number of Ukrainian sugar factories produce what is termed "2nd class liquid sugar" for further processing at refineries. At some of these factories all the sugar is in liquid form. The system is more economical than with production of crystal sugar, particularly since bagging is eliminated. However, prolonged storage may cause deterioration in the liquid sugar quality. The measures adopted in various countries and the microbiological standards set are briefly reported. Laboratory tests were conducted under conditions approximating to normal industrial conditions, in which liquid sugar prepared from bulk stored white sugar was poured into sterilized glass jars and stored at various temperatures, while some samples were stored in metal containers in the open, with only a large roof over them to keep out the rain. The physico-chemical properties and bacterial populations of the samples were determined at monthly intervals. Samples were also prepared from sugar of varying colour content and then stored. The results, which are tabulated, showed that the initial quality of the sugar used for preparation of the samples had no effect on storage properties provided it conformed to standards laid down for refining. The properties of the liquid sugar samples were virtually unchanged after a period of up to 4 months at temperatures in the range between —20° and +10°C; during the same period, there was a marked fall in the number of particular types of micro-organisms. Even a slight increase in the numbers of certain bacterial species when sugar was stored for up to 6 months at low temperatures did not affect quality. Liquid sugar prepared from bagged sugar was, however, unsuitable for prolonged storage because of considerable initial bacterial infection.

An advance in sugar production. A. Woollen. *La Ind. Azuc.*, 1977, **84**, 225–226 (*Spanish*).—A brief description is given of the "Talofloc" process for refinery liquor clarification and colour removal.

Adaptation of the phosflotation process in the Indian sugar industry—a suggestion. A. C. Chatterjee. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.67–M.70A.—Advantages of the defeco-melt phosflotation process over sulphitation are discussed and details given of the process stages, additional equipment required and problems which could arise were the system to be adopted by an Indian sugar factory. The economics are briefly calculated.

An outline scheme for sugar refinery water supply. F. A. Demchinskii. *Sakhar. Prom.*, 1977, (10), 65–67 (*Russian*).—The outline water scheme for a refinery described earlier[1] is criticized and advice given on suitable modifications, particularly as regards the use of condensate and necessary safeguards.

Crushing of crystal sugar with a two-roller mill. R. Tschiersch. *Die Lebensmittelind.*, 1977, **24**, 401–402 (*German*).—Tests on crystal sugar crushing with a mill having two fluted rollers each of 315 mm diameter are reported. It was found that performance was governed by roller diameter, forward slip, throughput and the angle, number, depth and arrangement of the flutes. Some test results are tabulated.

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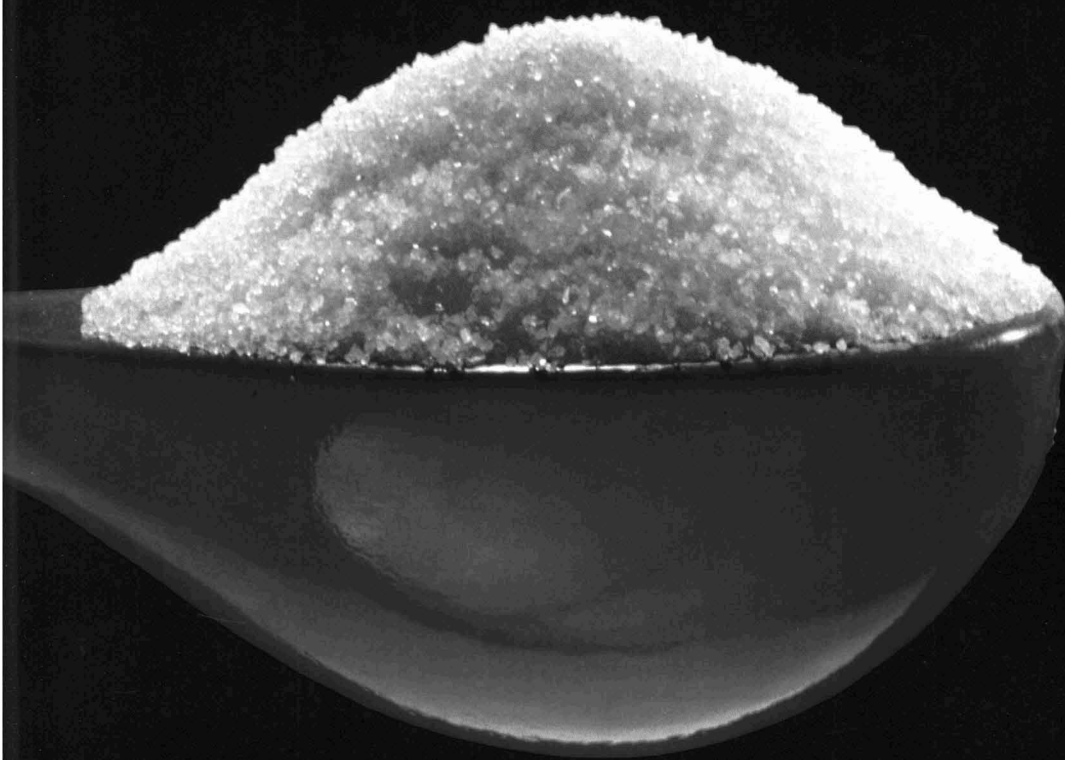
[1] Parkhomets *et al.*: *I.S.J.*, 1977, **79**, 294.



NEW BOOKS

Sugar and all that . . . A history of Tate & Lyle. J. A. C. Hugill. 320 pp; 17·0×24·5 cm. (Gentry Books Ltd., London; Tate & Lyle Promotions Ltd., P.O. Box 10, Oxted, Surrey.) 1978. Price: £9.50.

Tate & Lyle are a very large group, with roots stretching back to the mid-19th Century. The number of persons and events in its history is huge and an official history could have been a turgid and indigestible collection of facts and figures which would have bored the reader to death before he was a third of the way through. John Lyle, currently President of Tate & Lyle, persuaded Antony Hugill to write it, however, and the author's characteristically light touch has enlivened the record to give a book which may be read with pleasure from beginning to end. He has, of course, had the benefit of many company and personal records but the bibliographical list and details presented show that Mr. Hugill has worked extremely hard in his researches into the origins, activities and personalia of the constituent firms while he has also been aided by irreverent poems, etc. from the pen of F. H. (Tony) Tate.

He joined the company in 1946 and was in succession Trainee, Shift Manager, Personnel, Process and Packing Manager. He was involved in the anti-nationalization campaign of 1949/50 and became a Director in 1951. He was Managing Director of the West Indies companies from 1956 to 1965 and was later responsible for Research and Development, and for contacts in Europe and with F.A.O. He thus has a wide knowledge of people and events over the past 30 years with which about half of the book is concerned, a period of remarkable change from a UK-based refiner to an international group operating in several overseas locations and in a wide range of activities.

