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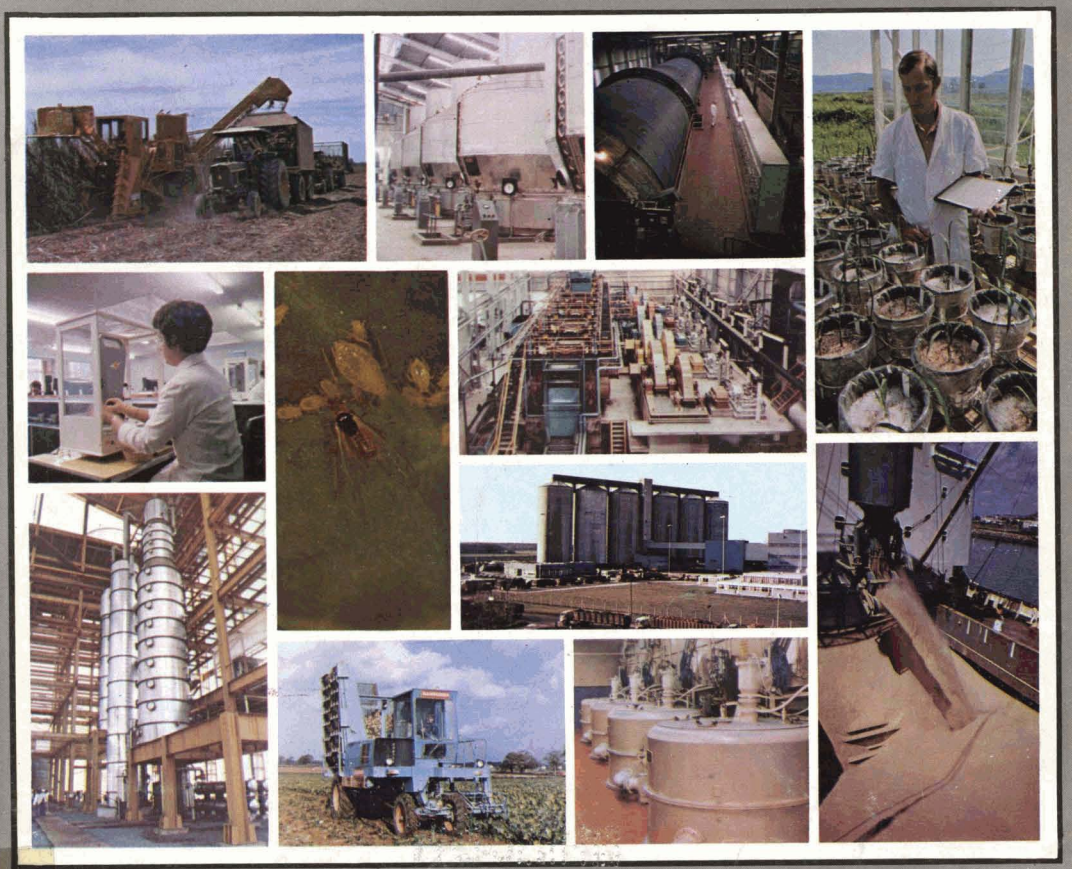

AUGUST 1978

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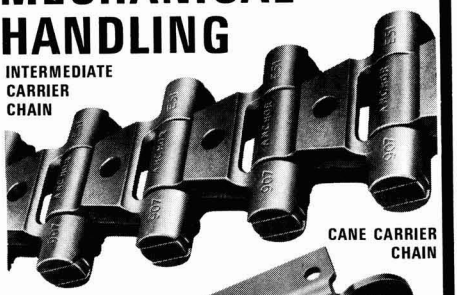

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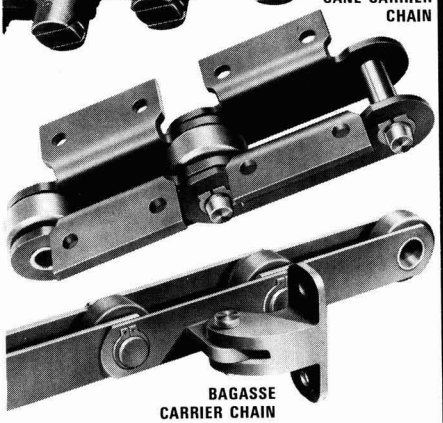

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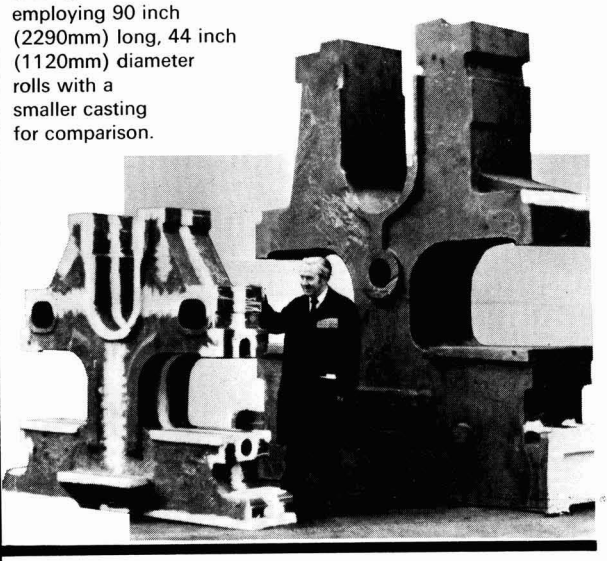

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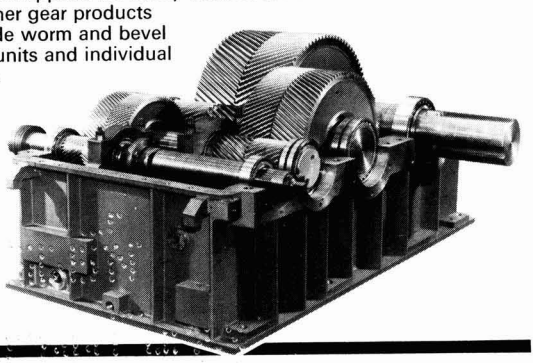

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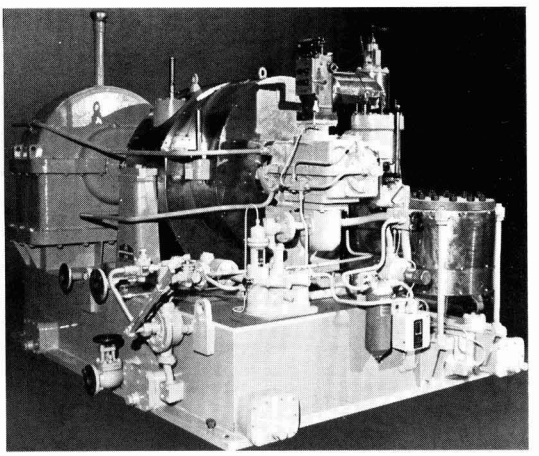

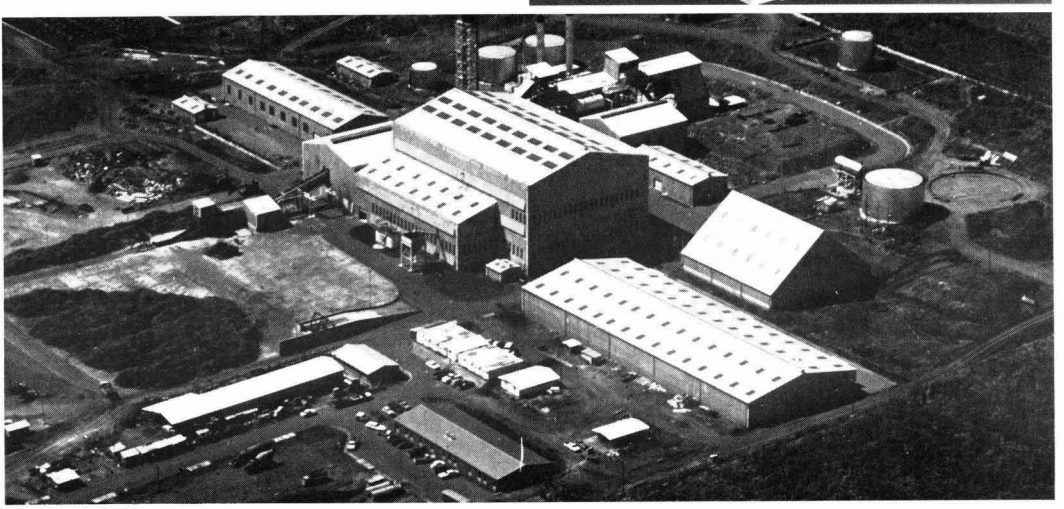

Photograph by courtesy of Fletcher and Stewart Limited

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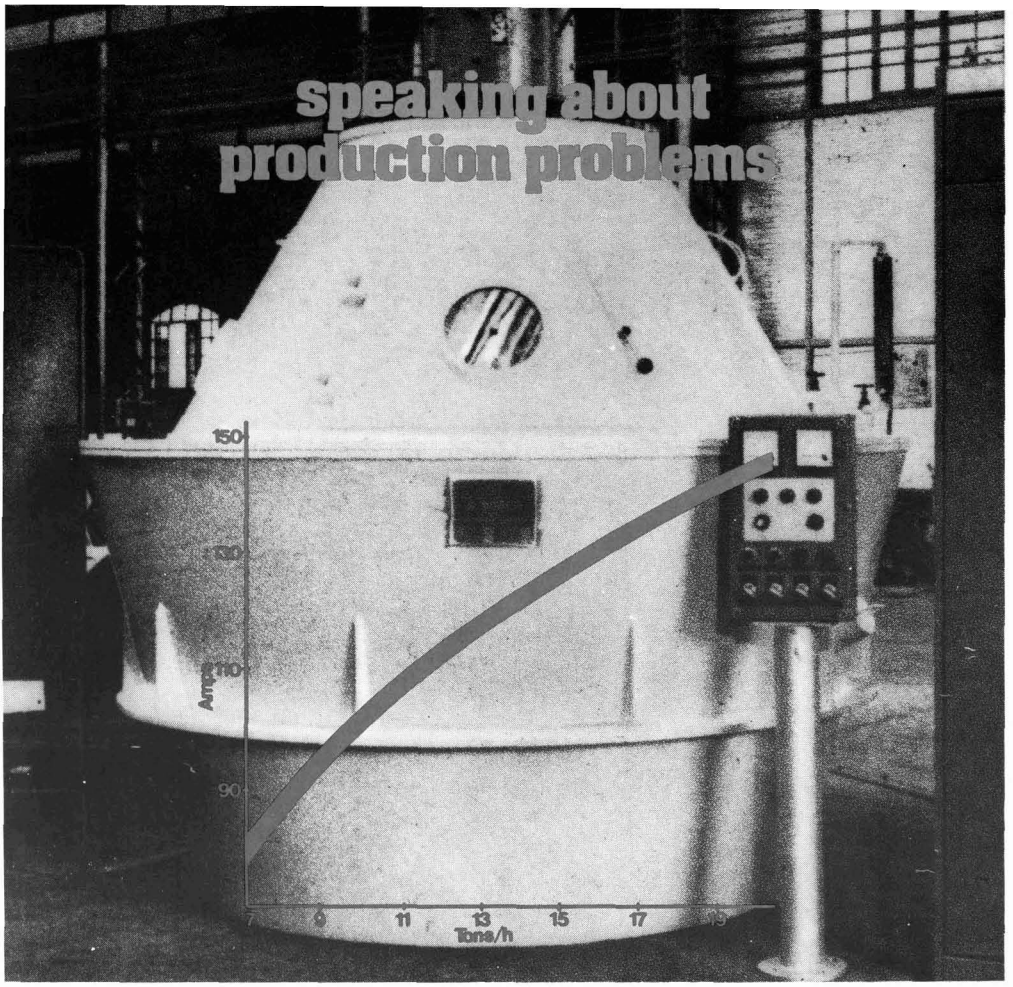

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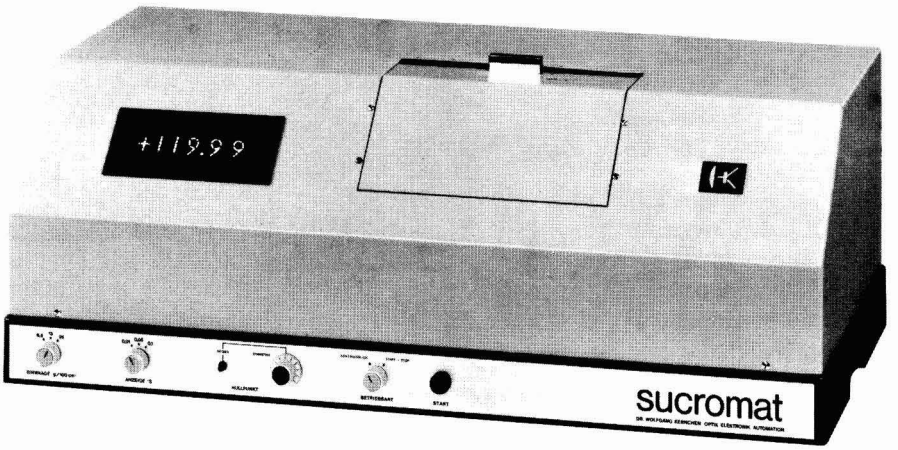

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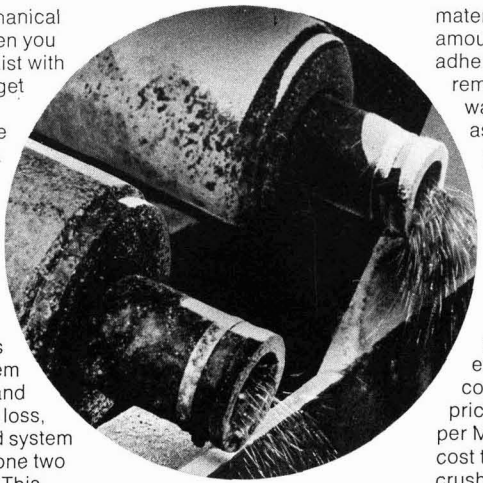

Dorr-Oliver DorrClone discharging sand.

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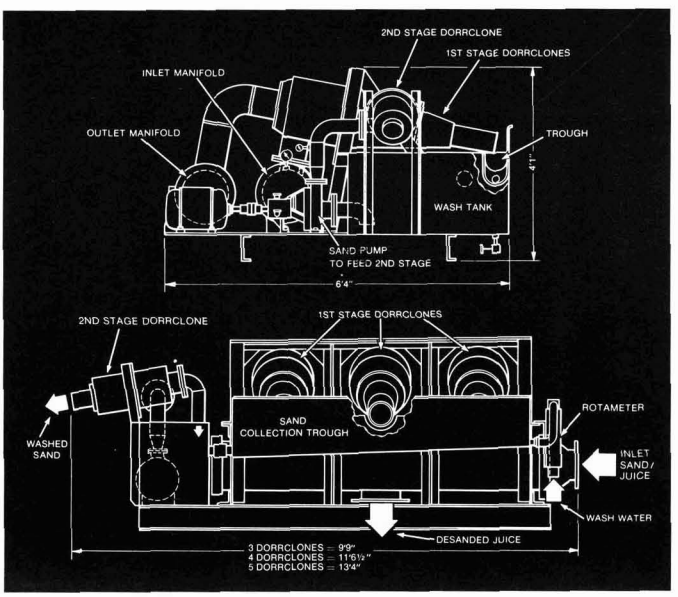

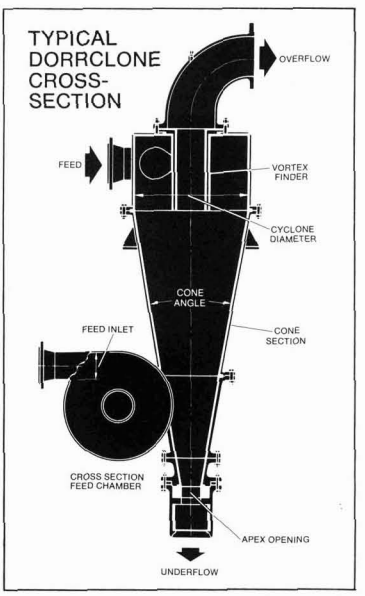

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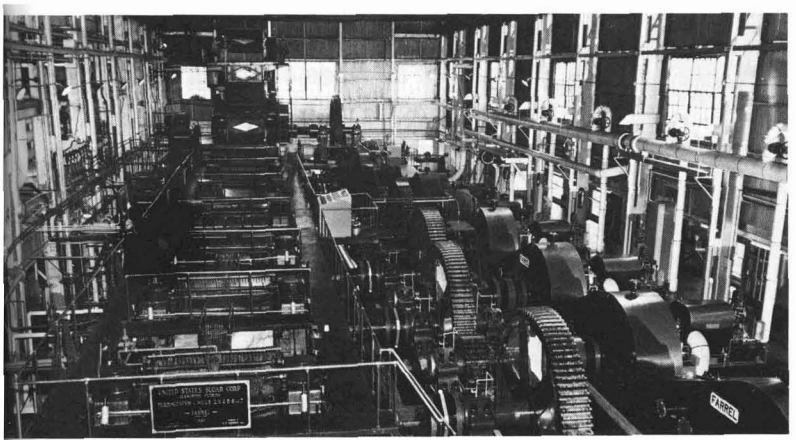

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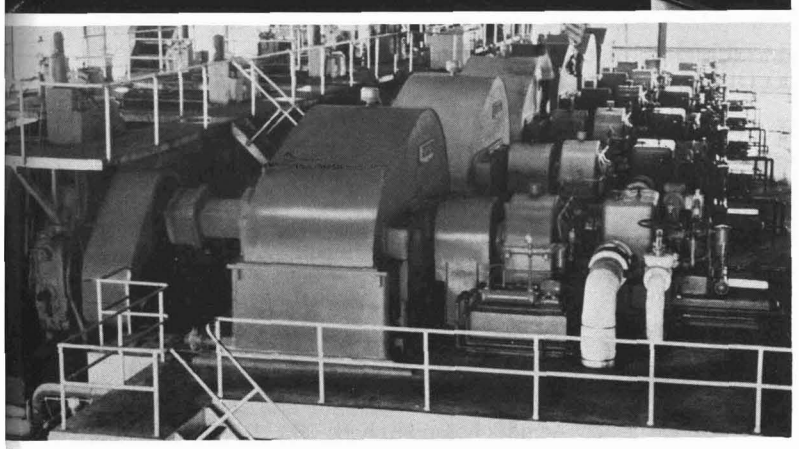

NEW CONSTRUCTION:
An 18-roll Farrel cane grinding unit with totally enclosed turbine drives was selected by Elizalde and Company and was installed at La Carlota/La Castellana, Negros Occidental, Philippines. This 40" x 84" milling tandem is adjacent to the older La Carlota factory and has a capacity exceeding the three tandems of La Carlota. Here also the gearing between turbines and mill rolls is two double reduction units, size DRB-4571 for the slow speed and DR-39 for the high speed.