But the early days of the constituent companies, and their development, absorption and amalgamation are faithfully recorded, and an interesting account given of the venture into beet sugar production at Bury St. Edmunds, Selby, Peterborough and Allscott from 1925 until the British Sugar Corporation was formed in 1936. Later Tate & Lyle were to be involved with beet sugar on their participation in the consortium which acquired the Say company, now Beghin-Say, in France.

There are 37 pages of illustrations, and what strikes the reviewer as a remarkable omission is that of Sir Oliver Lyle (although there is space on one page of portraits), who is one of the larger-than-life characters who played such a large part in the company's development. It is a little sad to be often reminded of friends who played their part in this history but who are no longer alive, but others remain who will no doubt continue Tate & Lyle's progress; a short survey of future prospects is included.

On the cover of this enjoyable book, the author's chief claim to fame is as the father-in-law of the composer of the music for "Jesus Christ Superstar" and "Evita"; on the contrary, millions will have read and many recall his name in Ian Fleming's *Doctor No,* where he is recommended to James Bond (007) by another Secret Service man as having been "one of us".

The new International Sugar Agreement. 28+37 pp; 21·0×29·7 cm (F. O. Licht, P.O. Box 1220, D-2418 Ratzeburg, Germany.) 1978.

This work is in three parts, the first, by Dr. Helmu Ahlfeld, being a survey of problems in regulating the free world market in sugar, the second a discussion by Dr. P. Baron of the 1977 International Sugar Agreement ni the absence of membership by the EEC, and the third the text of the Agreement itself.

Dr. Ahlfeld's paper describes the problem of instability in the market, its causes and socio-economic consequences and past efforts—producer cartels and international agreements—to reduce the instability. He sets out the objectives and mode of operation of the 1977 Agreement and then assesses the manner in which it can affect the market and inherent limiting factors. It is concluded that the Agreement mechanism will not cure extreme price movements but will damp more modest movements and, while it will not solve long-term problems, will help—if constantly adjusted—until individual countries' sugar policies are coordinated internationally.

The paper by Dr. Baron regrets that the proposals by the EEC for market regulation purely by internationally coordinated stock holding and movement was not presented to the Conference early enough or in sufficiently persuasive form. The Agreement reached is such that the EEC, with an estimated export availability of more than 3,000,000 tonnes, white value, is not a member, although the intention to contribute to the effectiveness of the ISA has been demonstrated by the Commission's price and quota proposals, now largely adopted[1]. Nevertheless, the Agreement is considered to be hampered by an unrealistic minimum price such as would encourage HFCS production if attained in the sugar market, so that it is being severely tested from the beginning.

A history of the United Molasses Company. W. A. Meneight. 212 pp; 15×22 cm. (United Molasses Co. Ltd., Sugar Quay, Lower Thames St., London, England EC3R 6DQ.) 1977.

In 1976 the United Molasses Co. Ltd. celebrated the fiftieth anniversary of its existence as a limited liability company, and the occasion was seen as a suitable opportunity to record the development of the company from its beginnings in Liverpool in 1907. The author has been associated with UM and particularly its shipping offshoot, Athel Line Ltd., for 50 years; he writes in a forthright manner about a company for which he obviously has great affection, and the result is a very interesting and easily readable book.

The reader is quickly carried through the early stages, from the arrival in Liverpool of Mr. (later to be Sir Michael) Kroyer-Kielberg from Denmark, his subsequent participation in the importing firm of Marquis Clayton, with particular responsibility for molasses (brought into the country for use in alcohol production and in animal feedstuffs), and the creation of The British Molasses Co. Ltd. which was later to become the shipping side of the

[1] *I.S.J.*, 1978, **80**, 193.

Pure Cane Molasses Co. Ltd. The business moved to London in 1925, and the United Molasses Co. Ltd. was created as holding company the following year. During the ensuing years the demand for molasses increased, especially with such customers as the Distillers Co. Ltd. taking regular deliveries from UM. The Pacific Molasses Co. was created in 1929 to take over the California & Hawaiian molasses distribution activities and facilities on the US West Coast, UM having agreed in the previous year to take all of the exportable molasses from Hawaii for a term of years.

The account of Athel Line activities in World War II makes a very harrowing story—of the fleet of 22 ships, 17 were sunk and 137 men killed; in addition, one ship sank as a result of an accident while sailing in a convoy. Of the remainder, one was torpedoed but survived. Of seven ships of Tankers Ltd., the shares of which were acquired by UM in 1941, only three survived. In 1951, after new ships had been built, the Athel Line Ltd. comprised 15 tankers (two more were under construction), Tankers Ltd. consisted of 6 tankers, while another acquisition, Anchor Line Ltd., included four passenger liners and five cargo liners. In 1965, UM itself was taken over by Tate & Lyle Ltd., and Athel Line merged with Sugar Line to become Tate & Lyle Shipping Ltd. in 1973.

In the meantime, UM had continued to expand, and by 1975 had agencies and/or subsidiary companies in 33 countries. Not only is the company responsible for transporting of molasses from overseas to terminals they own at various ports (a terminal is also under construction in Quebec, Canada), but it operates a fleet of road tankers in the UK for carrying not only cane molasses but also beet sugar factory and refinery molasses.

Laboratory manual for South African sugar factories. 352 pp; 17·0×24·8 cm. (South African Sugar Technologists Association, Mount Edgecombe 4300, South Africa.) 1977. Price: R30.00.

The first edition of this manual was published in 1962 although four previous compilations had been made previously, the first in 1927, and published in S.A.S.T.A. Conference *Proceedings* or as a booklet. After 15 years of advancing techniques and standards, the new edition has been produced by the Factory Control Advisory Committee under the Chairmanship of John B. Alexander, with considerable endeavours by a sub-committee comprising Dr. J. Bruijn, Dr. W. S. Graham, M. A. Brokensha and P. Mellet. The South African industry clearly owes the Committee a considerable debt of gratitude as will, no doubt, other sugar industries which adopt the methods described.

The new manual covers a wide range of subjects more comprehensively than the first, bringing up to date all aspects of chemical control and including a chapter on first aid. The cover is detachable, with loose leaves to permit replacement of sections by revised sheets in the future. Chapters cover the mass determination of factory materials, calculations, sampling equipment, analytical equipment, reagents and standard curves, sampling, analysis of factory products (prepared cane and bagasse, bagacillo, filter cake, mud and filtrate, syrup, remelt, massecuites and molasses, and sugars) and miscellaneous analyses (drinking water, boiler water analysis and boiler feed water treatment, flue gas analysis, lime analysis, α-amylase activity, individual, mill performance, analysis of sugar traces in water, chemical oxygen demand in effluent, and whole-stick cane).

The Australian Sugar Year Book 1978. 408 pp; 18·5 × 24·3 cm. (Strand Publishing Pty. Ltd., G.P.O. Box 1185, 432 Queen Street, Brisbane, Queensland, Australia.) 1978. $13.50.