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NOTES AND COMMENTS

US sugar legislation

The stalemate over US domestic sugar policy has continued through June; the President has indicated that the Church and de la Garza bills would raise the cost of sugar to the consumer too high and that they would be vetoed, while the Administration's own bill is looked upon with disfavour in Congress. On the 22nd June Mr. Carter met five of the leading Senators concerned with sugar legislation but no agreement was reached. As a consequence progress is blocked on domestic sugar policy and the US Government has not been able to ratify membership of the International Sugar Agreement by July 1st, as originally specified in the ISA. This has led to amendment by a Special Session of the International Sugar Council but also to problems in the Agreement's working.

While ratification has not taken place, sugar from non-members can be imported into the USA, and the EEC has taken the opportunity to expand sales. This has led to a demand by a group of US beet sugar producers that the Treasury Department look into their allegation that EEC sugar is "dumped" (sold at below price level in the supplier's own territory). The Department, not surprisingly, has concluded that the EEC sugar *is* subsidized and has said that countervailing duties may be imposed.

International Sugar Agreement

When it became clear that the US would not be able to ratify its membership of the ISA by 1st July, a meeting of the Executive Committee of the Organization decided to recommend to the Council that the deadline for ratification be postponed for six months, and at a meeting of the Council on 30th June this recommendation was accepted. Also accepted was a recommendation to delay by three months, to 1st October 1978, the obligations of members under article 51 governing contributions to the Special Stock Fund. Part of the Agreement requires that exporting members hold stocks, while all members contribute to their financing. While countries which have declared their intention to join but have not ratified their membership are not bound to provide such contributions, the Council felt that it was not equitable to expect members which had ratified to do so. This has meant, however, that funds are not available to provide loans to finance stocks already established, and that some of the poorer countries are under pressure to sell their sugar to save the costs of storage.

World sugar prices

Pressure to sell their stocks in the absence of loans from the ISO's Special Stock Fund led to weakening of the raw sugar price during the latter half of June, as did a series of announcements from Cuba during the month about the progress of the 1977/78 crop. Plagued by bad weather, this had been estimated at between 6 and 6½ million tonnes. The reports indicated that production would be higher and it was announced in early July that the planned target of 7·3 million tonnes had been reached by extending the crop. While gratifying to the Cubans, such a production level had a depressing effect on the market because, while Cuba's exports to the world market are limited by quota, this does not apply to sales to the USSR and anticipated Soviet purchases are thus likely to be smaller.

The LDP fell during the month from £102.50 to £94 per tonne, while the LDP(W), steady for the first three weeks, fell from £110 to reach £105 per ton as a consequence of selling pressure by the EEC for its white sugar.

Dominican Republic and the ISA

The Dominican Republic's ratification of the International Sugar Agreement will depend on the level of foreign earnings it can obtain under the Agreement's export controls, according to Sr. Alfredo Ricart, the country's chief delegate to the International Sugar Council[1]. He has requested special relief from current controls which restrict exports to 935,000 tonnes and will lead to an increase in stocks to more than 350,000 tonnes by the end of this year, from 153,000 tonnes, at the end of 1977.

Dominican Republic sugar production this year is likely to be one of the highest ever, at 1,325,000 tonnes, as a result of better yields and favourable weather, acreage not having been increased. The country is geared to exports, however, with domestic consumption around 175,000 tonnes, and there are no proper storage facilities for stocks of over 350,000 tonnes. Some 60% of foreign exchange earnings come from sugar and, as a result of this dependence, the International Sugar Council has set up a working party to consider the Republic's plea.

Some delegates have said that the Republic's request could be met partially from the Agreement's Special Hardship Fund, or a special Council decision, as allowed in the text of the Agreement in case of hardship.

US sugar support

The US Department of Agriculture has announced[2] price support loan levels for 1978 crop sugar as 14·65 cents per pound f.o.b. for cane sugar, raw value, and 16·90 cents for white beet sugar. The levels are based on the estimated July parity price for sugar. The Department also announced a system of location differentials for sugar produced and stored in Hawaii and Puerto Rico; these are discounts applied to the basic loan rate which reflect the estimated ocean freight and insurance costs of moving the sugar from bulk terminals to processor market outlets on the US mainland. The USDA has called for comments on setting location differentials for sugar produced on the mainland.

Processors must pay sugar growers at least the same prices set under the sugar payments programme to qualify for the support loans while the growers, in turn, must pay their workers at least the minimum wage rates set by the USDA. According to reports from Washington[3], the USDA appears to be worried about sugar stored under the 1977 programme. The Administration

[1] *Public Ledger*, 20th May 1978.
[2] *ibid.*, 10th June 1978.
[3] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (17), 12–13.

would waive a portion of the interest and/or principal if that were necessary to encourage repayment of existing loans. The Commodity Credit Corporation, which administers the loans, would offer processors the opportunity to claim their sugar at ½–1 cent below the 13·5 cents per pound loan level of 1977. Interest would be waived. With 1,200,000 short tons of sugar under loan the USDA is worried about reclamation of this volume before new crop sugar begins to arrive in September 1978 since there is not sufficient storage capacity for both 1977 and 1978 sugar. Unless the domestic market price rises to 13·5 cents per pound most processors will not redeem their sugar, however, and the CCC is prohibited from selling sugar under loan at less than 5% above the market price.

World sugar production, 1977/78

F. O. Licht GmbH have recently published[1] their fourth estimate of world sugar production for the current season. In spite of the fact that many countries' seasons had finished at the time of the last estimate[2], the total is set no less than 600,000 tonnes higher, at 93,045,000 tonnes, raw value, itself more than 5,500,000 tonnes more than in 1976/77. This arises above all from increases in the estimates for two countries: India where the forecast is raised by an astonishing 1,100,000 tonnes and Cuba, raised by 700,000 tonnes to 6,900,000 tonnes (in view of the recent announcement that Cuba had reached her target of 7,300,000 tonnes this last figure will presumably be further amended in a subsequent estimate). Originally India was expected to produce 5·2-5·3 million tonnes of sugar, but projections were raised when it became evident that a larger area had been planted, and that good weather would result in a record crop. The current estimate is for 6·7 million tonnes, raw value, and compares with an outturn of 5·25 million tonnes in 1976/77.

Other major changes are reductions of more than 200,000 tonnes each for the USSR and for US beet sugar production, both resulting from reports on the past crop which was disappointing in both countries. The overall figure represents a very large surplus over current consumption to add to the already burdensome stocks.

But a number of major producers have reported intentions to cut back production, and, while the European beet area is about the same as for 1977/78, very favourable weather would be required, as in 1977, to give as good a sugar crop. With only average weather, a smaller crop may be expected in Europe. Thus it would be reasonable to expect less sugar produced in 1978/79, which would help operation of the International Sugar Agreement and bring world sugar prices nearer production costs.

Europe sugar beet areas, 1978

F. O. Licht have issued their third estimate of beet areas in Europe[3] but changes from the previous estimate are not significant. Over the EEC as a whole the change is only some 2000 ha upwards; this does, however, represent decreases of 22,000 ha from 1977 for France, 20,500 ha for West Germany and 2700 ha for Denmark, offset by increases of 10,000 ha in Belgium, 7800 ha in Holland, 15,000 ha in Italy, 8100 ha in the UK and 1200 ha in Ireland. The net EEC drop of 10,000 ha is more than counterbalanced by an increase in the beet areas of the rest of Western Europe, in spite of major reductions for Austria (12,000 ha) and Spain (17,000 ha). The principal increases are of 14,000 ha in Yugoslavia and 25,400 ha for Turkey.

East European beet areas have not reacted to low world market prices and the total area sown to beets is now expected to be 0·76% or 39,700 ha greater in 1978. Most of this is in Poland (49,000 ha), Hungary (12,000 ha), Rumania (5,400 ha), Bulgaria (3000 ha) and Czechoslovakia (2000 ha), while a decrease of 31,000 ha is expected in the USSR's beet area. The estimated figures are tabulated below.

	1978	1977	1976
		hectares	
Belgium	108,000	98,000	98,000
Denmark	81,200	83,900	83,000
France	525,000	547,000	575,000
Germany, West	412,967	433,477	449,329
Holland	133,000	132,230	138,966
Ireland	36,400	35,208	34,400
Italy	255,000	240,000	290,000
UK	208,500	200,400	203,000
Total EEC	*1,760,067*	*1,770,215*	*1,871,695*
Austria	43,818	55,977	56,070
Finland	31,000	30,270	27,200
Greece	45,000	43,461	47,200
Spain	226,683	243,457	265,000
Sweden	52,000	53,800	53,500
Switzerland	13,100	11,938	11,296
Turkey	275,000	249,566	248,325
Yugoslavia	132,000	118,434	100,889
Total Western Europe	*2,578,668*	*2,577,118*	*2,681,175*
Albania	7,000	7,000	6,000
Bulgaria	78,000	75,000	72,600
Czechoslovakia	210,000	208,000	215,500
Germany, East	270,000	270,700	269,800
Hungary	125,000	113,000	128,386
Poland	581,000	532,000	555,000
Rumania	260,000	254,600	234,800
USSR	3,730,000	3,761,000	3,754,000
Total Eastern Europe	*5,261,000*	*5,221,300*	*5,236,086*
Total Europe	7,839,668	7,798,418	7,917,261

EEC duty rebates on HFCS exports[4]

The EEC Commission announced from 1st May that it would be giving export rebates of 16·63 U.A. per 100 kg dry basis for high fructose corn syrup, on which producers pay a levy of 5 U.A. per 100 kg. It was described as an act of fairness by the Commissioner for Agriculture, Mr. Finn Gundelach, but as "absolutely meaningless" by a spokesman for Tunnel Refineries Ltd., the main UK producers, who pointed out that there was virtually no exporting of HFCS except a little to Switzerland, since it was a costly and troublesome product to ship. A concessionary rebate on foods containing HFCS was also not much use, since the main outlet was in soft drinks which were not exported to a great extent from the EEC.

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[1] *International Sugar Rpt.*, 1978, **110**, (19), 1–5.
[2] *I.S.J.*, 1978, **80**, 163.
[3] *International Sugar Rpt.*, 1978, **110**, (17), 1.
[4] *Public Ledger*, 6th May 1978.

An enzymatic technique for the detection of dextran in cane juice and prediction of viscosity increases

By G. GERONIMOS and P. F. GREENFIELD
(Department of Chemical Engineering, University of Queensland, St. Lucia, Australia 4067)

Introduction

THE processing and quality problems caused by dextrans (α-1,6-linked glucans) from stale cane are well documented. Apart from crystal elongation, increases in viscosity of molasses and massecuites frequently result, with accompanying reductions in exhaustion and throughput. A recent paper has reviewed this field and quantified the effects of some dextrans on the viscosity of sugar solutions and cane molasses[1].

The standard method of detection of dextrans in juice and in sugar solutions is based on a turbidity increase produced by the addition of alcohol; this is commonly referred to as the "haze test"[2]. As Richards & Stokie[3] point out, the technique has a number of problems the most severe of which is the uncertainty of what constitutes the haze. In waste treatment studies amongst others, ethanol addition is regularly used to precipitate polysaccharides indiscriminately[4]. Richards & Stokie propose a detection method based on the enzymatic degradation and dialysis of dextrans, which is certainly more rigorous although it is very time consuming. The "haze test" itself has been modified by treating the juice sample with the enzyme dextranase, measuring the turbidity before and after enzyme treatment, and using the difference in readings as a measure of the dextran concentration. The "haze test" suffers from another problem, namely its inability to determine an average molecular weight of the dextran being measured. As Greenfield & Geronimos[1] have shown, the relative viscosity increases due to dextran are a function of both dextran concentration and molecular weight. Although it is believed the "haze test" precipitates the higher molecular weight polymers first, it is difficult to obtain a meaningful estimate of an average molecular weight value.

The aim of the present study was to develop a simple technique which could be applied to the relatively dilute cane juice from the mill train to detect dextrans and which would predict the subsequent viscosity increases to be expected. The basis of the technique lies in a simple measurement of the viscosity difference of a dextran-containing solution before and after treatment with the enzyme dextranase.

EXPERIMENTAL

The purpose of the experiments was twofold:

(i) It was intended to test the suitability of the capillary viscometer for detecting dextrans by measuring viscosity differences of juice samples before and after the addition of dextranase. This was aimed at developing a preliminary test which, if successful, would lead to mill trials.

(ii) It was also intended to test the hypothesis that increases in dilute juice viscosity due to dextran might be described by relationships similar to those found for molasses samples, so that prediction of subsequent viscosity increases may be made relatively simple. To achieve this aim, the viscosities of sucrose solutions and juice samples with known levels of dextrans having characterized molecular weights were measured using a capillary viscometer so that comparisons might be made with the results reported by Greenfield & Geronimos[1] for concentrated solutions.

Preparation of solutions

For the sucrose solutions, a weighed amount of sucrose was dissolved in water and made up to volume in a volumetric flask. For the juice samples, model juice solutions of between 15 and 25° Brix were made up by dilution of molasses samples. Care was taken to ensure that the molasses samples contained negligible dextran levels. To achieve a desired dextran concentration, known amounts of Pharmacia dextrans of weight average molecular weights ranging from 10^4 to 2×10^6 were added. Additionally, a high molecular weight fraction dextran produced by Sigma (Cat No.: D5884) and with a weight average molecular weight of approximately 2×10^7 was also used. The moisture content of the different dextrans was determined by drying to constant weight, and was of the order of 8-9%.

Measurement of viscosity

A glass U-tube viscometer (Fig. 1) was used to determine the viscosity of the juice samples and dilute sugar solutions. A range of viscometers is available

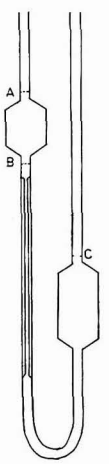

Fig. 1. Capillary viscometer

[1] Greenfield & Geronimos: *I.S.J.*, 1978, **80**, 62–72.
[2] Keniry, Lee & Mahoney: *ibid.*, 1969, **71**, 230.
[3] *ibid.*, 1974, **76**, 103.
[4] Pavoni, Tenney & Eckelberger: *J. Water Poll. Control Fed.*, 1972, **44**, 414.

with varying capillary diameters which allow an appropriate time of flow to be chosen. In these tests the viscometer used was a Technico BS/U Size B.

The viscometer was filled to the mark C with the test solution and, using a stand that had been levelled both horizontally and vertically, placed in a constant temperature water bath. After reaching the required temperature the solution was forced with compressed air to mark A. The time taken for the solution to drop to mark B was noted. This process was repeated three times and an average reading then calculated. After each test the viscometer was rinsed in water, alcohol and finally ether. Compressed air completed the drying process.

Effect of dextran on viscosity

This aspect of the experimental work involved using the capillary viscometer described above to measure the viscosity increase of dextran-containing solutions relative to a dextran-free solution of the same total solids. In other words, the time of flow was measured (triplicate samples were used) for solutions of varying Brix containing different levels of the various dextran samples.

Detection of dextran

The experimental study involved measuring the viscosity decrease in dilute sugar solutions and juice samples which contained dextran after the enzyme dextranase had been added to the solutions. The technique is that described above. After an initial reading was taken, a small amount of Sigma dextranase (Cat. No. D5884) was added to the solution and viscosity readings taken at regular time intervals. The enzymatic action was stopped by adding 2 drops of perchloric acid to the sample. This caused sufficient inhibition of the enzyme action for degradation to be effectively stopped. Additional testing showed that the addition of the acid did not affect the analysis nor cause further degradation in the time period involved.

Two levels of enzyme concentration were tested to enable realistic estimates to be made of the laboratory time and expense involved. The two levels corresponded to enzyme activities of 0·12 I.U. per cm³ of solution and 0·015 I.U. per cm³ of solution respectively (I.U. = International unit; one I.U. will liberate 1·0 μmole of *iso*-maltose from dextran per minute).

Although a number of samples were tested at different time intervals to follow the degradation, it is envisaged that the actual test procedure would involve only two viscosity measurements—one on the original sample and one at a standardized time after the enzyme was added. This will be discussed further in the next section.

RESULTS

Effect of dextran on dilute solution viscosity

The viscosity increase due to dextran can be characterized by the relative viscosity η_r

$$\eta_r = \eta/\eta_0 = t/t_0 \quad \text{.....(1)}$$

where η = viscosity of solution containing dextran
η_0 = viscosity of reference solution
t = time for a fixed volume of solution containing dextran to flow through capillary
t_0 = time for a fixed volume of reference solution to flow through capillary.

The reference solution was a solution of the same Brix but zero dextran; at the concentrations tested this was approximately the same as a solution of the same total solids but zero dextran. Tests showed that the above assumption was true within the limits of detection.

It may be shown that the relative viscosity is a function of both the dextran concentration and molecular weight. Greenfield & Geronimos[1] showed that the viscosity effects of dextrans could be predicted by equations of the form:

$$\eta_{sp} = k_{sp}\, c^{\alpha_{sp}} \quad \text{.....(2)}$$

or $$\ln(\eta_r) = k_r\, c^{\alpha_r} \quad \text{.....(3)}$$

where η_{sp} = specific viscosity = $\eta_r - 1$
c = concentration of dextran, g per decilitre
k_r, k_{sp}, α_r, α_{sp} = parameters which are functions of the average molecular weight of the dextran.