The latest edition—No. 37—of this annual publication is a mine of information on the Australian sugar industry and its developments during 1977. In addition to an overview presented in the form of "20 Facts about the Australian Sugar Industry", and a map showing the location of the sugar mills and refineries, bulk terminals and cane areas, it provides a Directory which includes names, addresses, officers and histories of a wide range of organizations serving or comprising part of the industry, from the Agricultural Bank to Voluntary Cane Pest Boards, with large sections on the A.S.P.A., Bureau of Sugar Experiment Stations, Cane Pest and Cane Prices Boards, C.S.R. Ltd., Q.C.G.C., Sugar Research Ltd., etc.

A wealth of statistics is tabulated, covering prices and production, mill peaks, areas, yields, time analysis, plant cane, ratoons and standover cane crushed in the various districts, mill data and varietal composition in the harvest, etc. Highlights of the 1977 annual review of the Sugar Research Institute are reprinted as they are from the Bureau of Sugar Experiment Stations Annual Report for 1977. A series of shorter articles are concerned with irrigation in Queensland, the new International Sugar Agreement, and the renegotiated sales contract with Japan, negotiations with China, the Australian Sugar Museum, use of aqueous ammonia, the proposed sugar terminal expansion at Lucinda, Bureau field days, the progress of green cane harvesting, etc.

Just under half of the book is devoted to district reports which provide general information on the various cane-growing areas, their history and the mills with details of their operation, equipment and personnel. The text is interspersed with advertisements but also some fine colour photographs of various aspects of sugar in Australia.

Instituto do Açúcar e do Alcool Relatório 76. 32 pp; 27·9×21·0 cm. (Instituto do Açúcar e do Alcool, Praça 15 de Novembro 42, Rio de Janeiro, Brazil 20.000.) 1977.

This booklet provides a great amount of information on the Brazilian sugar industry, with details of membership of the Governing Council of the Institute, personnel in charge of the various departments, sugar production per month in 1976, annual production by regions, and totals produced in the seasons 1970/71 to 1976/77, the last a record at 117,900,000 bags of 60 kg. Corresponding data on alcohol production by month and by region are tabulated, with figures for the past five seasons on production, use and exports of alcohol, with separate figures on the amounts used in motor fuel. Per caput consumption figures are illustrated and sugar exports by month, by state and by destination are tabulated, with block diagrams and graphs. Construction of the bulk sugar terminal at Santos is illustrated and an account given of the use of the special exportation fund. Development of the Planalsucar cane improvement programme is described, as is the National Alcohol Programme.

LABORATORY STUDIES

Interactions between reducing sugars and amino-acids. J. A. Weber. *Brasil Açuc.*, 1977, **90**, 397-412 (*Portuguese*).—A survey is presented of the various reactions which take place between reducing sugars and amino-acids and which give rise to browning of the solutions: formation of aldosylamines, Amadori rearrangement, dehydration, etc. A number of references are made to work reported in this field (without details of the source), although a bibliography of six references is provided.

Residual juice purity determination by using a "Rapi Pol" extractor. P. F. Jain and B. D. Sidnale. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), M.81-M.85 (+ figs.).—Tests are reported on the determination of the purity of residual juice in bagasse using the "Rapi Rol" extractor[1]. From the results and values of last mill juice purity, the fibre % bagasse was calculated (given the bagasse Brix and moisture content). The bagasse fibre content was, in all cases, lower when the residual juice purity was used rather than last mill juice purity, and the "Rapi Pol" method is therefore preferred. Acceleration of the process is made possible by use of a laboratory bagasse dryer.

Sodium hydrosulphite and sulphur dioxide as reducing and bleaching agents for colouring matter present in sugars. S. K. D. Agarwal, L. P. Tewari, P. C. Johary and S. K. Gupta. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.101-G.108 (+ figs.). Caramel, melanoidin and molasses solutions were treated with sodium hydrosulphite ("Blankit") and SO_2 individually, and the degree of decolorization noted. Spectrophotometric studies showed that sodium hydrosulphite was more effective than SO_2 in both degree and rate of decolorization; paper chromatography showed that the hydrosulphite altered the nature of caramel and melanoidin constituents by decomposing the high molecular weight compounds.

Inside and outside a sugar crystal. F. H. C. Kelly. *Seminar, Sugar Tech. Assoc. India*, 1975, 18 pp.—See *I.S.J.*, 1974, **76**, 201-204, 361-363; 1975, **77**, 195-197; 1977, **79**, 147, 264.

The behaviour of extracted nitrogenous sugar beet components during juice purification. H. Andres, A. Messler and V. Prey. *Zeitsch. Zuckerind.*, 1977, **102**, 646-649 (*German*).—Factory raw juice and laboratory prelimed and main limed juice samples were centrifuged and then fractionated by gel chromatography. The U.V. spectra were recorded, the extinctions measured at 420 nm and solids and total N distribution determined. Thin-layer chromatography was used, in conjunction with Kjeldahl N determination, to establish N distribution as peptides or free amino-acids. Results showed that the major high-molecular compounds extracted from raw juice were proteins or peptides, including browning products of enzymatic origin. Most of the nitrogen was in the form of low-molecular compounds such as amino-acids, amides and betaine. Pre-carbonatation was found to cause flocculation of albumins and proteins on the one hand, and on the other extensive (probably adsorptive) removal of high- and low-molecular browning products. Some of the high-molecular nitrogenous matter is already degraded and is found among the peptides and amino-acids. Liming causes the greatest amount of change in the nitrogen balance of juices. The nitrogen content of the high-molecular fractions rises, the albumins and proteins which have been flocculated in preliming undergoing hydrolytic cleavage to form soluble amino compounds which, however, are still of relatively high molecular weight. Loss of nitrogen in the low-molecular substances is a result of amide saponification.

Special filter fluorometer for routine determination of amino-acids in sugar beet and sugar factory products. B. Georgi and M. Burba. *Zeitsch. Zuckerind.*, 1977, **102**, 650-654 (*German*).—Details are given of the FFA II filter fluorometer for determination of amino-acids on the basis of the method previously described[2]. Light from a mercury vapour source is reflected from a concave mirror to a short-focus condenser system. The intermediate image of the stabilized light beam is reduced by an aspherical condenser lens and provides uniform illumination of a flow-through cell. An excitation filter permits passage at adequate intensity of both the 366 nm mercury line in *o*-phthalaldehyde and the 405/408 nm mercury line in fluorescamine. The fluorescence in the flow-through cell is transmitted to a measuring diode, while a glass plate reflects about 10% of the excitation light (depending on the angle of adjustment) onto a reference diode, the signal from which compensates for light intensity fluctuations from the lamp. A built-in digital voltmeter indicates the differences between the amplified measuring and reference signals. The properties of the diodes are such that, during measurement, current of some nA is generated; since such a small signal is easily affected by outside radiation, voltage conversion and pre-amplification are carried out immediately after the diodes. Means are also provided for prevention of random excitation and the effect of excitation on the measurements. Differences in sensitivity due to heat are avoided by providing the diodes with a common aluminium holder, so that they are thermally balanced. Measurements of reproducibility and stability using quinine sulphate gave good results. Comparison between a spectrophotometer with fluorescence means and the new instrument showed that the former had twice the sensitivity of the latter but gave much greater scatter between individual measurements. Correlation between white sugar measurements was highly significant, while the range of values was the same for both instruments. Since the new instrument is of simpler design, it is considered suitable for use in the sugar factory. The hitherto most sensitive method for amino-acids determination, using ninhydrin, was unsuitable for amino-N determination in white sugar because of the smallness of the content; on the other hand, the new method permitted extremely low contents to be found (in some cases, <20 µg per 100 g sugar). A linear relationship was established

[1] Bhalerao *et al.*: *I.S.J.*, 1971, **73**, 249.
[2] Burba & Georgi: *ibid.*, 1976, **78**, 348.

between amino-N and conductimetric ash in a large number of samples.