Figs. 2 and 3 show that the existing data can be fitted by similar expressions. The transformed data were fitted by least squares regression and estimates of the para-

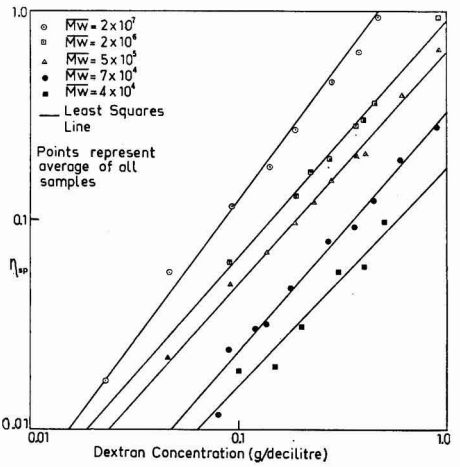

Fig. 2. Effect of dextran concentation on specific viscosity of dilute sugar solutions and juice samples (Equation 2)

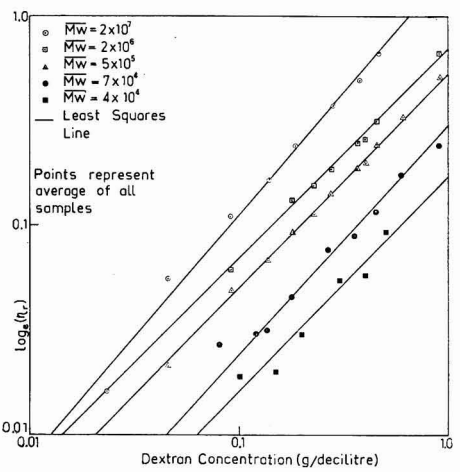

Fig. 3. Effect of dextran concentration on reduced viscosity of dilute sugar solutions and juice samples (Equation 3)

meters with measures of their reliability may be found in Tables I and II.

Table I. Prediction of equation parameters (Equation 2) by least squares regression
(Note: Concentration is expressed in g/decilitre solution)

Dextran Molecular Weight $\overline{MW}$	k_{sp}	95% Confidence Limits Lower Bound	95% Confidence Limits Upper Bound	α_{sp}	95% Confidence Limits Lower Bound	95% Confidence Limits Upper Bound	Correlation Coefficient
2×10^7	2·85	2·20	3·69	1·36	1·23	1·48	0·995
2×10^6	0·91	0·80	1·04	1·13	1·05	1·22	0·996
5×10^5	0·64	0·59	0·71	1·11	1·05	1·16	0·998
$6·99\times10^4$	0·33	0·24	0·45	1·14	0·96	1·32	0·978
4×10^4	0·18	0·10	0·31	1·05	0·69	1·41	0·971

Table II. Prediction of equation parameters (Equation 3) by least squares regression
(Note: Concentration is expressed in g/decilitre solution)

Dextran Molecular Weight $\overline{MW}$	k_r	95% Confidence Limits Lower Bound	95% Confidence Limits Upper Bound	α_r	95% Confidence Limits Lower Bound	95% Confidence Limits Upper Bound	Correlation Coefficient
2×10^7	1·66	1·38	1·99	1·17	1·09	1·26	0·997
2×10^6	0·70	0·65	0·74	1·01	0·97	1·06	0·999
5×10^5	0·53	0·50	0·57	1·03	0·99	1·07	0·999
$6·99\times10^4$	0·30	0·21	0·41	1·10	0·92	1·29	0·977
4×10^4	0·17	0·10	0·29	1·03	0·68	1·38	0·971

If the molecular weight dependence is taken into account explicitly, either of the two following expressions may be used to predict the viscosity increase due to dextran.

$$\eta_{sp} = k_1 \gamma^{k_2} c^{k_3} \quad \text{.....(4)}$$

$$\ln(\eta_r) = k'_1 \gamma^{k'_2} c^{k'_3} \quad \text{.....(5)}$$

where γ = weight average degree of polymerization
= $\overline{MW}$/(Molecular weight of polymer subunit)
= $\overline{MW}$/162.

The transformed data were fitted by multiple regression and the results are given in Table III. It is noticeable that Equations (4) and (5) are comparable to those found by Greenfield & Geronimos[1] for the prediction of viscosity increases in concentrated sugar and molasses solutions. Hence, a means exists for predicting viscosity increases to be expected in the later stages of processing. This will be discussed in a subsequent section.

Table III. Prediction of equation parameters (Equations 4 and 5) by least squares regression for effect of dextran on viscosity of dilute sugar solution and juice samples
(Note: Concentration is expressed in g/decilitre solution)

Equation	Parameter	Parameter Value	95% Confidence Limits Lower Bound	95% Confidence Limits Upper Bound	Multiple Correlation Coefficient
$\eta_{sp} = k_1\gamma^{k_2}c^{k_3}$ (Equation 4)	k_1	0·057	0·047	0·068	
	k_2	0·31	0·30	0·33	0·989
	k_3	1·21	1·18	1·24	
$\ln\gamma_r = k'_1\gamma^{k'_2}c^{k'_3}$ (Equation 5)	k'_1	0·058	0·050	0·067	
	k'_2	0·28	0·27	0·29	0·992
	k'_3	1·11	1·08	1·13	

Detection of dextran

The qualitative detection of dextran relies simply on observing a reduction in the time for a given quantity of solution to flow through the capillary after treatment with the enzyme dextranase. In Fig. 4 are shown typical plots of the change of viscosity with time for two different concentrations of enzyme. To detect dextran it is not necessary to produce the complete plot; it can be seen that after 10 minutes over 85% of the ultimate viscosity reduction has occurred. Hence it is suggested that, for a concentration of 0·12 I.U. per cm³ of solution, a reaction time of 10–15 minutes is sufficient. If a concentration is used so that the resultant enzyme activity is 0·015 I.U. per cm³ of solution, then 60 minutes should be allowed for reaction to occur. The important point to note is that the degradation is extremely rapid and any viscosity decrease will be observed almost immediately because of the rapid degradation of the high molecular weight components and because of their relative importance in influencing solution viscosity.

To determine quantitatively the level of dextran present requires an estimate of the average molecular weight of the dextran. This is not generally available without suitable experimentation which is time-consuming and rarely performed. Until more information becomes available in measurements of cane dextran molecular weight, it is suggested that some reasonable

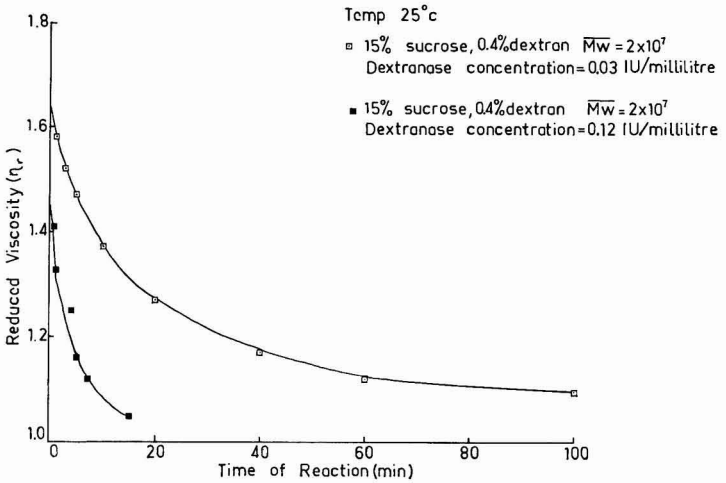

Fig. 4. Change in viscosity with time when dextranase is added to a sugar solution containing dextran

estimate be used. For the reasons advanced by Greenfield & Geronimos[1], a value of 2×10^7 will be used in the present analysis.

With such a value, Equations (4) and (5) become for cane dextran:

$$\eta_{sp} = 2{\cdot}2\, c^{1{\cdot}2} \quad \text{.....(4a)}$$

$$\ln(\eta_r) = 1{\cdot}5\, c^{1{\cdot}1} \quad \text{.....(5a)}$$

Rearrangement of Equations (4a) and (5a) and substitution from Equation (1) leads to two possible expressions for the concentration expressed in terms of time for flow of a fixed quantity of material through the capillary shown in Fig. 1:

$$c = [0{\cdot}45(t/t_0\text{-}1)]^{0{\cdot}83} \quad \text{.....(6)}$$

or

$$c = [0{\cdot}67\ln(t/t_0)]^{0{\cdot}91} \quad \text{.....(7)}$$

These equations are shown in the form of a nomograph in Fig. 5. As an example a change in flow time from 180 seconds to 170 seconds suggests a dextran level in the juice sample of approximately 0·05 g/decilitre or 500 ppm.

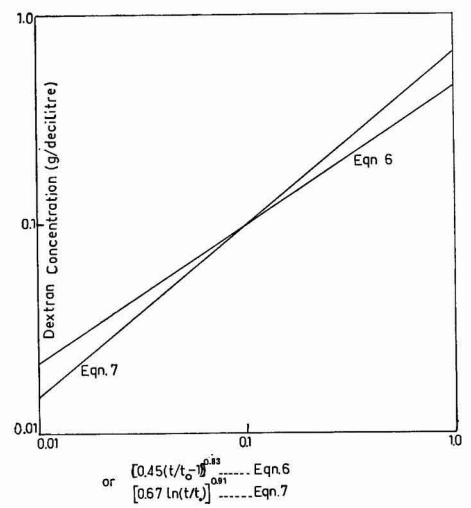

Fig. 5. Nomographs for determining dextran concentrations for dilute sugar solutions and juice samples (Equations 6 and 7)

It is suggested that, if the assumed molecular weight of the dextran is not regarded as reliable, curves of the type shown could be built up by more elaborate methods. One possibility is to use the "haze test" in conjunction with the above method to develop a relationship for viscosity and dextran concentration which can be used thereafter.

Prediction of viscosity effects during processing

Under certain assumptions, the information obtained concerning the dextran concentration in juice samples may be used to predict the viscosity increases to be expected during the later stages of processing. Without explicit knowledge of the dextran molecular weight an assumption must be made. If it is assumed that negligible further reaction takes place after the point where juice sampling occurs, then it seems reasonable to suggest that the average molecular weight remains constant. Hence, whatever value is assumed for the dilute samples is also suitable for use with the equations suggested by Greenfield & Geronimos[1] in the earlier paper. If 2×10^7 is assumed as a typical weight average molecular weight, the relative viscosity increase is given by either of the following equations:

$$\eta_{sp} = 2{\cdot}2\, c^{1{\cdot}2} \quad \text{.....(8)}$$

$$\ln(\eta_r) = 1{\cdot}1\, c^{0{\cdot}9} \quad \text{.....(9)}$$

It should be noted that c refers to the actual concentration of dextran in solution and any evaporation of water or addition of polymer must be taken into account in extrapolating from dilute solutions.

An example will be used to iilustrate the use of the equations. Following from the previous example, let us assume that the dextran level in the juice (20° Brix) is 500 ppm. Equation 8 suggests that at the stage of processing when the molasses reaches 80° Brix (the concentration of dextran is now approximately 2000 ppm), the viscosity of the molasses will be increased 1·3 times over the case when no dextran is present (under the assumption of an average molecular weight of 2×10^7). A decision can then be made on whether to treat the juice to degrade dextran.

A simplified scheme is also available. The reader can hardly have failed to note the similarity of Equations (8) and (9) to Equations (4a) and (5a), suggesting that the viscosity increases due to dextran are independent of the sucrose concentration. This is in agreement with the results of Greenfield & Geronimos. An alternative way of expressing this is to say that the increase in viscosity produced by dextran for low sucrose concentrations and for high sucrose concentrations can be predicted by identical equations. This was tested statistically by fitting all the data (i.e. from these experiments and those reported in the earlier paper) by Equations (4) and (5). The results are shown in Table IV where it is apparent that the above hypothesis is acceptable. This suggests that even if the exact form of the relationship between viscosity and concentration and molecular weight is not known, a given concentration of dextran in juice causes the same relative increase in viscosity as does that concentration in molasses. Of course the change in dextran concentration due to evaporation, etc. must be accounted for.

Table IV. Prediction of equation parameters (Equations 4 and 5) by least squares regression

(Note: Concentration is expressed in g/decilitre solution). Data base is from dilute sugar solutions, cane juice, concentrated sugar solutions and molasses

Equation	*Parameter*	*Parameter value*	95% *Confidence limits* *Lower bound*	*Upper bound*	*Multiple Correlation coefficient*
$\eta_{sp} = k_1\gamma^{k_2}c^{k_3}$ (*Equation* 4)	k_1	0·045	0·029	0·066	
	k_2	0·33	0·31	0·35	0·991
	k_3	1·19	1·15	1·23	
$\ln\eta_r = k'_1\gamma^{k'_2}c^{k'_3}$	k'_1	0·052	0·032	0·075	
	k'_2	0·26	0·24	0·28	0·988
	k'_3	0·96	0·92	1·00	

If it is assumed that the concentration dependence of relative viscosity is described satisfactorily by Equations (4) or (5), then this relationship can be written (for Equation 4) as:

$$\frac{\eta_{sp}^{HC}}{\eta_{sp}^{LC}} = \left(\frac{C^{HC}}{C^{LC}}\right) = \omega^{1{\cdot}2} \quad \text{.....(10)}$$

or

$$\frac{\ln\eta_r^{HC}}{\ln\eta_r^{LC}} = \frac{C^{HC}}{C^{LC}} = \omega \quad \text{.....(11)}$$

where ω = concentration change due to processing.

Since η_r^{LC} is given by t/t_0 and η_{sp}^{LC} is given by $(t/t_0\text{-}1)$, the relative increase in viscosity to be expected at a later stage of processing is given as a function of t,t_0 and the expected changes in concentration due to evaporation, etc. No value of the dextran molecular weight need be measured.

Alternatively, if both concentration and viscosity data are taken over a period of time it is possible to develop a graphical relationship which can be used to assess potential viscosity increases at any stage in the process. The viscosity data can be measured using a capillary viscometer while the modified "haze test" is used for estimating concentration.

Discussion

The enzymatic detection of dextran in dilute sugar solutions or juice samples has a number of potential applications.

(*i*) *Qualitative estimation of dextran concentration.* By using the simple capillary viscometer and dextranase, a change in the time of a given quantity of material to flow through the capillary is indicative of the presence of dextran. The greater the change, the more significant will be the future processing problems during the crystallization stages. Experience will allow a decision to be made on whether addition of dextranase to the process stream is necessary.

(*ii*) *Quantitative estimation of dextran concentration.* Equations (6) or (7) allow estimations to be made of the level of dextrans in cane juice subject to the assumption that the average molecular weight of cane dextran is approximately 2×10^7. When more is known about the typical molecular weights of cane dextran, these equations can be improved. Once the dextran concentration is known, processing problems can be assessed.

(*iii*) *Quantitative prediction of molasses viscosity.* Under the assumption that the average molecular weight of dextran in cane juice is the same as that in molasses (i.e. degradation after crushing is relatively insignificant), Equations (10) or (11) predict directly molasses viscosity as evaporation proceeds.

It should be noted that the above techniques predict the relative increase in viscosity due to dextran; they do not predict the absolute viscosity of the solutions. It is necessary, therefore, that information be available on the viscosity of the dextran-free molasses. Greenfield & Geronimos have shown that the relative increase in viscosity of molasses is independent of temperature and other dissolved compounds.

The advantages of the present technique lie in its simplicity and low cost and in its ability to account for the effects of both concentration and molecular weight of dextran. It is recommended that juice samples be filtered before testing.

It is planned to use the test in a series of mill trials; additionally it is planned to measure dextran concentrations in cane before crushing by extracting and testing some of the juice. The technique has potential for detecting deteriorated cane before crushing commences; hence, poor batches may be separated.

There are a number of disadvantages with the viscosity technique. The method is not absolute and requires certain assumptions to be made. It cannot detect very low levels of low molecular weight dextran and gives an indication of the presence of other polysaccharides. Additionally, the effect of shear rate on apparent viscosity is not considered. For highly non-Newtonian solutions, this may be significant.

Conclusions

Dextran may be detected in cane juice by measuring the change in viscosity of a juice sample after addition of the enzyme dextranase. A capillary viscometer is used to measure the juice viscosity with the time of flow directly related to the viscosity. If the average molecular weight of cane dextran is assumed to be 2×10^7, then the following expressions may be used to estimate the level of dextran in cane juice in g/decilitre.

$$c = [0{\cdot}45(t/t_0\text{-}1)]^{0{\cdot}83}$$

or

$$c = [0{\cdot}67\ln(t/t_0)]^{0{\cdot}91}$$

Alternatively, the test may be used merely to indicate the presence of dextran at concentrations which will cause processing problems.

Acknowledgments

The financial assistance of the Bureau of Sugar Experiment Stations and the Sugar Research Institute is appreciated.

Summary

The basis of a relatively inexpensive and simple means of detecting dextran in juice samples is described. The technique is based on measuring the difference in times for flow of a given quantity of juice through a capillary before and after addition of the enzyme dextranase. If dextrans are present the time difference is significant.

Additionally it is shown that the viscosity increases which are measured in dilute solutions can be used to predict viscosity increases for concentrated sugar and molasses solutions.

Une technique enzymatique pour la détection du dextrane dans le jus de canne et la prédiction des accroissements de viscosité

Le principe d'un moyen relativement peu couteux et simple, pour la détection du dextrane dans les échantillons de jus, est décrit. La technique est basée sur la mesure de la différence des temps d'écoulement d'une quantité donnée de jus à travers un capillaire avant et après l'addition de l'enzyme dextranase. S'il y a présence de dextranase, la différence de temps est significative. En plus, il est démontré que les accroissements de viscosité, mesurés sur des solutions diluées, peuvent être utilisés pour la prédiction des accroissements de viscosité dans les solutions sucrées concentrées et dans la mélasse.

Eine enzymatische Methode für den Nachweis von Dextran im Rohrsaft und für die Voraussage von Viskositätszunahmen

Eine relativ billige und einfache Methode für den Nachweis von Dextran in Saftproben wird beschrieben. Das Verfahren beruht auf der Messung der Durchflussdauer einer bestimmten Saftmenge durch ein Kapillarrohr vor und nach der Dextranase-Zugabe. Bei Vorhandensein von Dextranen ist der Zeitunterschied bedeutend. Ausserdem wird gezeigt, dass der Visko-

An enzymatic technique for the detection of dextran in cane juice and prediction of viscosity increases

sitätsanstieg in verdünnten Lösungen dazu benutzt werden kann, die Viskositätszunahme in konzentrierten Zucker- und Melasselösungen vorauszusagen.

Una técnica enzimática para la detección de dextrano en jugo de caña y predicción de aumentos de viscosidad

Se describe el base de un método bastante barato y sencillo para percibir dextrano en muestras de jugo. La técnica se base en medición de la diferencia en tiempo para flujo por un tubo capilar de las mismas cantidades de jugo antes y después de adición del enzima dextranasa. Si hay dextranos en el jugo, la diferencia es significativa. Además, es demostrado que los aumentos de viscosidad medidas en soluciones diluidas pueden usarse para predecir aumentos de viscosidad en soluciones concentradas de azúcar y de melaza. □

Estimating sugar cane damage from regional freeze night temperature measurements

PAUL R. NIXON*, DALE E. PHINNEY† and MANUEL R. GAUTREAUX‡
(Soil, Water and Air Sciences, Southern Region, Science and Education Administration, USDA, and the Texas A & M Agricultural Research and Extension Center, Weslaco, Texas, USA)

SUGAR cane growers are greatly concerned about cold night temperatures because of the possibility of cane damage from subfreezing conditions. Damage is most likely during clear, calm nights, when a high pressure system follows cold front passage, and radiational cooling lowers plant temperatures below critical levels. Such conditions prevailed in the Lower Rio Grande Valley (LRGV) of Texas on the night of 20th-21st December 1973. Freezing temperatures were reached long before dawn at all locations and remained long enough to cause freeze damage to nearly all unharvested sugar cane.

Using data from this event, this paper addresses the question: Can the relative magnitudes of freeze damage be estimated, field by field, from temperature measurements made during the freeze night? If this is possible, a method free of human bias is available for rescheduling harvesting operations after a freeze so as to minimize loss from sugar cane deterioration.

The setting

Fig. 1 shows the sugar cane growing portion of the LRGV. The cane fields are usually not concentrated; rather they are scattered throughout the agricultural portions of the extensive flood plain of the Rio Grande River. Lack of topographical relief precludes the establishment of well-defined nocturnal cold air drainage patterns. Temperatures are influenced by the proximity of the warm water of the Gulf of Mexico and from smaller bodies of water within the area. Also contributing is surface air drift, which varies in direction and velocity depending upon prevailing conditions. Significant in local temperatures is the soil moisture status and the extent and type of vegetative cover. During the 1973 freeze, the very dry soil of the LRGV (except for a few recently irrigated fields and groves) contributed to the severity of the freeze.

Nearly all fields after the freeze had time-dependent deterioration of cane. Similar sugar content decreases after a hard freeze have been observed by many others[1]. An attempt was made to minimize sugar loss in the LRGV by rescheduling the order in which fields were harvested according to the extent of deterioration shown by laboratory analyses of sugar cane samples. This cooperative effort by the USDA, Texas A & M Agricultural Experiment Station, and the Rio Grande Valley Sugar Growers Association is credited with partially limiting the freeze loss. Difficulties with this approach are the requirements of adequate field sampling and the laboratory time involved.

Analysis approach

In this paper, mill records of recovered sugar of the harvested sugar cane are compared with temperature measurements made on the night of the freeze. These records of % recoverable sugar on an operational scale are considered to be the most practical indicator of freeze damage. Comparison of yield weights would be more confounded by management practices during the season and by other factors, such as site fertility. In this study, we examined 45 fields of 16·2 ha (40 acres) or larger of N:Co 310 cane. This variety, the most widely grown in the LRGV, is late-maturing; the freeze occurred before maturity, and maximum sugar contents had not yet been reached.

Temperature criteria

We estimated freeze-night temperatures at each of the fields using four different criteria: (1) minimum air temperature, (2) degree-hours of below-freezing air temperature, (3) surface temperature, indicated by satellite from the evening overpass (2107 CST), and (4) estimated surface temperature at dawn, determined by adjusting satellite data.

With each of the respective criteria, we divided the fields into three temperature classes (cold, tepid, warm) of 15 fields each. The temperature ranges of the fields in each classification are listed in Table I. Details of the temperature criteria are given below. Interpolated temperature determinations were computer-estimated, using the latitude and longitude locations of the sugar cane fields and the weather stations.

* Agricultural Engineer, USDA, Weslaco, Texas.
† Principal Scientist, Lockheed Electronics Co., Houston, Texas.
‡ System Analyst, Texas A. & M. Agric. Expt. Sta., Weslaco, Texas.

[1] Miller & Gascho: *Proc. Amer. Soc. Sugar Cane Tech.*, 1974, 36–41.

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Table I. Range of temperatures in N:Co 310 sugar cane fields [16·2 ha (40 acres) or larger] during the night of 20th-21st December 1973, in the Lower Rio Grande Valley, Texas

	Temperature, by four criteria			
	Min.air	*Degree-hour*	*Surface (by satellite)*	*Adjusted satellite*
	°C			
Cold fields	—6·6 to —5·5	40 to 27	—4·8 to —0·8	—12·4 to —7·8
Tepid fields	—5·5 to —4·4	27 to 20	—0·7 to +0·8	—7·6 to —6·3
Warm fields	—4·4 to —3·8	20 to 17	+0·8 to +4·9	—6·3 to —1·8

Degree-hours. The summation, hour by hour throughout the freezing period, of the number of degrees Celsius that air temperature was below freezing supplied the degree-hours. This information was obtained for each field location by interpolating data from the four nearest weather stations in a manner similar to that used for

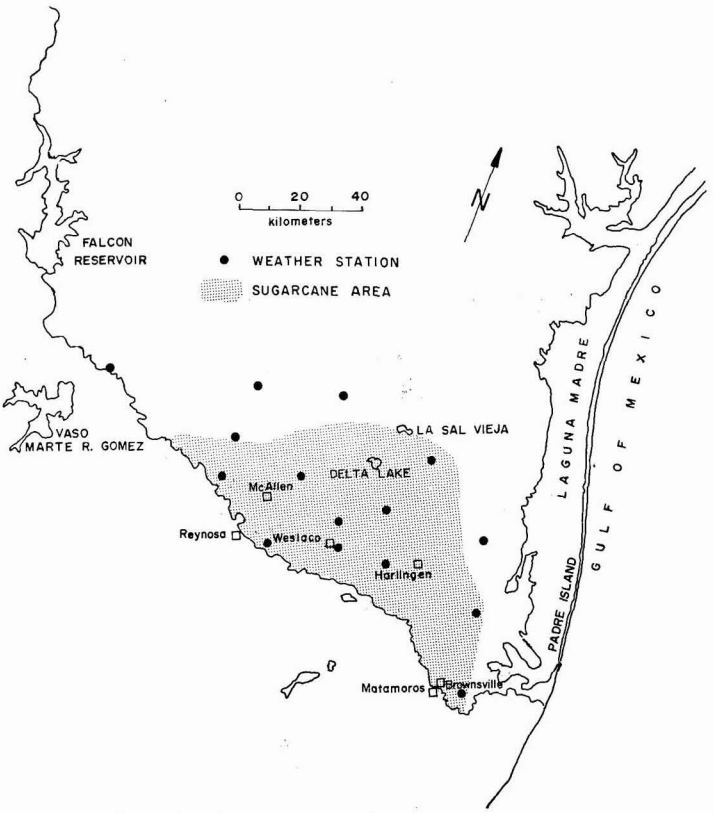


Fig. 1. Locations of weather stations in respect to the sugar cane growing area of the Lower Rio Grande Valley, Texas.

Minimum air temperature. The minimum air temperatures in each field were estimated by interpolating data from the four weather stations operated cooperatively by the National Weather Service nearest to the field. The weather station minimum temperatures were weighted according to the inverse of their distance from the fields. Four stations were used in estimating the field temperature so as to limit using stations only on a cold (or warm) side of a field and to reduce the influence of an atypical weather station location.

This approach gave a relatively small range of minimum temperatures of 2·8°C among the sugar cane field locations (Table I). A similar temperature range (0·1°C higher) was measured at the 10 weather stations within the cane growing area (shaded area, Fig. 1). Table I shows that the temperature range of the 15 coldest fields was about twice that of the 15 warmest fields (1·1° *vs.* 0·6°C).

determining minimum air temperatures. Thermograph records from the stations showed the customary lower temperature trend throughout the night; however, some stations had periods of fluctuating temperature during the night. Since these irregularities did not fit a regional pattern, local influences were suggested. To avoid imposing local irregularities on fields some distance from the weather stations, the degree-hours determined for the fields were based on smoothed temperature decreases to the minimum values[2].

The accumulated freeze effect, expressed in degree-hours, was more than twice as great for the coldest field as for the warmest field (Table I). The degree-hours of the 15 tepid fields ranged about twice that for the 15 warm fields. Similarly, the range of degree-hours observed in the cold fields was twice that of the tepid fields, or about four times that of the warm fields.

Estimating sugar cane damage from regional freeze night temperature measurements

Satellite-indicated surface temperatures. Current and forthcoming generations of earth-orbiting satellites, equipped with high resolution thermal scanners, are greatly increasing the practicality of obtaining land surface temperatures over large areas. In this study to estimate surface temperatures at sugar cane field locations, we used very high resolution thermal infrared (10·5 to 12·5 μm) data from the NOAA-2 satellite in polar orbit, 1450 km above the earth, that orbited the earth twice daily[3]. The night time pass at 2107 hr CST, 20th December 1973, supplied the information discussed here[4]. Fig. 2 is a representation of the variations in night time surface temperature of a part of the test area (about 90 × 140 km) shown in Fig. 1. It is a photograph of the cathode ray tube of an interpretation system upon which the satellite data image was displayed. Warm areas appear lighter and cold areas darker. On the right side of the figure, the warm water of Laguna Madre forms a "ridge" between the colder areas of Padre Island and the mainland.

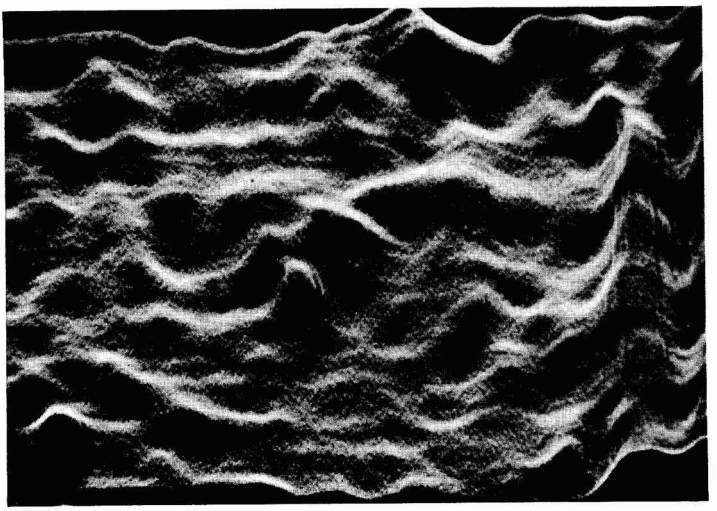


Fig. 2. Representation of surface temperatures of a portion of the Lower Rio Grande Valley at 2107 CST hours, 20th December 1973. Warm areas are represented as lighter spots and cold areas are darker. The illustration was prepared from electronic display of satellite-derived data.

Digitized satellite data registered to a 1:250,000 base map were interrogated by computer to determine the surface temperatures of cane field locations. The temperature was calculated for the centre of each field by linear interpolation from the nearest 4 pixels (satellite data points, each representing an area of about 0·8 km² at nadir).

Table I shows that the surface temperatures varied over a range of 9·7°C with the 15 tepid fields all falling within a 1·5°C range straddling zero degrees.

Adjusted satellite surface temperatures. We attempted to estimate minimum surface temperatures attained at dawn by assuming that the surface temperature decreases after the evening satellite overpass were of the same magnitude as the air temperature decreases during the same period. The satellite-determined surface temperature of each field was adjusted by interpolation of air temperature decreases from the four nearest weather stations, in the same manner previously described for minimum air temperature interpolations. The data on air temperature decrease were available through the cooperation of the weather observers who read the air temperatures at their stations at the time of the satellite overpass and also recorded the minimum air temperatures that were reached.

The interpolated decreases in air temperature were about 7°C during the approximately 10 hours after the satellite overpass. Table I shows that application of these adjustments to the satellite data compressed the temperature range of tepid fields and expanded the temperature ranges of the cold and warm fields.

Recoverable sugar

Fig. 3 shows recovered sugar of factory-milled N:Co 310 sugar cane in relation to harvest dates. The general downward trend of recoverable sugar with time after the December freeze is apparent. The decrease would have been even more pronounced if the fields had been harvested at random, rather than by a schedule that attempted to harvest the more seriously affected fields first. Without the freeze, this late-maturing variety would have increased in sugar content during most of the period[5].

In this study, the time-dependent change of recoverable sugar was considered when classifying the fields according to their relative amounts of recoverable sugar. The classification was made by comparing the deviation of individual fields from the second-degree polynomial curve that best fits the data from all 45 fields (Fig. 3). The 15 fields with the greatest positive deviation were designated as high sugar content; similarly the 15 fields with most negative deviation were called low sugar content. The remaining 15 fields, which occupied a narrow band along the best-fit curve, were considered to be of medium recoverable sugar.

In Fig. 3, we also show the freeze-night temperature classifications into which the fields fell according to the surface temperature criterion. Warm fields, as identified by satellite, are shown by upward pointing arrows and cold fields by downward pointing arrows. Data points without arrows were classified as tepid fields.

[2] Nixon: 1974. "Unit thermograph for minimum temperature prediction". (Agricultural Research Service, Weslaco, Texas). Unpublished report. 3 pp.

[3] Schwalb: "Modified version of the improved TIROS operational satellite (ITOS D-G)". *NOAA Tech. Mem. NESS* 35. (Nat. Oceanic and Atmos. Admin., Washington, D.C.) 1972.

[4] Nixon, Phinney, Arp & Wiegand: *J. Rio Grande Valley Hort. Soc.*, 1974, **28**, 86–90.

[5] Fuchs, Gerard, Reeves & Sund: *Research Center Tech. Rpt.* (Texas A. & M. University Agricultural Research and Extension Center, Weslaco, Texas), 1973, (73–6).

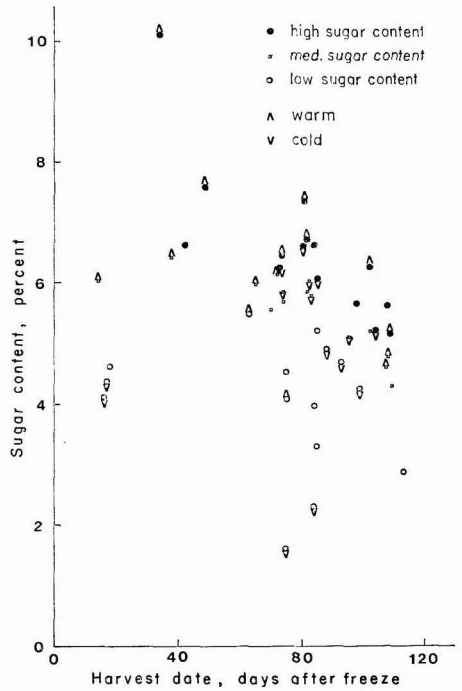


Fig. 3. Factory-recovered sugar from N:Co 310 fields of 16·2 ha or larger, with respect to time since freeze. Fields identified by satellite as warmest on the freeze night are shown by upward pointing arrows, and coldest fields by downward pointing arrows. Data points without arrows are from tepid fields.

Table II shows the relationship between post-freeze recoverable sugar and freeze-night temperatures at sugar cane field locations by showing the number of fields that fell in each combined class of sugar content and temperature. Analyses of each temperature criterion were made separately, with 15 fields in each temperature and each sugar content class. The table gives the results for each of the four temperature criteria that were investigated.

If the only factor affecting recoverable sugar had been freeze night temperatures and the temperature criteria were adequate, all 15 of the coldest fields would have had low recoverable sugar. Similarly, the medium and high-recoverable sugar fields would be perfectly matched with their respective temperature classifications. The data of Table II showed this tendency, indicating an interdependence between recoverable sugar and freeze night temperatures.

Table II shows the results were similar on a basis of minimum air temperature and degree-hour criteria; however the same fields did not aways fall within a given sugar *vs.* temperature category. Classification of individual fields by minimum air temperature and by degree-hours did not agree in 8 out of 45 cases. Similarly, classifications by surface temperature and adjusted satellite criteria differed for certain fields.

Further evidence of a relationship between post-freeze recoverable sugar and freeze-night temperatures is given in Fig. 4. This illustration, based on adjusted satellite temperatures, shows the best-fit second degree polynomial curve for the 15 fields falling into each temperature range. Fields identified as warm yielded about one-third more sugar than fields identified as cold.

For a period after the freeze date, recoverable sugar increased as shown by the cold and tepid curves in Fig. 4. This trend was also present in some of the best-fit curves obtained with the other temperature criteria. This is attributable mainly to the scheduled order of field harvesting that was practised in the attempt to minimize freeze loss. However, recovery after a freeze, even if only partial and temporary, was noted by Gowing[6] and Irvine & Legendre[7]. The curve shapes were greatly

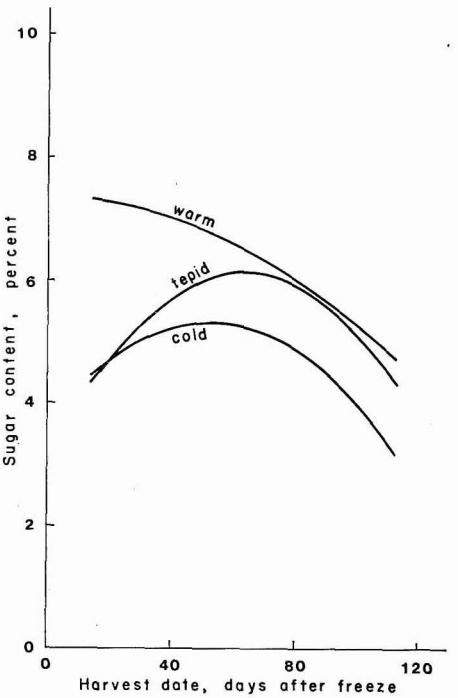


Fig. 4. Best-fit curves of yields from fields that were classified according to temperature by adjusted satellite data.

[6] *I.S.J.*, 1975, **77**, 326–329.
[7] *Agric. Research*, 1977, **25**, (8), 15.

Table II. Relationship of post-freeze recoverable sugar to freeze-night temperatures at 45 fields of N:Co 310 of 16·2 ha (40 acres) or larger. The entries show the number of fields falling in each classification

	Temperature, by four criteria											
Sugar	*— Minimum air —*			*— Degree-hour —*			*—Surface (by satellite)—*			*—Adjusted satellite—*		
content	*Cold*	*Tepid*	*Warm*	*Cold*	*Tepid*	*Warm*	*Cold*	*Tepid*	*Warm*	*Cold*	*Tepid*	*Warm*
Low.....	6	5	4	6	5	4	7	6	2	8	4	3
Medium	7	3	5	7	3	5	4	5	6	5	4	6
High ...	2	7	6	2	7	6	4	4	7	2	7	6

influenced by the three low-sugar content fields that were harvested 16 to 18 days after the freeze (Fig. 3). Had harvesting of these seriously damaged fields been delayed, the yield would have been very low, probably uneconomical to harvest. The result would have been curves that sloped continuously downward to the right.