Rapid analysis of carbohydrates by high-pressure liquid chromatography. E. C. Conrad and J. K. Palmer. *Food Technol.*, 1976, **30**, (10), 84, 86, 88-92; through *Anal. Abs.*, 1977, **33**, Abs. 4F10.—The results of a study of the separation of carbohydrates in various food products by high-pressure liquid chromatography on, e.g., microparticulate silica column packings, are presented.

The effect of certain parameters on the rheological properties of molasses. W. Nowicki, P. Kolodziejczyk, P. Banasik, A. Malaszewski and M. Rygiel-Sawa. *Gaz. Cukr.*, 1977, **85**, 221-225 (*Polish*).—Investigations at temperatures in the range between —10° and +50°C of the viscosity of five molasses samples of 72·8–88·4% dry solids and 44·6–55·9% sugar content are reported. The results showed that molasses is a non-Newtonian, rheostable liquid having a viscosity which is independent of the time it is subjected to shearing force. Viscosity rises with fall in temperature (the effect of temperature being greater with higher viscosity) and falls as a function of temperature with increase in the slope of shearing rate, tending asymptotically to a constant value, from which it is assumed that at higher shear rates molasses acts as a Newtonian liquid. The relative increase in viscosity at low shear rates was found to be greater for molasses of lower sugar content. Where molasses has to be pumped, resistance can be reduced by transferring at a velocity which is greater than that at which the molasses has a constant viscosity. Viscosity can be reduced by heating or by diluting with $\not>$10% water.

Estimation of pressed pulp yield. J. Bureš. *Listy Cukr.*, 1977, **93**, 226–228 (*Czech*).—The table drawn up by Dörfeldt[1] for establishing the pressed pulp yield % beet and diffusion sugar losses when all the press water is recycled to diffusion applies where pulp pol is in the range 0·3–1·5 and its dry solids content 14–22%, with a beet marc content of 4·0–5·5%. However, in most Czechoslovakian sugar factories, pulp dry solids are below 14% and beet marc sometimes less than 4%. The table has therefore been extended, using the same method as Dörfeldt, to cover a beet marc range of 3·5–5·5% and a pulp dry solids range of 8–22%, while the pulp pol range is the same as before. The table is reproduced and a sample calculation given. Another table also gives sugar losses and pulp yield for pulp solids of 8–22% at 2-unit intervals and 0·4, 0·8 and 1·2 pol for each solids content.

Electrochemical determination of invertose and its behaviour in the sugar recovery process. E. Krause, F. Tödt and W. Mauch. *Forschungsbericht Inst. Zuckerind.*, 1977, (7), 336 pp. (*German*).—The theory and practical application of the method for invert sugar and dextrose determination based on oxidation by periodate are explained. While use of a galvanic cell to measure periodate consumption has a number of disadvantages, use of a special electronic polarograph incorporating a potentiostat, which maintains the measuring electrode potential constant at a required level so as to prevent current generation by oxygen dissolved in the electrolyte and eliminate from the measurements the iodate formed by reduction, has permitted periodate consumption to be measured to within ±1·5% in a reaction time of 1-5 minutes. The method makes use of the difference in oxidation rates between mono- and disaccharides in a buffered periodate solution. The aim is not to obtain complete oxidation cleavage of all reactive groups but to effect gradual, stepwise oxidation. The mercury film measuring electrode in the original instrument was replaced with a tungsten electrode which was used in conjunction with an alloy steel anode and a "Thalamide" electrode of high electrochemical stability in the temperature range 0–70°C. Tests were conducted to establish optimum reaction conditions in the presence of sucrose, and invert sugar was determined in beet and cane sugar factory products. Variation in the dextrose: levulose ratio in beet sugar factory products was revealed, ranging from 2·7 in beet to 0·4 in molasses, while it was 1·0 in thin and thick juice; on the other hand, during cane sugar manufacture there was little change in the ratio, which ranged between 1·5 in cane and 1·0 in molasses. The differences are attributed to the differential behaviour of the two monosaccharides as a result of rearrangement, cleavage and condensation reactions. Storage of cane and beet molasses as well as model solutions for 1–4 days at 80°C revealed hexose destruction in the beet molasses mainly as a result of the Maillard reaction in the presence of amino-N excess relative to invert sugar, leading to a fall in the dextrose:levulose ratio. In cane molasses there is an excess of carbonyl components relative to amino-N, so that the Maillard reaction is negligible. Comparison was made between the new method of determination and nine well-known copper reducing methods, all of which showed superiority in sucrose:invert sugar oxidation ratio as well as levulose:dextrose ratio. On the other hand, the new method is easy to carry out, costs little as regards chemicals, and takes only a very short time. Further comparisons were made between the new method, copper reducing methods, the potassium permanganate method and enzymatic determination of invert sugar in beet and cane products. Correlation coefficients were established for the various methods and the products in question, from which it is concluded that the new method is a suitable means of invert sugar determination.

Experiences in juice purification with maintenance of an optimum preliming and 1st carbonatation flocculation point as determined by a modification of the Baczek-Jesic method. L. Büsching. *Zucker*, 1977, **30**, 595-600 (*German*).—The Baczek & Jesic method for determination of optimum alkalinity and pH at which flocculation is maximum in preliming and carbonatation[2] was found to suffer from poor reproducibility in some cases, necessitating modifications. For preliming, milk-of-lime is added dropwise to 2 litres of raw or mixed juice, i.e. raw juice plus recycled 1st carbonatation juice concentrate, with constant stirring. Once precipitation takes place, the juice is left to stabilize for 1 minute while stirring is continued. Portions of the solutions are transferred to 170 mm long × 30 mm diameter test tubes and further milk-of-lime added dropwise to each sample. The pH is measured at about 0·4 unit intervals; as the optimum end-point (indicated by a clear separation between juice and mud) is approached, the pH intervals are narrowed to 0·1 unit. The end-point is exceeded when a considerably larger amount of milk-of-lime than before is needed to raise the pH. The samples are stood for about ½ hour in a water bath at approx.

[1] *I.S.J.*, 1960, **62**, 165.
[2] *I.S.J.*, 1975, **77**, 217.