The average mill-processed recoverable sugar of each temperature range is shown in Table III for the four temperature criteria investigated in this study. These average values for the post-freeze harvest period were obtained from best-fit curves, like those in Fig. 4 for the adjusted satellite criterion. The data of the table are further indication of the possibility of separating sugar cane fields according to degree of freeze damage using freeze-night temperature measurements.

Table III. Average recoverable sugar of N:Co 310 fields determined by best-fit curves representing three temperature classifications for each of four temperature criteria. The average sugar contents are for the period of 14–113 days after the December 1973 freeze

	Temperature criteria			
	Min. air	*Degree-hour*	*Surface (by satellite)*	*Adjusted satellite*
	% *sugar*			
Cold fields	5·3	5·3	4·8	4·7
Tepid fields	5·0	6·0	5·2	5·5
Warm fields	6·3	6·2	6·4	6·3

According to the t-test made on data from the individual fields, the correlations between freeze-night temperature and recoverable sugar were significant at the following levels:

Minimum air temperature	30%
Degree-hour	50%
Satellite-indicated surface temperature...	10%
Adjusted satellite surface temperature	1%

The F-ratio was significant at the 5% level for the multiple correlation of harvest dates and satellite-sensed temperatures with recoverable sugar; and 1% when adjusted satellite temperatures were used.

The latter low probabilities that the results were due to chance variations alone support the applicability of the satellite approach. It was likely that the higher probabilities of chance associated with the air temperature measurements were related to inadequate sampling of air temperatures—an indication that the weather station network was too sparse for this application.

Discussion and conclusions

The analysis made here is a rigorous test of the use of freeze-night temperatures for estimating sugar cane freeze damage. The following factors worked against obtaining good results: (1) the deliberate attempt to offset freeze effects by rescheduling the harvesting order of the fields masked more pronounced results that would have come from randomized harvesting order, (2) weather stations were too few and too poorly distributed geographically with respect to the sugar cane fields, (3) the satellite overpass occurred about 10 hours before the minimum temperature which was too early for observation of fully-established nocturnal temperature patterns, (4) most of the sugar cane fields were smaller in size than the satellite resolution elements, and (5) other factors not related to the freeze (such as management during the growing season) also influenced recoverable sugar, the basis of these comparisons.

Despite these limiting conditions, good relationships existed between the regional freeze-night temperature measurements and the recovered sugar of the subsequent harvest. The nature of these conditions obscured, or worked counter to, the temperature relationship. However, that these relationships did persist under the circumstances suggests that temperature measurements on a freeze night can be useful in estimating the relative degree of freeze damage in individual fields and serve as a guide in rescheduling harvest operations so as to minimize loss from post-freeze deterioration.

From the data presented here the application of satellite data seems to be especially promising because of the statistically significant relationship with recoverable sugar. Better estimates of surface temperatures will be possible with future satellites that have overpasses timed closer to the occurrence of minimum temperatures and have better resolution (e.g. The Heat Capacity Mapping Mission satellite scheduled for launch in 1978 will overpass at about 0230 local time with a nadir resolution of 0·6×0·6 km). Thermal data from the NOAA satellite is presently available as magnetic tape from the National Climatic Center within a few days of the overpass. It is hoped that data from future thermal satellites will be available even more promptly.

A presently available alternative source of surface temperature information that could be explored is the use of an aircraft-mounted thermal scanner. The resulting thermal images or digital data would contain more detail than the best satellite data. Sutherland & Bartholic[8] have demonstrated the possibility of using a thermal scanner in freeze studies in a citrus-growing area of Florida. A drawback of the thermal scanner is that essentially instantaneous coverage of a large agricultural area is not possible. However, conditions are ideal on clear cold winter nights for high altitiude thermal scanner flights covering swaths of land many kilometres wide.

Possibly the most important contribution of satellite-derived surface temperature information will be in identifying areas of repeatedly low freeze hazard for planting temperature-sensitive crops. Surface temperature maps can be routinely prepared from digital satellite data using computer facilities. Computer programmes are available to register satellite data to a base map scale. Using symbols the computer can show areas of warmest and coldest temperatures (correcting if necessary for differences in surface emissivity). The authors are currently studying such maps from several cold nights for recurrence of warm and cold locations.

Acknowledgment

We gratefully acknowledge the help of Kenneth A. Sund during the development stage of this investigation. Thanks are also due to the Rio Grande Valley Sugar Growers Inc. and to the U.S. Weather Service for making their records available, to C. M. Barnes of the National Aeronautics and Space Administration for help in acquiring and processing of satellite radiometric data; and to the 16 cooperative weather observers, who gratuitously made air temperature measurements at the time of the satellite overpass.

Summary

A computer-based statistical study was made of the effects of minimum air temperatures, degree-hours of below freezing air temperatures, evening surface temperatures measured by orbiting satellite, and dawn

[8] *Proc. Florida State Hort. Soc.*, 1974, **87**, 65–69.

surface temperature obtained by adjustment of the satellite data. The measurements and estimations were compared for a period of freezing temperatures in December 1973 with the damage to cane recorded during the subsequent three months. Significant correlations were obtained between damage and satellite-indicated surface temperatures; satellite data may thus be used to identify fields which are likely to have suffered damage and so permit re-scheduling of harvest to minimize sugar loss. Satellite-derived temperature data can be used to identify areas down to 600 m × 600 m which are particularly vulnerable to low temperatures and should not be used for sensitive crops.

L'estimation des dégâts occasionnés à la canne par les gelées nocturnes régionales

Une étude statistique a été effectuée sur ordinateur concernant les effets des températures minimales de l'air, les degrés-heures des températures de l'air inférieures à zéro, les températures de surface le soir, mesurées par satellite sur orbite et les températures de surface au matin par ajustage des données fournies par la satellite. Les mesures et estimations ont été comparées, pour une période de gel en décembre 1973, avec les dégâts à la canne enregistrés au cours des trois mois suivants. Des corrélations significatives ont été obtenues entre les dégâts à la canne et les températures de surface mesurées par la satellite; des données fournies par satellite peuvent ainsi être utilisées pour identifier les champs qui sont susceptibles d'avoir subi des dégâts et permettre une autre programmation de la récolte pour minimiser la perte en sucre. Les données de température obtenues par satellite peuvent être utilisées pour identifier des superficies aussi petites que 600 m × 600 m qui sont particulièrement vulnérables aux basses températures et qui ne devraient pas être destinées à des cultures sensibles.

Schätzung der Schäden an Zuckerrohr durch lokale Nachtfröste

Mit EDV wurde eine statistische Studie durchgeführt über die Wirkung von Minimum-Lufttemperaturen, Froststunden, Abend-Oberflächentemperaturen, gemessen von einem Umlauf-Satelliten, und Tagesanbruch-Temperaturen, erstellt nach Satelitten-Unterlagen. Die Messungen und Schätzungen wurden während einer Periode mit Frost-Temperaturen im Dezember 1973 mit den am Rohr in den folgenden drei Monaten festgestellten Schäden verglichen. Man erhielt signifikante Korrelationen zwischen Rohr-Schädigung und vom Satelliten stammenden Oberflächentemperatur-Unterlagen; Satelliten-Unterlagen können also benutzt werden, um Felder zu identifizieren, die wahrscheinlich Schäden erlitten haben, so dass die Ernte neu geplant und die Zuckerverluste minimiert werden können. Vom Satelliten stammende Temperatur-Unterlagen können benutzt werden, um Anbaugebiete ab 600 m × 600 m zu identifizieren, in denen besonders niedrige Temperaturen auftreten, und auf denen empfindliche Rohrsorten nicht angebaut werden sollten.

Estimación de daño a caña de azúcar de temperaturas regionales de noches de helado

Se ha hecho por computador un estudio estatístico sobre los efectos de temperaturas ambientes mínimas, grado-horas de temperaturas ambientes abajo del punto, de congelación, temperaturas del sobreficie en la tarde medido por satélite orbital, y temperaturas del sobreficie al alba obtenido por ajuste de los dados del satélite. Se han comparado las medidas y estimaciones para un período de temperaturas abajo de 0°C en diciembre de 1973 con el daño a caña registrado durante los tres meses después. Corelaciones significativas se han obtenido entre el daño y las temperaturas superficiales indicado por satélite; dados obtenido por uso del satélite pueden usarse para identificar campos donde es probable que daño ocurrirá y por éste permitirán re-proyectar el corte para reducir les pérdidas al mínimo. Temperaturas derivado de un satélite pueden usarse para identificar áreas hasta 600 m × 600 m que estan especialmente vulnerables a temperaturas bajas y no deben usarse para cosechas sensitivas. □

The 29th UK National Sugar Beet Spring Demonstration, 1978

THE 29th UK National Sugar Beet Spring Demonstration was held at Brome, near Eye, Suffolk on 24th May 1978. The site comprised parts of two farms operated by C. A. West & Son; 70 ha were planted to beet for the event. The soil varies from light sandy to medium heavy loams. In the autumn of 1977 a mixture of P_2O_5, K_2O, Mg salt and B had been applied, while a 4:1:3: N:P:K compound was applied in the spring of this year at the rate of 690 kg.ha^{-1}, the quantity of N applied (138 kg.ha^{-1}) slightly exceeding the recommended amount, as all the beet tops are to be used as animal fodder. "Avadex" and "Pyramin" as a tank mix were incorporated in the seedbed and the crop sown on 30th March–5th April by members of the British Sugar Corporation Holmewood Hall field station, using a 15-row precision drill at a row width of 50·8 cm and a seed spacing of 18·3 cm. Granular soil pesticides "Temik" or "Decamox" were applied in the seed furrows of about half of the beet area. It was intended to apply post-emergence herbicides with a 15-row band sprayer, followed by a soil-incorporated herbicide "Treflan" where late-germinating weeds were expected. A 6·5 ha trial field was prepared and drilled by the agricultural staff of Ipswich sugar factory using a 5-row drill.

On 31st March drill manufacturers were invited to sow pelleted monogerm seed at 4 forward speeds (2, 3, 4 and 5 miles.hr^{-1}) and a target seed spacing of 15 cm in a special plot with the aim of allowing assessment of the performances of drills currently available to UK beet farmers. Results were recorded on 8th–9th May and were presented at the Demonstration in the form of block diagrams for 11 drills, showing the percentage of spaces against the space between plants for each target speed.

Apart from static exhibitions of machinery in the open, there were a number of research station exhibits in the main exhibition marquee which also housed stands representing various official organizations and manufacturers of, mostly, agricultural chemicals.

On the day of the Demonstration, a very cold, dry wind was blowing at sufficient speed to raise dust from the top crust of soil and create some discomfort for

onlookers at the various demonstration plots. The adverse weather conditions of last spring, with lower temperatures than normal, frequent cold winds and above-average rainfalls, had had an adverse effect on beet growth, which has been retarded by some 2-3 weeks. In fact, at the Demonstration, the beet plants in many cases were only just visible.

Apart from a large number of tractor hoes, 12 precision drills were demonstrated. The National Institute of Agricultural Engineering experimental unit (shown in Figs. 1 and 2) attracted wide interest. One of the most interesting units was that of Broom's Barn Experimental Station shown in Fig. 3; this is a pneumatically-operated 5-row precision drill with provision for application of nitrogen prills on each side of the row press wheel, which permits N to be applied simultaneously with drilling instead of the normal practice of application some two weeks after drilling (to avoid scorching).

Granule applicators and straw planters (for prevention of wind blowing of beet rows) were demonstrated, as were a number of crop sprayers. Figs. 4 and 5 show a W.F. Engineering 11-row sprayer, while a 15-row band sprayer with hydraulic lifting and folding of the front-mounted frame, manufactured by the same firm, is shown in Fig. 6.

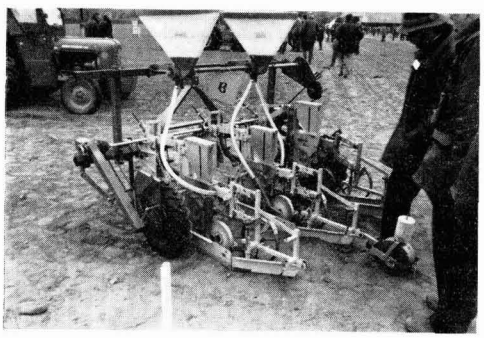


Fig. 1. NIAE experimental drill

Fig. 2. NIAE experimental drill

Fig 3. Brom's Barn experimental precision drill plus N applicator

Fig. 4. Inter-row 11-row crop sprayer, W.F. Engineering

Fig. 5. 11-row crop sprayer

Fig. 6. 15-row band sprayer, hydraulic folding

It was announced at the Demonstration press conference that the British Sugar Corporation had contracted with growers for an area of 209,150 ha for the 1978/79 campaign. □

SUGAR CANE AGRONOMY

Putting into commercial practice—tissue test technique. S. V. Parthasarathy and B. Krishnan. *Sugar News* (India), 1977, **9**, (3), 19-24.—The value of leaf sheath moisture and leaf blade nitrogen determination as guides to cane growth and maturity is discussed, and the possibility of increasing the sugar content by reducing the moisture and nitrogen contents to below 73-74% and 1%, respectively, examined. Reference is made to work done in Hawaii in respect of improving the physiological status of the crop and introducing new varieties, and the author points to the need for the Indian cane sugar industry to adopt a similar approach.

Soil physical and chemical factors affecting growth of sugar cane roots. R. L. Narasimham. *Indian Sugar*, 1977, **27**, 79-81.—The effects of soil structure, surface crusting, temperature, oxygen supply, waterlogging and drainage on cane root growth are discussed, as are soil pH, salinity and alkalinity, fertilization and root cation exchange capacity. The adverse effect of nematodes is also noted.

Intercropping cereals in sugar cane. S. H. Gawhane and R. S. Patil. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 1-Ag. 10.—See *I.S.J.*, 1977, **79**, 223.

Effect of harvesting dates on the yield and quality of plant and ratoon crops of sugar cane. P. P. Singh. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 11-Ag. 16.—In north India, cane harvesting takes place at any date within the period November-May. A field experiment was carried out in 1971-72 and 1972-73 to determine the effect of harvesting date on the performance of plant and ratoon crops. Results, which are tabulated, showed that there was little effect on plant cane yield up to 30th January, after which there was a steady fall with time. On the other hand, the highest sugar contents occurred in cane harvested in the period 28th February-15th April, maximum sugar yield being obtained on 30th December. Harvesting date had little effect on ratoon cane yield after plant cane harvesting in the October-March period, but cane and sugar yield fell when the plant cane had been harvested in April-May.

Response of sugar cane to row spacing and nitrogen in the Tarai tract of Uttar Pradesh. R. S. Dixit and J. S. Saroj. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 17-Ag. 19.—In trials on a well-drained sandy loam conducted in 1970-71 and 1971-72, the effects of row spacing and nitrogen fertilization on cane yield and quality were determined and the results tabulated. Highest cane yield was obtained at a row spacing of 90 cm by comparison with 75 and 112·5 cm and at a nitrogen dosage rate of 150 by comparison with 90 and 210 kg.ha^{-1}. Highest juice sucrose content and purity were obtained at the smallest row spacing and N application rate, but the yield was considerably lower than at 90 cm and 150 kg.ha^{-1} N, which proved to be the most profitable.

Weed control—some important considerations. D. G. Dakshindas. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 49-Ag. 55.—The harmful effects of weeds on crops are discussed and developments in chemical control examined. The author stresses the need for more research into various aspects of the subject, including means of increasing herbicide effectiveness. The problems on a national scale, created by certain specific weeds, also require greater concentration.

Intercropping of potato in sugar cane. D. G. Dakshindas. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), Ag. 57-Ag. 61.—Requirements of a plant suitable for intercropping with cane are listed, and the advantages of a new variety of early-maturing potato in respect of growth habit and lack of competition with cane are indicated. Trials conducted at four locations in 1974-75 are reported in which potatoes were planted very shortly after cane. Potato yields varied from 91 to 183 quintals.ha^{-1} after a crop duration of 84-94 days, while no adverse effect on cane was observed (although full results would be available only later). The economics are briefly considered.

Plant population studies in sugar cane. S. Shanmugasundaram *et al.* *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 1-Ag. 4.—In trials with three commercial varieties, increase in the seed rate (20, 30, 40, 60 and 80 3-budded setts per row) was accompanied by a fall in % germination 30 and 45 days after planting. On the other hand, the number of millable canes per plot rose with seed rate, but since stalk girth fell with increased seed rate, the final cane yield was unaffected; sugar yield was also unaffected by seed rate, but fell with a 100% increase in the amount of 2:1:1 N:P:K: applied.

Green manuring in standing sugar cane with summer legumes—a profitable practice. M. L. Agarwal, S. K. Ojha and Z. A. Khan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 5-Ag. 12.—Legumes are important as green manure crops because of their nitrogen fixation property through the activity of *Rhizobium* bacteria. Trials were conducted with three types of legume, the seeds of which were inoculated with *Rhizobium* culture and sown between cane rows. When two months old, the legume crop was turned into the soil. Results over a 3-year period showed that all three legume crops increased cane yield by comparison with the control, while inoculation increased the positive effect of the green manure still further. The economics are discussed.

A note on the (effect of) planting methods on yield and quality of late-planted sugar cane. G. B. Singh, B. K. Maheshwari, S. R. Seth and A. B. Singh. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 31-Ag. 36.—In sub-tropical India, there has been a tendency for farmers to grow more wheat and less cane; two ways of growing wheat within the rotation are companion cropping with autumn-planted cane or growing wheat before late-planted cane, i.e. planted in April. However,

considerable reductions in cane yield have been reported as a result of delayed planting. Four planting methods were therefore tested: (i) vertical planting of 6-bud pre-germinated top setts in deep furrows 90 cm apart; (ii) as (i) but using ungerminated setts; (iii) conventional planting of 3-bud setts in deep furrows 90 cm apart; and (iv) as (iii) but with furrows 60 cm apart. In the first three methods, planting density was 42,500 per ha, while in method (iv) it was 85,000 plants per ha. Results showed that, although the highest yield was obtained with method (i), it was much less profitable (because of the high labour costs involved in trench digging and associated work) than method (iii) which gave almost the same yield as (i).

Is soil application of gamma-BHC paying to the sugar cane growers of Maharashtra? B. V. Mohite, S. J. Ranadive, L. B. Sabnis and S. P. Patil. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag.37-Ag.41—Trials are reported on soil application of gamma-BHC as a means of increasing nutrient uptake by cane. Results were expressed as % germination and tillering, plant population per ha and yield per ha (but not sugar yield). Tabulated date indicate that application of 1 kg gamma-BHC per ha increased the positive effect of nitrogen, best results being obtained with 300 kg N per ha, which also gave the maximum profit. Hence, use of gamma-BHC is considered economically justifiable.

Effect of soil application of gamma-BHC for improving the nitrogen efficiency in sugar cane. II. Yield of sugar cane and sugar juice quality, N uptake and efficiency. S. Thangavelu, E. Lalitha and K. C. Rao. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 43-Ag.50.—See *I.S.J.*, 1978, **80,** 205.

A note on the geometry of the cane stalk in the production of rayungan tails. R. K. Sharma, P. K. Varma and S. R. Sharma. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 55-Ag. 57.—See Verma: *I.S.J.*, 1977, **79,** 167.

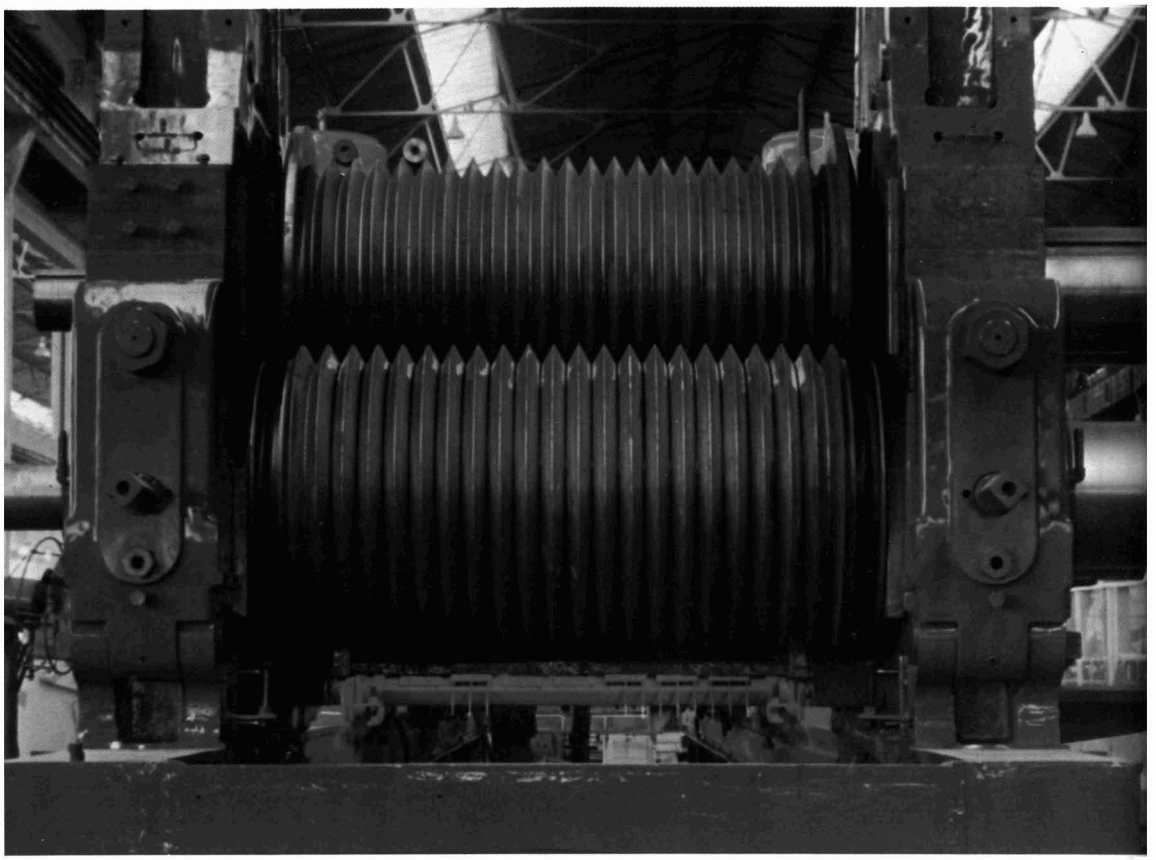
Effects of some chemical ripeners on maturation of cane and maintenance of quality in late season. A. S. Chaeravarti, A. K. Sarkar and A. K. Thakur. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 67-Ag. 74.—Field trials were conducted with BO 17 (a mid-season to late variety) in 1973-74 and with BO 74 (also a mid-season to late variety) in 1974-75; pot tests were carried out with BO 17 and with BO 47 (an early variety) in 1974-75. Water treatment of cane was used as control. The ripeners tested were "Planofix", "Hostacycline", "Cycocel", "Polaris", "Racuza", "Sustar", "Ethrel", "Regim-6", cycloleucine, aureofungin and aureomycin. Results are tabulated. Differences were found in the effects according to dosage, variety and method of application (foliar spraying or root zone irrigation). "Planofix", "Hostacycline", "Cycocel", cycloleucine, "Polaris" and aureofungin had significant effects on two varieties, as shown by fibre reduction and sucrose increase, in mid-February. Combined application of "Planofix" and "Cyclocel" had an effect which neither gave when applied at the same dose but separately. Spraying at the end of November and early in January had the same effect on cane quality as did mid-February application; there was no difference in the effect between a single spraying at the end of December and two sprayings, one at the end of December and one at the end of January. None of the treatments affected cane yield. The pot experiments indicated the possibility of maintaining considerably higher sugar recoveries into the late season (up to the end of April or even later) with "Cyclocel", "Sustar", "Racuza", "Ethrel", "Planofix" or "Polaris" applied by either method tested.

Effect of low-temperature pre-treatment of setts for planting on sugar. D. G. Dakshindas. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 103-Ag. 109.—Experiments were conducted on setts to see if exposure to low temperatures would have any effect on subsequent germination, growth and yield. The temperatures selected were in the range 20-40°F (pre-treatment at 6-14°F in preliminary tests completely prevented germination), and the exposure times were 8 or 16 hours. Generally, pre-treatment had little effect on germination and yield, although in some cases it reduced flowering incidence and gave slightly higher pol than the controls. It is suggested that the trials should be repeated at more suitable temperatures and using setts having pre-activated buds.

Effect of dose, time and mode of nitrogen fertilization on yield and quality of sugar cane. T. K. G. Rao, S. Jothimoorthi, S. D. Rajan and T. R. Srivastava. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 121-Ag. 126.—A 3-year trial on nitrogen application effects on cane yield showed that 125 kg.ha^{-1} applied 45 days after planting (the highest dosage rate) gave maximum yield and was not affected by a second dose 90 days after planting. Cane sugar content was unaffected by treatment.

The performance of subsurface drainage and its effect on sugar cane growth on fine-textured soils in Taiwan. S. J. Yang, P. L. Wang, Y. T. Chang and T. C. Yang. *Taiwan Sugar,* 1977, **24,** 378-384.—Field experiments were conducted in an area of southern Taiwan which is characterized by very high rainfalls in the period May-October. The drains were laid at 0·8 or 1·2 m depth, with spacings of 15, 20 or 25 m between them, equal spacing and depth being used in each test; only the central two out of four tile lines and the land area between them were used for the measurements. Results showed that the 1·2 m depth lowered the water table faster than did the 0·8 m depth, while the narrower the spacing the more effective was the drain in lowering the water table. Peak discharge and total discharge increased with decrease in tile depth and spacing, about 78% more water being discharged from the 1·2 m drain than from the other. The oxygen concentration in the control (undrained) plot never exceeded 5% at a depth of 20-30 cm, while in all the drained plots the oxygen content seldom fell below 10%. The improved aeration in the root zone resulting from subsurface drainage promoted root growth and increased cane yield. While the overall trend was for higher yields from the deeper and closer spaced drains, yield differences between all six treatments were small.

The implications of green cane harvesting. Anon. *Producers' Rev.*, 1977, **67,** (8), 11-13.—See *I.S.J.*, 1978, **80,** 206.



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SUGAR CANE MECHANIZATION

Mechanization of sugar cane cultivation. F. Cáberg. *La Ind. Azuc.*, 1977, **84**, 13 (*Spanish*).—Mechanization of sugar cane cultivation requires, in the following order, establishing a change of attitude by adequate education so that the new system becomes acceptable, creation of field conditions required for mechanization, and acquisition of suitable equipment over a reasonable time. Each of the stages is discussed in some detail.

Machinery selection by costing analysis. S. S. Booysen and A. G. de Beer. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 12-15.—A system of costing is described in which graphs are produced which relate the hourly cost of operation to the total number of hours operated per annum and allow for both fixed and variable costs. The graphs allow comparison of different equipment on a basis of the duty required and can be an aid to selection of the most economical type.

Interim report on McConnel Stage II cane harvester. M. M. Boast. *Proc. 51st Congr. S. African Sugar Tech.*, 1977, 16-18.—A pre-production prototype of this, the cleaning and loading component of the McConnel harvester[1], has been under test in South Africa in order to determine weak points and so allow modifications to improve efficiency and reliability. These modifications have included a centre pivot hitch suitable for 2-wheel drive tractors, power steering, a stronger bin frame, construction of a re-cycling shroud and fitting of louvres in the lower fan shroud for better trash and tops separation. While it is not claimed that the unit is now a fully commercial machine ready for full-scale production, it is believed that with a centrifugal air blower to replace the carousel and top fan, so improving cleaning, the harvester/cleaner-loader combination will deliver whole-stalk green cane in bundles at a rate of 20 tonnes.hr^{-1} with a total trash content less than 7%.

Field efficiency of chopper harvesters. A. G. de Beer and T. C. Boevey. *Proc. 51st Congr. S. African Sugar Tech.*, 1977, 19-20.—Trials were conducted on five chopper-type cane harvesters, operating on burnt cane grown on flat land. Analysis of the time spent in cutting as a proportion of the total time, which also included time for servicing, repair and maintenance, waiting, turning and other lost time, showed that it varied between 35·4% and 54·5% for different machines, and this corresponded to field records over a 25-day period for a machine which had been operated for a number of years. As a consequence, in the worst case, a cutting rate of 62·8 tonnes.hr^{-1} was reduced to an overall field rate of 22·3 tonnes.hr^{-1}, while in the best case the corresponding rates were 38·4 and 21·0 tonnes.hr.$^{-1}$ Efficiency could be improved by adequate infield transport and maintenance, but even with 350-450 m rows in fields with adequate headlands, turning will still take 10% of the total field time.

Harvesting of sugar cane. L. A. R. Pinto. *Brasil Açuc.*, 1977, **89**, 208-221 (*Portuguese*).—The development of mechanical harvesting of cane is briefly surveyed and illustrated by a time chart. Another chart indicates the possibility of using different systems with erect and lodged cane, both green and burnt. The various systems are compared and costs discussed. Requisite conditions for satisfactory operation of cane harvesters are tabulated in respect of soil and topography, cultivation, administration, transport, reception and storage. Future development is expected to provide harvesters which cut, top, clean and load with greater capacities and give cleaner cane of higher recoverable sugar; the need for introduction in Brazil of a payment system for cane on a basis of recoverable sugar is mentioned.

Economic aspects of mechanical harvesting. R. E. Torres. *La Ind. Azuc.*, 1977, **84**, 106-111, 131-136 (*Spanish*). Introduction of semi-mechanical harvesting (separate cutting and loading or integral harvesting, i.e. simultaneous cutting and loading) involves investment in the form of capital as well as a cost in the reduced value of the cane owing to its higher trash content than manually harvested cane. This is offset by the savings in reduced labour cost, and examples are given of calculation of the break-even points in terms of the minimum tonnage of cane to be harvested before the semi-mechanized and integral systems become economical, using new and second-hand equipment having half its full working life left, using imported and Argentina-built harvesters, and having various reductions in cane value for different trash contents.

Mini-loader for planting material. Anon. *Australian Sugar J.*, 1977, **69**, 201-203.—Illustrations and a brief description are given of a hydraulic three-point linkage mini-loader for loading of whole-stalk plant cane into a trailer. It is attached to the quick-hitch attachment of a tractor, has a main arm extendable to just over 7 ft and can handle cane without excessive inter-twining of trash, thus permitting easier removal of the cane from the trailer during planting.

TSC achieved higher mobility in sugar cane handling for the 1976-77 crop. C. S. Chang. *Taiwan Sugar*, 1977, **24**, 385-388.—The 1976-77 crop was the first in the 4-year project for higher transportation mobility devised by the TSC to replace the original rail system with a complete road transportation scheme (although the rail system is still needed for supply of cane for night crushing). Details and photographs are given, showing direct haulage from field to factory instead of the earlier rail system involving transloading. The use of "Load-O-Matic" trucks by eight factories has considerably increased haulage efficiency; the system is based on the use of interchangeable bodies, which are rolled off the truck along a guide rail and left to stand on legs by means of a hydraulic lift installed on the rear axle. When full, the body is slid onto the truck, for which operation only 6-8 minutes is required. Mention is also made of the establishment of a cane yard system at factories for overnight storage of cane equivalent to 14 hours of crushing.

[1] Hudson *et al.*: *I.S.J.*, 1976, **78**, 47.

CANE PESTS AND DISEASES

Preliminary report on the population distribution of *Diatraea* spp. in the cane growing region of north-east Brazil. S. H. Risco B., C. E. Ferreira, A. Mendonça, J. M. B. Costa, S. M. Sobral and H. D. de Souza. *Brasil Açuc.*, 1977, **89**, 185-194 (*Portuguese*).—In 1974 Planalsucar began a study on the incidence and biological control of cane borers in Brazil. In 1975 observations were made as to relative occurrence of *D. saccharalis* and *D. flavipennella* in various areas of the north-east region of the country where it was found that proportions varied markedly in different areas. Work was commenced to discover the reasons for this divergence and to see what natural factors helped to control each species, so that their aid may be sought in other areas to control the pests. With this object, a climatic study has been started, together with an evaluation of the action of natural parasites and predators.

Sugar cane diseases. Anon. *Cane Growers' Quarterly Bull.*, 1977, **41**, (1), 4-24.—This issue of the *Bulletin* is devoted to cane diseases which are an actual or potential hazard in Australia, and lists those symptoms which may occur at various stages of the crop with causative diseases. Coloured illustrations are then provided of such symptoms with observations on the cause, symptoms, spread, effects, control measures and additional notes on the specific diseases: Fiji disease, leaf scald, ratoon stunting, red stripe/top rot, eye spot, yellow spot, mosaic and striate mosaic, chlorotic streak, pineapple disease, basal stem, root and sheath rot, sclerophthora, bacterial mottle, smut, pokkah boeng, ring spot, rind disease and red rot. Notes are also given on cane killing weeds—*Striga* spp. and *Thesium australe*—as well as harmful environmental effects such as those of low temperatures and frost, high temperatures and wind, lighting, hail, excessive sun, floods and damage by farm operations.

Sugar cane smut. An alarming problem in Uttar Pradesh. S. C. Gupta and K. P. Verma. *Cane Grower's Bull.*, 1977, **4**, (1), 9-11.—The variety Co 1158 was introduced in Uttar Pradesh because it was fairly resistant to the prevalent red rot disease; however, it is susceptible to smut, and this has consequently spread seriously in the state, the extent being indicated in tables for the various districts. Measures recommended are: roguing of infected stools, use of seed cane from unaffected fields, hot water treatment (50°C for 2 hr) of setts, and replanting of fields when smut is detected.

Eldana saccharina **Walker: rearing method on artificial diet and laboratory observations on its biology.** M. Betbeder-Matibet, J. Coquard and D. Bordat. *Agron. Trop.*, 1977, **32**, 174-179 (*French*).—The rearing of this stem borer on an artificial diet for multiplication and study is described, as well as biological observations on the life-cycle of pests reared under the same artificial conditions.

Study on a strain of sugar cane mosaic virus. P. Baudin. *Agron. Trop.*, 1977, **32**, 66-96, 180-204 (*French*). A strain of mosaic isolated in Madagascar and called SCMV-Ampefy has been purified and various physico-chemical characteristics determined, in particular the molecular weight of the protein sub-unit (34,000) and the aggregation pH of the virus particles (4·5). Comparison with American strains of mosaic virus showed it to be closely related to the A, B and D strains but different from the SCMV-H strain. Temperature effects on the biological properties of the virus were studied; it was found to develop the disease on susceptible cane and maize varieties at all temperatures. Development was optimum between 16 and 20°C; at 30°C multiplication of the virus was rapid but it was not stable. Studies on the strain are reported in connexion with quarantine problems.

Introduction and adaptation of *Apanteles flavipes* Cam. (Hym.:Braconidae), parasite of *Diatraea* spp. in the states of Pernambuco, Paraíba and Rio Grande do Norte. C. E. F. Pereira, R. O. R. Lima and A. M. V. Boas. *Brasil Açuc.*, 1977, **89**, 279-286 (*Portuguese*).—A tabular and map record is presented on releases of this cane borer parasite in the three states in 1975 and 1976; systematic recovery from the release fields showed that it had become adapted to the areas.

A new device for hot water treatment of sugar cane seed material. S. C. Gupta. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (1), Ag. 33-Ag. 36 (+ figs.). A description is given of a hand-operated vertical circular tank in which setts housed in six conical expanded metal cages are immersed in hot water for 2 hours at 50°C and rotated gently 5-8 times per hour. After treatment, the setts are dipped in cold water containing "Aretan" or "Agallol" fungicide (125 g/100 litres).

Prospects of chemical control of sugar cane stalk borer, *Chilo auricilius* Dudg. P. N. Avasthy and A. Varma. *Sugar News* (India), 1977, **8**, (10/11), 25-26. Reference is made to the literature on chemical control of the stalk borer. "Monocrotophos" has proved consistently effective in trials over the last three years. Borer damage can be considerably reduced by systematic removal of dry foliage in September-October after spraying, although objections have been raised by growers because of the increased threat of damage by frost and the possibility of sprouting of open buds once the dry foliage is removed.