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20°C to cool and permit settling of the precipitate. A sample of juice is then carefully pipetted (without disturbing the precipitate) from each test tube into a 1-cm photometer cell for extinction measurement at 530 nm. The pH is measured at 20°C and the two sets of values plotted to give the optimum flocculation pH at which extinction is minimum. For 1st carbonatation optimum end-point determination, a 10-litre laboratory unit was designed with the aim of improving CO_2 distribution in defecation juice and facilitating adjustment of juice pH (earlier made difficult by considerable foaming). 7 litres of juice is fed into the vessel and held at 1st carbonatation temperature, e.g. 85°C; CO_2 is introduced via a wash bottle or gas meter (to permit continuous control of the reduction in pH), and when a pH of 12·4–12·2 is reached, nitrogen is fed into the vessel for ½ minute to effect good mixing and stabilization of the juice. (Compressed air may be used instead of N, but in that case allowance must be made for the effect of oxygen on juice colour.) Samples of juice are then transferred to test tubes as used for the prelimed juice. After cooling for ½ hour in a water bath at 20°C, 20-cm^3 aliquots of the clear juice are pipetted into other test tubes, and the extinction and pH measured after shaking of the contents. Direct measurement of the extinction automatically gives a combined measurement of turbidity and colour, so that the colour is also measured separately after filtration through a permeable membrane. Results obtained during three campaigns at Rain am Lech factory are discussed and a description given of the carbonatation scheme used. It was found that direct measurement of the extinction gave an optimum flocculation point different from that obtained by measurement of the colour alone. Investigations, in which the turbidity and colour were measured separately and the filtration coefficient determined, showed that minimum turbidity occurred at pH 11·8, while the lowest colour content occurred at pH 11·4 and the minimum filtration coefficient at pH 10·9 (the turbidity and filtration coefficient minima being less distinct than the colour minimum), indicating that low pH values in 1st carbonatation favour filtration but increase colour. Because of the turbidity-filtration coefficient relationship, it is possible to use measurements of the coefficient as an indicator of the optimum flocculation point by plotting against pH. Maintenance of high pH values in carbonatation proved beneficial for filtration of juice from low-quality beet in the 1975/76 campaign.

Electrophysical properties of molasses. V. A. Karasenko and E. M. Zayats. *Izv. Vuzov, Pishch. Tekh.*, 1977, (3), 87–90 (*Russian*).—The conductivity of molasses samples taken from a yeast plant was measured in a cell and the effects of a number of factors investigated. Temperature was found to have the greatest effect, the temperature-conductivity relationship being exponential in nature as found with semi-conductors having ionic conductivity. In the temperature range 20–60°C the most probable conductivity value ranged from $0{\cdot}237\times10^{-3}$ to $1{\cdot}966\times10^{-3}$ $S.cm^{-1}$ with maximum deviation of the confidence limits of $\pm27\%$ from the arithmetical mean. Investigations of the Seebeck (thermoelectric) effect and of the Hall effect revealed the presence of electron conductivity at a magnetic flux density up to 0·12 $Wb.m^{-2}$; with increase in the magnetic field strength, this conductivity was converted to hole conductivity, which however, had little influence by comparison with the ionic conductivity.

Control test for molasses exhaustion. K. Wagnerowski. *Zeitsch. Zuckerind.*, 1977, **102,** 715–720 (*German*). See *I.S.J.*, 1978, **80,** 219.

Determination of the technical quality of sugar beet. J. Trzebinski. *Zeitsch. Zuckerind.*, 1977, **102,** 720–722 (*German*).—The formula derived by Reinefeld *et al.*[1] for calculation of molasses sugar Z_m has been found to be valid only in the case of "normal" chemical composition of beets, but not where excessive nitrogen application has caused marked changes, especially an increase in the α-amino N content and hence a fall in the alkalinity coefficient A_K ($= \frac{K + Na}{N_{Bl}}$ where N_{Bl} is the "blue" number). A correction factor X (meq of alkali) is applied to the formula for A_K, which is assumed, for normal beets, to have a value of 1·8. The value of X is substituted in the original formula for molasses sugar and the formula reduced to $Z_M = 0{\cdot}71\,N_{Bl} - 0{\cdot}31$ where A_K has a value below 1·8. Tabulated analytical data represent the pol, K, Na, N_{Bl} and A_K values for normal, freshly harvested, over-fertilized (with N) and long-stored beet samples, together with molasses sugar as calculated by the original and modified formulae. It is stressed that the modification refers only to deviation in the alkalinity coefficient, whereas it is recognised that a fall in alkalinity in many cases is governed chiefly by the invert sugar content, for which allowance is difficult to make in estimations of sugar loss and white sugar yield.

Thermodynamics of sucrose solutions. W. J. Dunning. *Zeitsch. Zuckerind.*, 1977, **102,** 727–730.—The thermodynamics of sucrose dissolution in a two-component system (sucrose + water) and a three-component system (sucrose + water + non-sucrose, where the latter is e.g. raffinose or KCl) are examined, using the Gibbs-Duhem equation relating change in the activity of one component to changes in the activities of the others. Growth of crystals is then considered. It is stressed that in the case of supersaturated solutions containing an additive, we know that the solution is supersaturated because sucrose crystals form, but we do not know the magnitude of the "driving force", so that an additive may reduce the rate of crystal growth either by diminishing the driving force or by directly affecting the kinetics, e.g. by adsorption. It is suggested that the habit of a crystal may change with supersaturation; if so, some of the differences in habit recorded when crystals are grown from impure factory syrups may not be due to the effect of the impurities on the growth processes at the different surfaces but to differences in the driving force. The dislocation theory of crystal growth argues that each crystal is an individual and inherits the dislocations from its seed or nucleus, such dislocations being analogous to the genes in a biological cell; however, the study of these "genes" presents a major problem. The growth of crystals having inclusions or dislocations is discussed, and techniques used to study dislocations are described.

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[1] *I.S.J.*, 1974, **76,** 347.

BY-PRODUCTS

Production of oxalic acid from gur. A. C. Raha, R. B. Nigam and P. Sanyal. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.1-G.6.—Laboratory experiments are reported on production of oxalic acid from gur by hydrolysis of sucrose to dextrose which was then oxidized with nitric acid in the presence of vanadium pentoxide as catalyst and a dehydration agent. Maximum oxalic acid yield from 50 g gur was 64 g with consumption of 250 cm^3 nitric acid, 100 cm^3 dehydrant and 10 mg vanadium pentoxide.

Establishment of bagasse-based mini paper plants by sugar factories. P. J. M. Rao. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.1-G.27.—See *I.S.J.,* 1976, **78**, 349.

The effect of maltol on *Saccharomyces cerevisiae* **and** *Aspergillus niger.* N. Banerjee and L. Viswanathan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.77-G.83.—Maltol, a Maillard reaction product, had a marked inhibitory effect on both yeast and alcohol yield—the minimum concentration at which yeast growth was affected was 1 $mg.cm^{-3}$, while it was 2 $mg.cm^{-3}$ in the case of alcohol, the effect increasing with maltol concentration. However, at 0·08 $mg.cm^{-3}$ maltol, alcohol yield rose by 18% by comparison with the yield when no maltol was added. At 0·5 $mg.cm^{-3}$ or more, maltol inhibited *A. niger* growth as well as the total acids and citric acid yield, although at 0·1–0·25 $mg.cm^{-3}$ it stimulated formation of the acids. Since maltol is a chelating agent, it is suggested that at lower concentrations it chelates those metal ions which inhibit the growth processes, whereas at higher concentrations it also chelates the metal ions which are essential for growth.