An assessment of sugar cane varieties for susceptibility and resistance to sugar cane smut in artificial conditions. A. O. Patil, M. B. Bachchhav and J. S. Jadhav. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 51-Ag. 53.—Thirty-two varieties were tested for smut resistance. Results showed that three (Co 6608, Co 6609 and Co 62101) were completely resistant and two (Co 740 and Co 6507) highly susceptible to the disease. Of the remainder, eight were resistant, i.e. showing up to 5% infection, fourteen were moderately susceptible (up to 15% infection) and five were susceptible (up to 30% infection).

SUGAR BEET AGRONOMY

Influence of sowing and harvesting dates, planting density and variety on some qualitative characteristics of the beet. G. Venturi, M. T. Amaducci, G. Pritoni and S. Quaquarelli. *Ind. Sacc. Ital.*, 1977, **70**, 91-99 (*Italian*).—Factorial design trials were carried out in 1975 and 1976, at four different locations, to compare the effects of the title parameters. Characteristics examined included the K, Na and amino-N content of the beet as well as extractable sugar. Singly, improvements were obtained by growing high-sugar varieties, by sowing and harvesting earlier and by using higher plant populations within the ranges covered by the trials. Combined effects were also observed, e.g. the amino-N content of the varieties affected the response of beet yield to harvest date.

Yield pattern in long-term sugar beet cultivation under different local ecological conditions. G. Bachthaler and P. Behringer. *Zucker*, 1977, **30**, 519-524 (*German*).—Trials first planted in 1964, 1968 and 1969 at three different locations in southern Germany are reported. The sites differed in respect of soil type, altitude above sea level and rainfall. After 7, 8 and 10 years of beet growing, it was found that fluctuations in yield from year to year were related to soil and climatic conditions but that repetition of beet cultivation over the period in question had no adverse effect on yield. Applications of compost, farmyard manure or green manure were of benefit by comparison with absence of organic fertilizer. A cereal-leaf crop rotation with beet increased beet yield by 37% at the most suitable site, but by only 6% at a less favourable location. In only one case did an increasing incidence of *Heterodera schachtii* and *Rhizoctonia violacea* nematodes affect yield. Changes in soil pH, K and P were attributed more to organic fertilizer application than to long-term beet growing.

Causes of heavy metal traces in food and feedstuffs. G. Steinle. *Zucker*, 1977, **30**, 535-540 (*German*).—The increase in quantities of heavy metals in the environment which have taken place in recent years are discussed, and the sources of some of them indicated. Their occurrence in plants and in foods and fodder obtained from the plants is discussed. The increase in the lead content of the atmosphere, soil and water is mainly attributable to car exhausts and other combustion waste gases as well as industrial processing. Investigations in West Germany in 1964 showed that the underground portion of the sugar beet contained 1·3-9·6 ppm dry solids Pb, whereas the average content in leaves was 11 ppm dry solids at sites far removed from traffic, and 29 ppm in leaves 5 m from a motorway; wind direction and rainfall also affected the levels. Rinsing with water was found to remove 30-65% of the lead in plants. Cadmium also originates from car exhausts, industrial processing and domestic heating oil, as well as cigarette smoke. Mercury chiefly occurs in plants via water which is polluted with industrial effluent, such as from paper mills; Hg compounds have been used widely as fungicides. Arsenic, found in many plants (e.g. 0·04 ppm in beet), occurs naturally in soil and ground water, and occasionally in the atmosphere as a result of emission from coal-fired boilers. It also occurs in plant protection materials. The contents of the four above-mentioned heavy metals in water, soil, sugar beet, beet pulp, molasses and white sugar are tabulated from the literature. Zinc, an essential trace element for plants, presents no danger to man at the normal levels encountered. Copper in the soil, as a fodder additive, in piping and equipment as well as packing materials, does not normally pose a threat to man; as with zinc, it is a deficiency in the element which is to be avoided. However, sugar beet must not be grown in copper-contaminated soil because of the former's high sensitivity to the element. Similarly, a chromium deficiency is significant, not its abundance. A lack of Cr in man and animals reduces the glucose tolerance, so that the element is regarded as a co-factor of insulin. Brief mention is made of other heavy metals which are highly toxic, but which are the subject of stringent regulations, so that there is little danger of their accumulation in plants. The Cr, Cu, Mn, Zn, Co, Ni, Mo and Se contents in water, sugar beet, molasses and white sugar, as obtained from the literature, are tabulated.

A systematic method for studying seedling emergence. D. F. Wanjura and D. R. Buxton. *J. Amer. Soc. Sugar Beet Tech.*, 1977, **19**, 207-218.—A systematic procedure for developing seedling emergence models is outlined. A model was established to describe the emergence of cottonseed, but which is also applicable to other crops including sugar beet; it covers the two phases of emergence: (i) radicle emergence, which extends from planting until the radicle length of the seedlings in a plot averages 3 mm, and (ii) hypocotyl elongation which starts with radicle emergence and continues until emergence of the hypocotyl from the soil. The first phase is primarily dependent on water absorption by the seed, so that the water status is used to indicate germination progress; phase two involves parameters such as soil temperature, moisture tension and physical resistance (measured as pressure in $kg.cm^{-2}$). Laboratory experiments were used to establish values of coefficients of the soil parameters, and simulation was used to quantify the sensitivity of emergence to the individual parameters. The model was found to predict radicle emergence time to within $\pm 9\%$ of the actual values, while predicted hypocotyl elongation with time was not significantly different from observed values in nine out of ten comparisons. A procedure for estimating maximum expected emergence for optimum soil conditions was developed from the model simulations and verified in field tests.

Use of "Nitrofen" for controlling weeds in sugar beet (*Beta vulgaris* L.). A. C. Bhalerao, O. P. Singh, A. R. Ghanekar and A. D. Karve. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (II), Ag. 99-Ag. 102. Trials on the use of "Nitrofen" ("Tok") as a pre-emergence herbicide in beet crops are briefly reported. In only one case did treatment increase beet yield by comparison with a hand-weeded control, whereas there was considerable increase relative to an unweeded control. It is therefore recommended to use "Nitrofen" at 1·87-2·50 kg a.i. per ha.

BEET PESTS AND DISEASES

Is it possible to increase yield by controlling sugar beet powdery mildew (*Erysiphe betae*)? H. C. Weltzien and W. Ahrens. *Zucker,* 1977, **30,** 288-291 (*German*). Powdery mildew occurs when the average monthly temperature during the beet growth period exceeds 20°C and there is very little rain during the 4-5 months preceding harvest. While conditions favoured a severe outbreak in European countries in 1976 it is stressed that the disease, occurring at the end of the growth period, does not have any serious effect on sugar yield in West Germany, although it can cause considerable falls in beet and sugar yield in other countries where beet is grown under irrigation. While sulphur treatment is the cheapest and most commonly used means of combating the disease, results have indicated that fungicides such as "Benomyl" are more effective.

Sugar beet cyst nematode problem gets worse on Oregon-Idaho border. Anon. *Sugarbeet Grower,* 1977, **15,** (5), 11.—Nematodes are not as serious a problem in the beet growing areas around Nyssa, Oregon, as in the Magic Valley of Idaho, but are a growing menace partly because of the favourable environment for them created by the well-developed root systems of the high-yielding beets grown. Crop rotation is practised but is not sufficient to reduce the problem, and trials have been carried out with soil fumigation and recently use of "Temik" granular pesticide. These trials are described, and it is considered better to use a split application at planting and after emergence, while deep application has given higher yields.

Preliminary studies on the effect of root "beardiness", caused by *Polymyxa betae,* on sugar beet quality. C. Winner and W. R. Schäufele. *Zucker,* 1977, **30,** 459-463 (*German*).—A series of experiments were conducted on beets in 1976 to establish the effects of *P. betae* fungus, symptoms of which are root fanginess and production of many fibrous roots to form a "beard". Leaf discoloration, as found by other authors, was not observed. The disease caused a marked fall in weight, and reduced the sugar content, while the K, Na and amino-N contents increased, as did invert sugar. The visual appearance of the beets in the field tended to act as a guide to incidence of the disease, which (because of the fall in sugar content) may be connected with a fungus-transmitted virus.

Rating sugar beets for damage by the sugar beet root maggot. C. C. Blickenstaff, R. E. Peckenpaugh and G. G. Mahrt. *J. Amer. Soc. Sugar Beet Tech.,* 1977, **19,** 188-191.—As an aid in evaluation of the effectiveness of insecticide treatment for the control of the beet root maggot *Tetanops myopaeformis,* the USDA laboratory at Kimberly, Idaho, has adopted determination of the number of maggots per beet as its almost exclusive method since 1962. However, attempts have also been made to devise a system of damage ratings; the scale used in 1971 covered a range from 0 to 5, representing, respectively, a beet having no scars and a heavily damaged beet with more than ¾ of the root area blackened. The ratings closely correlated with maggots per beet (a correlation coefficient of 0·9736); while closer correlation was found between the maggot counts and the percentage of beets with soil sample infested with maggots (whether the beets were scarred or not), establishment of the degree of infestation necessitated sifting the soil. The correlation between % beets scarred and maggot counts was 0·9446. Although any of the methods mentioned could be used to give a satisfactory evaluation of insecticide efficiency, in heavily infested areas there may still be 100% infestation or scarring of beets even where good or excellent reduction of the maggot population has been obtained, in which case only maggot counts or the degree of damage are suitable criteria. Hence, the damage rating system seems to be most suitable, since it requires the least amount of time and effort; the scale was used satisfactorily in 1975 tests.

Pectolytic activity of *Aphanomyces cochlioides* in culture and in diseased sugar beets. L. J. Herr. *J. Amer. Soc. Sugar Beet Tech.,* 1977, **19,** 219-232.—Hydrolysis of cell wall constituents, particularly pectins, is a feature of pathogenesis common to a wide variety of plant pathogens; pectolytic enzymes are involved in tissue maceration and inter-cellular invasion, and possibly in the killing of host cells. While investigations have suggested that endopolygalacturonase (EPG) produced by *Aphanomyces euteiches* facilitates parasitism by partial maceration or softening of the root tissues of peas, little investigation has been conducted on the related species, *A. cochlioides,* the sugar beet black root pathogen. Detailed experiments are reported in which the pathogen produced EPG, the activity of which was increased by adding pectin to the culture medium. A number of factors affected EPG growth, however. Although culture filtrates of the enzyme readily macerated potato tuber tissue, pectolytic activity by *A. cochlioides* in diseased beets was not unequivocally demonstrated, although there was some evidence of it. Extracts from diseased beet tissue showed both EPG and pectin methyl esterase activity, which was lower in healthy beet tissue. The diseased plant extracts also slowly macerated potato tuber tissue.

Effect of "Benomyl" on *in vitro* and *in vivo* biology of "Benomyl"-tolerant strains of *Cercospora beticola*. E. G. Ruppel and S. J. Petersen. *J. Amer. Soc. Sugar Beet Tech.,* 1977, **19,** 233-239.—Increased concentrations of "Benomyl" fungicide up to 1000 μg a.i. per cm^3 *in vitro* inhibited the growth of two tolerant strains, H1-12T and HB-6T, of *C. beticola,* but had little effect on production of conidia, the viability and length:width ratios of which tended to decrease with increase in "Benomyl" concentration. Increase in the fungicide concentration tended to reduce severity of the disease and sporulation in sugar beet, the effects being less pronounced in the more tolerant strain. However, because of the limited extent to which the fungicide inhibited growth and disease severity, its continued use for leaf spot control in the field is not recommended for those areas where tolerant strains have developed.

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CANE SUGAR MANUFACTURE

Liming—a case study. A. C. Chatterjee, B. R. Math, P. L. Apte and S. R. Kalaswad. *Sugar News* (India), 1977, **8**, (10/11), 7-12.—Requirements for good clarification are indicated and reactions between lime and SO_2 and between lime and juice constituents, particularly phosphate, discussed. Tests are reported in which milk-of-lime and phosphate were added to sulphitation juice. The lime salts content of the clear juice was higher as a result of the phosphate addition and led to evaporator scaling. Subsequent addition of Na_2CO_3 to the juice was found to effect a slight reduction in the CaO + MgO content.

Use of stainless steel in sugar factories. E. Hale. *La Ind. Azuc.*, 1977, **84**, 260-266 (*Spanish*).—The use and drawbacks of mild steel and copper or brass tubes for evaporators are described and the increasing use of welded stainless tubes is discussed. Characteristics of the material and its heat transfer properties are described as is its application in juice heaters, evaporators, etc. Problems associated with stainless steel are considered; these are small compared with the advantages gained, and usually arise from improper or inadequate practices, e.g. contamination of water with chlorides, improper cleaning procedures, etc.

A study on cane preparation. H. L. Verma, V. K. Rohatgi and H. K. Modgil. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), E.43-E.52.—Cane preparation methods and the power consumed are discussed and features of the Unice chopper-fiberizer[1] are described. Modifications made at Daurala sugar factory included installing a heavy-duty leveller before the first of two sets of knives in a common hood, and mounting an anvil plate on the second set of knives to act as a shredder. As a result, cane preparation improved considerably, and there was better utilization of installed power.

Cane preparation. K. C. Garg, H. N. Gupta and P. N. R. Rao. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), E.53-E.60.—Recent trends in cane preparation in India, where performance in this field is considered low, are described. The positive effect of reversing the direction of the knives is discussed and reference made to the installation of fixed knives in the hood of a reversed knife set. The consequence of this in trials in which the 1st set of knives operated in the conventional direction, while the second set was reversed, was an appreciable increase in the preparation index.

Trials on DDS milling-diffusion. P. Chandramohan, R. Gajaraj, N. Gunasekaran, P. C. H. Rao and M. Selvam. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.1-M.8 (+ figs.).—Two DDS diffusers were installed at Aruna Sugars Ltd. for operation with a primary 3-mill crusher and a 6-mill bagasse dewatering tandem. Trials conducted in 1975-76 are reported; major problems prevented smooth operation of the diffusers and detailed studies could not be made. However, satisfactory results are expected (based on DDS diffuser performances in other Indian factories). Important factors influencing diffuser performance are listed and trial data tabulated.

A study on the performance of low-grade massecuites at low purities. P. Chandramohan, K. K. Rao, S. Srinivasan, V. K. Cholladurai and C. N. Jayaraman. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.9-M.18.—*Details are given of the operation of the* low-grade station at the authors' sugar factory where the *C*-massecuite purity in 1975-76 averaged 57·58 and the final molasses purity 31·31 compared with 60·66 and 34·38, respectively, in the previous season.

A new system and mechanism for continuous conditioning and feeding of molasses and efficient removal of non-condensable gases with maximum heat recovery. Development of a conditioner-cum-feed rate regulator for low-grade sugar boiling vacuum pans. S. P. Mishra. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.19-M.24 (+ figs.). See *I.S.J.*, 1977, **79**, 123-125.

Quarez sulphitation system in Nagaland Sugar Mills Company Limited. (Double carbonatation and double sulphitation process.) K. Srinivas, S. K. Gupta and K. R. Sanyasirao. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.25-M.28 (+ figs.). Details are given of the continuous Quarez sulphitation system[2], which has been widely used in the French beet sugar industry. By this means, the SO_2 is drawn from the furnace under suction using a jet nozzle arrangement *comparable to a filter pump, the juice itself being used* as gas carrier and subjected to recirculation through the system. The scheme was introduced at the authors' factory where it has proved superior to conventional sulphitation in a number of ways. These are listed and details *given of the system and its operation.*

Clarification efficiency. B. S. Gurumurthy and V. L. J. Ahmed. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.33-M.40.—The present method used in India to calculate clarification efficiency is discussed and criticized, since the non-sugars removed in clarification are considered as extra to the non-sugars removed by filtration, thus giving an inflated efficiency. Mittal's formula is an improvement on this, but does not take account of the sugar lost in clarification as a result of inversion, the error being larger the greater the purity drop from mixed juice to clarified juice.

Entrainment and uneven cake formation in a Dorr-Oliver vacuum filter. T. S. Thiyagarajan and M. Thirunavukkarasu. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.41-M.43 (+ figs.).—While a Dorr-Oliver vacuum filter of 400 ft² filtration area operated efficiently with little entrainment between 1965 and 1971, a second Dorr-Oliver filter of the same size but of slightly different design, installed in 1971-72 as part of an expansion programme, proved defective in operation.

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[1] *I.S.J.*, 1975, **77**, 140-142.

[2] Dubourg: "Sucrerie de Betteraves" (Baillière, Paris) 1952, pp. 228-229.

Major problems were a high incidence of entrainment (particularly at start-up), high pol loss in filter cake, and uneven cake formation. Remedial work was carried out, resulting in prevention of entrainment except in the initial stages, although the pol loss was still too high at 3% on cake, and normal cake formation took a long time. Details are given of the work carried out. Further investigations pointed to an inadequacy of suction points as the main cause, and it is proposed to increase the number under each screen.

A way to expand economically—"syrup mill" method. R. Lokan, N. R. Babu, N. Chinnappan and G. Ramanathan. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), M.53-M.60.—By comparing processing data, machinery requirements, fuel and steam consumptions and sugar recoveries, the authors show that (i) expanding a factory from 1500 to 2500 t.c.d. up to and including the evaporator station and storing the syrup from the extra 1000 tonnes of cane for post-season processing as in Venezuela will be much more profitable than (ii) straight expansion of the factory to 2500 t.c.d., maintaining conventional processing.

Studies on the use of flocculating agents during sugar cane juice clarification. X. Settling studies with "Primafloc A-10", "Morarfloc A-40H", "Dedenol O.T." and "Hyflock". S. Bose, K. C. Gupta and S. Mukherjee. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), M.61-M.66.—Laboratory tests were conducted on the four title flocculants of Indian manufacture against "Separan AP-30" used as standard. Results showed that best results were given by 2 ppm "Primafloc A-10" and 2 ppm "Hyflock" (130 cm^3 and 120 cm^3 mud after 1 hr, respectively, compared with 125 cm^3 given by 2 ppm "Separan AP-30"). The other two flocculants mentioned in the title did not improve on settling without flocculation aid (150 cm^3 mud after 1 hr), even at an optimum dose of 4 ppm.

Storing of sugar bags in a godown. S. K. Chattopadhyay. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.7-G.9 (+ figs.).—With expansion of sugar factories in India, there is need for greater use of available storage space (costs of new godowns being very high). In experiments which are described it was found possible to store 50-kg bags in 50 vertical layers by slightly sloping the sides of the stack. Over a period of 180 days no bag burst, there was no caking of the sugar, nor any change in sugar colour or crystal size, and counting of the bags presented no problems. Passage of air up through the stack was promoted by means of corrugated zinc sheets placed between the floor and the stack; holes were made in the sheets at 1-ft intervals.