Preliminary studies on the continuous fermentation of dextran. R. Bhatnagar and K. A. Prabhu. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.91-G.94 (+ figs.).—In studies on continuous growth of purified *Leuconostoc* sp. (obtained from cane juice) in a modified Stacey's medium, dextran formation reached a maximum after 72 hours, after which it slowly fell, total yield being about 30% on sugar utilized and 65% of theoretical conversion. Satisfactory conditions during 1 week's operation were a feed rate of 12 $cm^3.hr^{-1}$ in a 50-hour cycle, and a temperature of 23±1°C, the medium being well agitated.

Preliminary studies on the feasibility of fermentation of bagasse. K. N. Vaish and L. Viswanathan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.85-G.89.—Studies on fermentation of bagasse acid hydrolysate to yield alcohol and citric acid are reported. Since xylose is a major constituent of bagasse hydrolysate, its effect on *Aspergillus niger* growth and citric acid yield was first investigated. While xylose on its own, at 14 g/100 cm^3, gave only 0·075 g citric acid per cm^3 and 0·464 g mycelium (as dry weight) per 100 cm^3, a sucrose:xylose mixture (8·4:5·6 g/100 cm^3) gave the maximum citric acid yield of 1·7 g/100 cm^3 and the second highest mycelium yield (0·546 g/100 cm^3); sucrose on its own at 14 g/100 cm^3 gave 0·650 g/100 cm^3 citric acid and 0·473 g/100 cm^3 mycelium. Total acid yield was also greater with the mixture than with sucrose alone. Hydrolysis with 0·5N HCl for 3½ hours under reflux or by treatment in an autoclave with 0·5N H_2SO_4 for 3½ hours at 1 $kg.cm^{-2}$ pressure yielded about 26% or 29% reducing sugars, respectively, and hydrolysed most of the pentosans and some of the cellulose. In preliminary experiments, the hydrolysates inhibited growth of both *Saccharomyces cerevisiae* and *A. niger*; this is attributed to the probable effect of lignin derivatives.

Effect of disinfectants on dextran-producing *Leuconostoc* **bacteria.** R. Bhatnagar and K. A. Prabhu. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.95-G.99.—Tests were conducted on the control of cell growth and dextran synthesis by various disinfectants added to Stacey's medium in which *Leuconostoc* sp. was cultured to give a population of 1000 per cm^3 (corresponding to that generally found in contaminated cane juice samples). Complete inhibition of cell growth and dextran synthesis by intact cells was achieved by SO_2 at 50 ppm, and by sodium metabisulphite, mercuric chloride, copper sulphate, formaldehyde, "Busan 881", gentian violet and thymol at 100 ppm. In the case of a culture which was centrifuged and twice washed to remove soluble polysaccharide material before inoculation in Stacey's medium, complete inhibition of cell growth and dextran synthesis was obtained with 20 ppm mercuric chloride, SO_2 and chloramphenicol; other disinfectants gave slightly less than complete control, in some cases having a greater effect on cell growth than on dextran synthesis and *vice versa.* None of the disinfectants gave complete control of enzyme activity, even when added at 100 ppm to a dextran sucrase solution made up of 10 cm^3 enzyme solution and 2 cm^3 60% sucrose solution incubated at 30°C and buffered to pH 5·2. Mercuric chloride, formaldehyde, ammonium bifluoride, bleaching powder, chlorine, penicillin and SO_2 at 50 ppm all reduced the total bacterial and *Leuconostoc* bacterial numbers by varying degrees in crusher and mixed juice, by far the best results being given by mercuric chloride and SO_2.

Bio-gas generation from distillery slop. R. G. Camarungan and C. S. Abrigo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.,* 1976, 209-217.—Experiments were carried out in which distillery waste at 8·5°Bx was neutralized with milk-of-lime, inoculated with methane-producing bacteria and incubated at 55°C in an air-tight metal digester under batch conditions; the pressure, volume and temperature were measured during a week's fermentation. The pH fell rapidly during the first two days because of the formation of organic acids, and gas production was highest in this period at about 70%. The heat generated during the period was only 50%, however, indicating that the methane content of the gas produced in the last five days was higher. The BOD of the distillery waste was reduced from 72,000 ppm to 9000 ppm and the sludge found to contain 0·1% N, 0·012% P and 0.53% K. It is concluded that bio-gas generation is a socially and economically viable venture.

Sugar Industry Technologists

38th Annual Meeting

The papers presented at the 37th Annual Meeting of SIT in London in 1978 are considered to have been the best yet. SIT is looking to continue this upward trend in presentations and needs papers on refining technology, equipment, energy conservation measures, or other subjects important to refiners to be presented at the 1979 meeting in Boston during the 7th-10th May. In his first call for papers, Kenneth R. Hanson, Programme Chairman asks "Do you have something new . . . something unique . . . something exciting? Get on the speakers list early! Please send me, at 1251 Avenue of the Americas, New York, NY 10020, USA, the title and author of the paper your organization desires to present at the 38th Meeting".

New sugar refinery for Iran[1].—According to a report from the Czechoslovakian News Agency CTK, a sugar refinery with a capacity of 500 tonnes a day is to be built at Dezful, Iran, by two Czechoslovakian construction firms. The refinery should be completed in 1979.

Egyptian beet sugar projects[2].—After completion of studies on a project for establishment of a beet sugar factory in the Lower Egyptian province of Kafr El Sheikh, which is to be erected in cooperation with a French firm and will have an annual capacity of 120,000 tonnes of white sugar, studies are to be made in cooperation with a British firm on the possibility of growing beets in the West Nubariya Zone, on land to be developed in the Western Nile Delta by means of the new Nubariya irrigation canal.

Morocco sugar imports, 1976[3].—Morocco imported 273,000 tonnes of sugar in 1976 compared with 246,000 tonnes in 1975. Domestic sugar production during these two years was 310,000 tonnes and 254,640 tonnes, respectively. Production has risen from only 5000 tonnes in 1963 and 19,600 tonnes in 1964 but this increase is much less than the corresponding reduction in imports during the period from 345,000 tonnes in 1964. The difference is due, of course, to higher domestic consumption.

New Vietnam sugar factory[4].—The most modern sugar factory in Vietnam, with a daily capacity of 7000 tonnes of cane, is to be put into operation at Tay Ninh. This province is near the Cambodia border and its agricultural area is to be increased three-fold, part of which increase will be devoted to cane growing.

Syria sugar imports[5].—According to a USDA report, official trade statistics indicate Syrian 1976 raw sugar imports at 126,800 short tons and refined sugar imports at 57,300 tons. Although the volume was up 28% over levels of a year earlier, the combined value was lower. Nevertheless, sugar imports in 1976, at $80·8 million, were the equivalent of one-quarter of Syria's agricultural imports. Syria's 1977 sugar beet crop is estimated at 310,000 tons. Not all of the 1977 crop will be delivered to sugar factories, however, an estimated 40,000 tons being intended for use as livestock feed.

Turkey sugar production, 1977/78[6].—In the 1977/78 campaign 995,433 tonnes of sugar were produced, as compared with 1,165,000 tons in the previous campaign.

Cameroun sugar factory.—Following its feasibility study for a sugar project in Cameroun[7], Redpath Industries is to build a complex at Kerewa, near Garoua, which will produce some 50,000 tons a year[8]. Redpath will provide 25% of the investment, with the remainder provided by the State.

Cuba sugar statistics[9]

	1977	1976	1975
	tonnes, raw value		
Initial stocks	412,655	557,429	373,071
Production	6,953,284	6,150,797	6,427,382
	7,365,939	6,708,226	6,809,453
Exports	6,238,162	5,763,652	5,743,711
Consumption	519,009	531,919	499,313
Final stocks	608,768	412,655	557,429
Exports			
Albania	8,370	13,169	14,171
Algeria	51,145	35,191	46,495
Angola	51,063	31,881	—
Bulgaria	218,585	232,042	185,728
Canada	139,058	149,041	156,192
China	228,087	254,315	182,877
Colombia	41,936	—	—
Czechoslovakia	67,374	109,172	55,745
Denmark	—	21,739	21,089
Egypt	71,893	23,006	13,699
Ethiopia	11,430	—	—
Finland	131,166	71,111	95,978
France	—	15,100	12,127
Germany, East	228,940	194,868	169,195
Hong Kong	12,035	13,332	—
Hungary	51,416	70,007	41,762
Indonesia	140,991	—	—
Iraq	86,591	83,003	78,395
Ireland	—	10,581	
Jamaica	—	—	4,468
Japan	183,452	149,941	338,825
Korea, North	18,542	21,999	50,441
Lebanon	5,708	—	22,035
Malaysia	—	18,861	—
Mali	—	—	22,143
Malta	—	4,096	—
Mongolia	2,283	2,083	2,698
Morocco	166,052	108,777	100,280
New Zealand	17,435	34,990	93,673
Poland	31,099	16,642	43,100
Portugal	25,582	92,011	115,656
Rumania	25,868	39,303	11,224
Senegal	—	46,175	31,831
Spain	158,948	114,519	326,523
Sudan	24,003	—	27,260
Surinam	3,972	1,098	—
Sweden	35,349	108,291	35,252
Switzerland	2,750	2,097	1,038
Syria	109,476	106,222	52,794
Trinidad and Tobago	—	—	4,073
Tunisia	10,897	—	12,442
Turkey	—	—	22,828
UK	—	138,756	16,671
USSR	3,790,424	3,035,566	3,186,724
Venezuela	1,760	—	—
Vietnam	67,680	124,538	86,918
Yugoslavia	12,573	266,360	60,767
Other countries*	4,229	3,769	594
	6,238,162	5,763,652	5,743,711

* Donations of sugar.

New Iran sugar factory.—In addition to the new sugar factory at Moghan being built for the Industrial Development and Renovation Organization[10], another factory is planned for erection at Bistun with an output of 27,000 tonnes of sugar per year[11].

[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (17), 17.
[2] *Zuckerind.*, 1978, **103**, 529.
[3] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (17), 16.
[4] *Zuckerind.*, 1978, **103**, 529.
[5] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (17), 17.
[6] *Zuckerind.*, 1978, **103**, 440.
[7] *I.S.J.*, 1977, **79**, 119.
[8] *Zuckerind.*, 1978, **103**, 441.
[9] C. Czarnikow Ltd., *Sugar Review*, 1978, (1396), 130.
[10] *I.S.J.*, 1978, **80**, 76.
[11] *Zuckerind.*, 1978, **103**, 441.

India and Bangladesh sugar economies

Continuing its studies of the sugar economies of individual countries, the International Sugar Organization has issued the second of its booklets up-dating the two volumes published in 1963, "The World Sugar Economy, Structure and Policies. " This booklet covers India and Bangladesh.

India has been growing sugar cane since prehistoric times and cane of Indian origin has found its way into most producing countries. It is now the third largest producer of centrifugal cane sugar, ranking after Brazil and Cuba; if non-centrifugal sugar is included, it is probably the world's largest producer. Only in recent years, however, has India become a major exporter of sugar. In some years, even as late as 1972, production had to be supplemented by drawing on stocks to meet the requirements of the domestic market. The expansion in sugar production contemplated in the successive Five Year Plans was until recent years primarily intended for this rapidly increasing home market.

There is great variation in the conditions under which sugar cane is grown in India. Much of the expansion since 1960 in the area under cane has been in the tropical zone where irrigation is more common and yields per hectare higher. The additional factories built to handle the increased volume of cane have also been largely in the tropical zone. One feature of the industry common to both the tropical and sub-tropical zones is the growth of cooperative factories, which in 1972/73 accounted for over one-third of the total number.

Production of sugar in what is now Bangladesh suffered a set-back during hostilities leading up to independence but has since recovered and the country is beginning to export sugar. The sugar factories have been nationalized since 1972. As in India, besides the centrifugal sugar manufactured by the mills, a large volume of non-centrifugal sugar is produced in the villages for domestic consumption.

This booklet is available in English, while translations into French, Russian and Spanish are in preparation. Copies may be obtained from the International Sugar Organization, 28 Haymarket, London SW1Y 4SP, price £1.00 (plus postage).

Canada sugar factory closure[1].—The oldest beet sugar factory in Canada, at Picture Butte, Alberta, erected in 1935/36, has now been closed.

Molasses alcohol in the US[2].—Holly Sugar Corporation has announced its application to participate in a USDA-sponsored pilot programme to produce hydrocarbons and alcohols from agricultural commodities. US legislation provides for guaranteed loans to finance construction of pilot projects to produce alcohol at a net energy saving. Holly would like to erect such a plant in California where it produces about 300,000 tons of molasses annually. The plant would produce about 16 million US gallons of ethanol a year. The company is also constructing a wet milling plant for corn at Tracy, California, and could use the separated starch as raw material to produce ethanol.

US beet sugar factory possibility[3].—The Minnesota Valley Growers Development Corporation is to study the possibility of erecting a beet sugar factory at Appleton, Minnesota. It will consider the prospects for buying the closed sugar factory at Easton, Maine, and re-erecting this at Appleton.

Philippines sugar exports, 1977[4]

	1977	1976	1975
	tonnes, raw value		
Algeria	33,696	37,939	0
China	277,418	81,104	11,016
Indonesia	13,125	0	0
Iran	0	0	57,031
Japan	250,352	93,446	377,039
Korea, South	5,886	0	0
Malaysia	37,064	0	0
Morocco	0	0	27,909
New Zealand	0	13,011	0
Portugal	0	0	11,376
Rumania	0	31,907	0
UK	0	33,521	181,882
USA	1,301,570	992,415	339,411
USSR	655,714	231,230	0
Total	2,574,825	1,514,573	1,005,664

PERSONAL NOTES

R. Charles Hodson, Jr., will become General Manager of the American Sugar Cane League in January of 1979, according to an announcement by the League's Board of Directors. Hodson will succeed **Gilbert J. Durbin**, who will retire after serving over 27 years as the League's chief executive officer. Hodson has been the League's Economist since February 1972 and has also served as Assistant General Manager for more than a year.

British Sugar's Assistant Chief Executive and Financial Director, **Jim Brown**, retired at the end of August. **Tom Rodgers**, executive director with responsibility for the company's £150 million expansion and modernization programme, has become Assistant Chief Executive. Three new appointments to the Board are: **Bob Chappell**, presently Director and General Manager of Beet Sugar Developments, one of British Sugar's subsidiary companies; **Rodney Lund**, presently Director of Sugar Sales and Distribution; and **Geoff Mulcahy**, presently Director of Finance.

Ben Oxnard of New York resigned from the Board of E. D. & F. Man Ltd. with effect from 31st July 1978, while **J. M. Darling** was appointed a Director of E. D. & F. Man (Sugar) Ltd., with effect from 1st August, with responsibility for Sugar Terminal trading and its administration.

Following a reference by **Lord Jellicoe** in his Chairman's Interim Statement, to a future streamlining of the company's management structure, Tate & Lyle Ltd. have announced the following appointments: **F. Thomlinson** (Divisional director, UK food and distribution), **C. D. Runge** (Managing director, Tate & Lyle Refineries Ltd.), **L. E. Fenn** (Managing director, Tate & Lyle Transport Ltd.), **J. C. R. Scott** (Group personnel director, Tate & Lyle Ltd.), **J. M. Ferguson** (Chairman, Refined Syrups and Sugars Inc.) and **J. W. C. Mitchell** (President, Refined Syrups and Sugars Inc.).

Albert Slater who retired recently after 43 years' service with Tate & Lyle companies received the Order of the British Empire (OBE) in the Queen's latest Birthday Honours list for his services to British exports. He joined Tate & Lyle as a clerk in the packet department, which he left in 1940 to join the Royal Navy. After the war he started with the Tate & Lyle Pension Fund before joining TLTS and A. & W. Smith & Co. Ltd. as company secretary. As Managing Director of A. & W. Smith he travelled widely and led a team of engineers and salesmen, obtaining many contracts overseas. In 1975 he became managing director of Tate & Lyle Engineering Ltd. and brought together, under one umbrella, the many different operating companies of the Group.

1 *Zuckerind.*, 1978, **103**, 441.
2 F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (16), 12–13.
3 *Zuckerind.*, 1978, **103**, 442.
4 *Lamborn*, 1978, **56**, 84.

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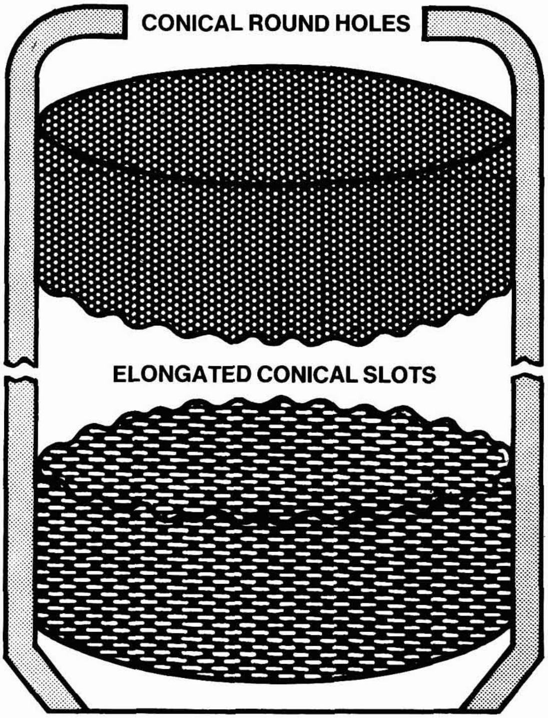

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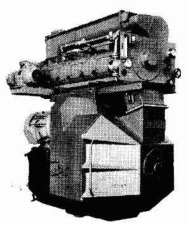

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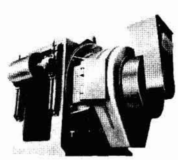

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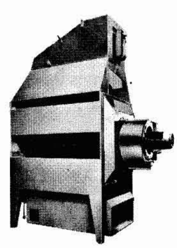

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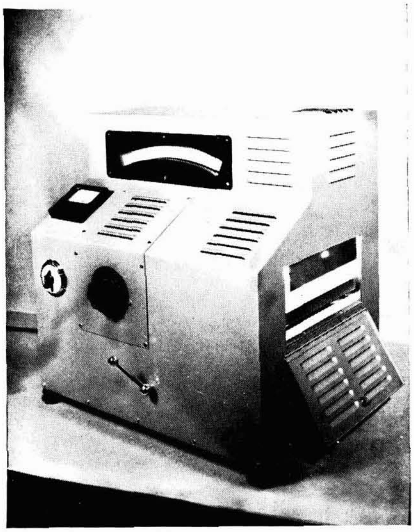

MOISTURE BALANCE—TYPE D

The moisture balance type D illustrated is essentially the same as the type CB excepting that it can take samples from 100 to 1000 grm depending on the density of the product. In the case of bagasse the weight of sample possible is 100 grm contained in a dish 250 mm long × 200 mm wide × 22 mm deep.

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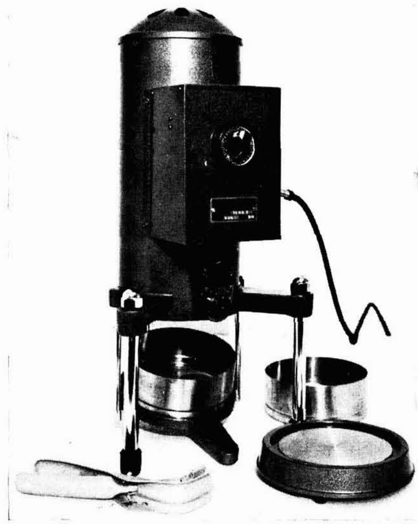

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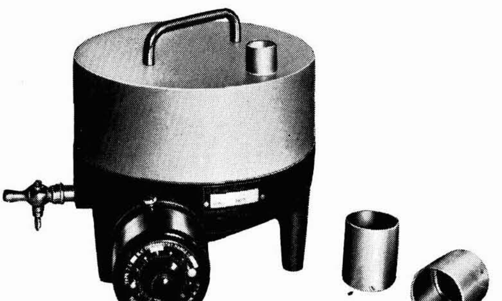

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