Trials of chemical cleaning of an evaporator with sulphamic acid. M. Singh, V. G. Bahulekar, V. S. Desai, S. N. Bableshwar and S. R. Dave. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.25-G.34. Evaporator descaling trials were conducted with sulphamic acid at a total consumption of 2200 kg, smaller quantities being used for the 1st and 2nd effects and larger quantities for the 3rd and 4th effects. Results showed that boiling for 8 hours completely removed the scale from the first two effects, while partial success was achieved in the last two effects. Further trials are to be carried out with the aim of complete scale removal from all effects. It was possible to crush 50,000 tonnes of cane before evaporator cleaning, compared with only 35,000 tonnes when boiling out with NaOH followed by mechanical cleaning. A longer tube life was also anticipated in view of the reduced subjection of the tubes to mechanical stress and strain.

Use of wireless communication equipment in sugar factories for obtaining fresh supplies of sugar cane. P. J. M. Rao. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.55-G.68.—The use of radio transmitters and receivers to maintain contact between factories and field staff so as to ensure fresh supplies of cane is discussed, and descriptions are given of the various systems used by specific Indian factories.

Conditioning boiler water—a case study of three new sugar units. S. K. D. Agarwal, S. K. Dubey, R. P. Shukla and J. K. Srivastava. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.69-G.74.—Reference is made to the treatment of boiler feedwater with a cation exchange resin in Na^+ form at three Indian sugar factories. Treatment reduced the hardness (as established with EDTA) from 160-180, 160-180 and 110-120 ppm to 5-8, 0 and 4-6 ppm, respectively. One important factor discussed is the storage of the untreated water. At one of the factories the water was stored in two tanks and offered no problems in resin treatment; on the other hand, the water at another was fed direct from a tube well and led to considerable accumulations of sand in the resin bed.

Study on flocculating agents in cane juice clarification. A. C. Chatterjee, S. R. Kalaswad, B. R. Math and V. B. Taware. *Sugar News* (India), 1977, **9,** (1/2), 13-20. See *I.S.J.,* 1976, **78,** 309.

Flocculants. H. Narain and S. L. Kapur. *Sugar News* (India), 1977, **9,** (1/2), 21-26.—After a brief look at the various types of flocculants used for cane juice clarification, the authors devote most of the article to the subject of polyelectrolytes. Descriptions are given of the procedures used in the preparation of some typical polyelectrolytes, with mention of various products available on the market. The manufacture of SP-2 and SP-10 polyelectrolytes based on acrylonitrile using a process developed by the National Chemical Laboratory in India is briefly described. Both have been found to be comparable in efficiency to imported flocculants, best results being achieved at an application rate of 2-5 ppm.

Tight corner. G. R. Swamy. *Sugar News* (India), 1977, **9,** (1/2), 29-30.—Specific problems encountered by the author as chief engineer of a sugar factory are recounted, including overheating of the bearings on cane knife sets, stoppage of the central power generating turbine as a result of pressure loss in the steam feed (the pressure reverted to normal as soon as the turbine was stopped), and loss of vacuum in the pan station. Possible causes of the problems and their remedies are discussed.

Cane sugar industry waste classification, prevention and treatment. B. S. Rao. *Sugar News* (India), 1977, **9**, (1/2), 31-33.—The forms of solid and liquid waste occurring in a cane sugar factory are given as bagasse, press mud, floor washings and boiler blowdown, soda and acid wastes from heater and evaporator cleaning, excess condensate, condenser cooling water and domestic effluent. The ranges of pH, COD, BOD, oil, grease, solids (both total and suspended) and chloride contents of the industrial effluent from ten Indian sugar factories are indicated, and suggested methods of treating the wastes are briefly described.

Studies on the properties of a polycomponent saccharine system to form a basis for the design of resistance heaters for improving the fluidity of *C*-massecuite. R. C. Sharma. *Sugar News* (India), 1977, **9**, (1/2), 47-55.—The author outlines the sulphitation and carbonatation processes of sugar manufacture and explains the effect of inorganic constituents in syrup, massecuite and molasses on viscosity and sucrose solubility. The effect of temperature is also discussed in relation to the possibility of designing a massecuite resistance reheater.

Studies on various characteristics of the polycomponent saccharine system for designing a resistance heater to improve the fluidity of *C*-massecuite in sugar factories. R. C. Sharma. *Sugar News* (India), 1977, **9**, (3), 9-11.—The effects of temperature on massecuite electrical resistance, viscosity, flow and dielectric properties are discussed in relation to resistance heating of *C*-massecuite, and brief mention is made of a resistance heater based on the author's studies which has given satisfactory results, leading to a 2 unit drop in molasses purity.

Some aspects of the expansion of one of the largest sugar factories in South America. M. Mouras. *Ind. Alim. Agric.*, 1977, **94**, 749-754 (*French*).—Information is given on Da Barra sugar factory in Brazil which was expanded from a daily crushing capacity of 12,500 tonnes of cane to 18,000 t.c.d. (increasing the daily white sugar output from 1250 to 1800 tonnes); subsequently a refinery section was added which was designed to handle 900 tonnes/day of remelted low-grade sugar, producing half its output in the form of "amorphous" sugar. The refinery started operations at the end of 1976, since when a plan has been drawn up for addition of a distillery to produce 640,000 litres of anhydrous alcohol daily from molasses and juice; the factory crushing rate is to be increased to 24,000 t.c.d. by 1979 with the distillery feedstock based on 6000 t.c.d., i.e. 25% of the total cane intake. In the meantime, with installation of new mills, it is considered possible for the factory to increase its crushing capacity to 20-21,500 t.c.d. Full details are given of expansion plans and equipment involved.

The development of the sugar industry in Upper Volta. R. Chollet. *Ind. Alim. Agric.*, 1977, **94**, 757-763 (*French*).—Details are given of equipment and processes used at Banfora sugar factory/refinery in Upper Volta which started operations in 1975. The factory is designed for a crushing capacity of 1500 t.c.d., expandable to 2400 t.c.d., and production of 150 tonnes of sugar daily —either as white refined crystal or a 98·5 pol light-coloured raw sugar, while 50 tonnes of tablet sugar can be made daily from melted granulated sugar. Extension of the season from the present 150 days would, with expansion of the factory, permit production of 35,000 tonnes annually. In its second season alone, the factory/refinery produced 16,200 tonnes of sugar, thus covering domestic needs of 15,000 tonnes/year and providing some for export. The domestic consumption is expected to rise to 20,000 tonnes annually, which is slightly less than what the factory produced in its third season in 1977.

The South African sugar economy. M. Content. *Ind. Alim. Agric.*, 1977, **94**, 767-773 (*French*).—A survey is presented of the South African sugar economy, with a table showing the main sugar factories with details of capacity as well as cane crushed and sugar produced in 1974/75. Other tables show sugar production, consumption, exports and importing countries. The organization of the sugar industry is also indicated, and future prospects are discussed.

The Somalia sugar factory. A. Bernard. *Ind. Alim. Agric.*, 1977, **94**, 775-781 (*French*).—The history of the erection in 1927/28 and subsequent expansion of the sugar factory in the Uebi Shibeli Valley, Somalia, is recounted by the man responsible for the initial work. Since the start of 1977 the factory has had a crushing capacity of 2200 t.c.d. compared with 225 t.c.d. when it first operated. Mention is also made of the Juba Valley project[1].

Working of a new integral condenser at Sri Chamundeswari Sugars Ltd., Kalamuddana Doddi, Maddur TK, Mandya Dist., Karnataka. K. K. Menon, A. V. Vallabh, V. L. Rajagopal, P. N. Bhakthavatsalu and D. B. S. Naidu. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.5-E.10 (+ figs.).—Details are given of a barometric condenser fitted inside a vacuum pan. Because of a number of defects in its operation, modifications had to be made and the redesigned condenser tested in complete factory trials. However, preliminary indications are that the modified version has performed better than the original condenser.

Assessment of cane preparation. S. S. Thakur. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), E.29-E.32 (+ figs.).—The percentage of ruptured cells in prepared cane *Y* was determined by the method of Aldrich & Rayner[2] and the bulk density of prepared samples *X* (kg.m^{-3}) found by the method of Murry[3]. Tabulated values are given of *X* and *Y* at cane fibre contents *Z* within the range 12-17·5%. Linearity was established between *X* and *Y* at constant fibre content, a graph being obtained for each value of *Z*. For each graph, values of the straight line slope *m* and of constant *C* in the equation $Y = mX + C$ were obtained and plotted against *Z*. A linear relationship was found between *Z* and *C*. Equations were derived for calculation of *C* and *m* in terms of *Z*. Hence, given values of *Z*, *X*, *C* and *m*, it is possible to find the percentage of ruptured cells *Y*.

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[1] *I.S.J.*, 1977, **79**, 299.
[2] *ibid.*, 1964, **66**, 91.
[3] *ibid.*, 1959, **61**, 82.

BEET SUGAR MANUFACTURE

Formulation of a dynamic production programme for raw sugar factory boiling houses. J. Buriánek, I. Šafrová, M. Kmínek and L. Jakl. *Listy Cukr.*, 1977, **93**, 153-158 (*Czech*).—Balances for two campaigns from all 30 raw sugar factories in Czechoslovakia were processed by computer using previously established relationships, and the performances of the boiling houses assessed. The system used was as described earlier[1]. The assessment of each factory was based on ten criteria, and from the results a basic programme was formulated for optimum boiling house operation on the conventional two-massecuite system used, allowance being made for individual parameter changes such as beet composition.

Optimum campaign starting times for Ukrainian sugar factories. V. V. Goloborod'ko and V. G. Losev. *Sakhar. Prom.*, 1977, (9), 33-35 (*Russian*).—Computer processing of data for the period 1971-75 (weight of beet processed, beet losses, amount of sugar produced, average sugar yield percentage, date of factory start-up and total period of factory operation) showed that the optimum time at which to start the campaign is September 6th and not the actual date of September 16th. This would allow the factories to produce a total of 32,400 tonnes more sugar per year while reducing the beet processed to 400,000 tonnes. Use of a formula to calculate the optimum date by substituting known values of given variables also gave September 6th.

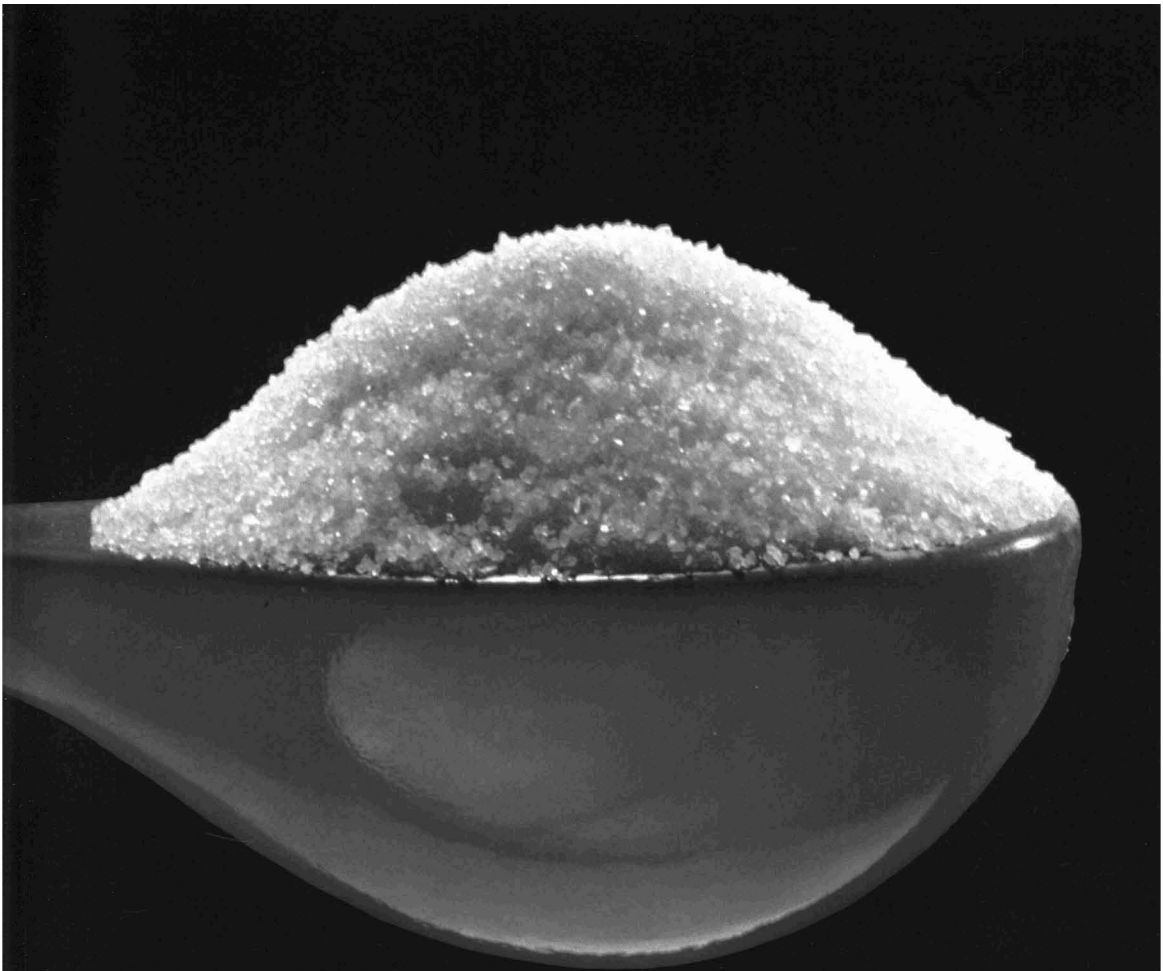
Improvement in schemes and equipment for steam condensing. S. Z. Ivanov, I. P. Orobinskii and M. V. Goncharuk. *Sakhar. Prom.*, 1977, (9), 38-41 (*Russian*). Among the aims of improvements in vacuum raising and steam condensing are achievement of a maximum vacuum of 680-700 mm Hg in vacuum pans, utilization of low-potential steam heat from vacuum pans and vapour cell, use of a variable scheme for diffusion water pre-treatment, and design of condensers for factories having daily slicing capacities of 6-9,000 tonnes of beet. Theoretical and experimental investigations have shown that reduction in the massecuite boiling temperature to 65-70°C (from the level generally used in the Soviet Union) would considerably reduce colouring matter formation, decrease sucrose decomposition and improve the resultant white sugar quality. At the same time, steam from 2nd and 3rd evaporator effects could be used in vacuum pans, while maintaining the required effective temperature difference. A system used in the USA, in which each vacuum pan has its own condenser, is briefly described and its advantages indicated; it is thought that, despite the complexity of such a scheme, it should be tested in the USSR. The adverse effect of incondensable gases on steam condensing and its economics is discussed, references being made to the views of certain authors, including Honig. It is considered inadvisable to withdraw incondensable gases from an evaporator by passing them from one effect to the next or from the pan station by transferring them to subsequent pans, since this would lower the heat transfer coefficient and increase tube corrosion. Heat losses can be reduced by using contact or surface preheaters; the use of juice deaerators before evaporation is also advocated, since this would reduce sucrose degradation and tube corrosion (as a result of oxygen decrease in ammonia gases and condensate). Where condenser water is used for diffusion after multiple recycling in a closed circuit, it has been found that the diffusion process and 1st carbonatation juice filtration are slower; hence, it is recommended to use the water only after a single pass through a condenser. Three possible schemes for diffusion water treatment are suggested, all of them associated with use of recycle water in condensers. Since calculations have shown that fresh water has to be added to recycle water to make up sufficient for use in condensers, it has been suggested that some of the water could be used in a rotary attachment to a condenser to cool incondensable gases and air withdrawn from the vacuum pans. Possible means of raising the efficiency of condensers are briefly examined; it is thought necessary to provide complete automatic control of condensers together with requisite alarm systems.

Advances in flow measurement in the sugar industry. W. Hogrefe. *Zucker*, 1977, **30**, 427-432 (*German*). The principles on which operate the magnetic induction and vortex types of flow meters are explained by a representative of Fischer & Porter GmbH. Advantages of both types of meter are listed, and possible applications within the sugar factory are indicated. The magnetic induction type is considered highly suitable for incorporation in control schemes involved in diffusion juice and water flow, milk-of-lime metering and carbonatation juice flow, and thin juice feed to evaporation. The vortex type of meter is applicable for condensate flow measurement in the evaporator and pan stations as well as centrifugal wash water feed. For molasses flow the magnetic induction type is able to measure only the total flow, but cannot distinguish between air and molasses where a lot of air bubbles form. In this application and in effluent flow measurement, a semi-spherical electrode is used.

Modern boiling and (its) control. P. Güray. *Seker*, 1977, **27**, (104), 16-29 (*Turkish*).—The theory and practice of modern massecuite boiling are explained, with examination of those factors of importance in boiling and in pan performance evaluation, including crystallization rate, massecuite circulation, vacuum, boiling time and supersaturation. Three graining methods are described, viz. the waiting method, shock seeding and fondant seeding, and the significance of Brix, temperature and viscosity explained, the last-mentioned factor also in connexion with final curing and molasses exhaustion. The conductivity method of boiling control is briefly described and information given on some commercial systems.

Chemical protection of stored beet with particular reference to "Faltan". J. Zahradníček, O. Šebíková, M. Ondráček and V. Koula. *Listy Cukr.*, 1977, **93**, 169-181 (*Czech*).—Tests conducted on treatment of stored beet with fungicides are reported. Results showed that, of

[1] Buriánek & Kmínek: *I.S.J.*, 1976, **78**, 311.



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the 20 compounds tested, the best was "Faltan" (N-trichloromethylthiophthalimide), manufactured by Standard Oil Development Co. Applied as an aerosol at 8 g a.i. per m^3 of beet, it gave lower alpha-amino N, ash and invert sugar contents and a greater percentage of healthy beets as well as lower daily weight and sugar losses than with the untreated control, and when used in combination with forced ventilation it improved on the results obtained with the latter alone. Residual quantities of the fungicide in beet, cossettes and flume water were <1 ppm and were negligible in pulp, molasses and sugar.

Development of modern beet storage in the factory yard. K. Hangyál. *Cukoripar*, 1977, **30**, 102-105, 152-155 (*Hungarian*).—Details are given of beet reception and storage at Harvan sugar factory, where the beets are unloaded from rail and road trucks with the aid of water jets and pass by conveyors to beet pumps for transfer to a central belt conveyor feeding a mobile beet piler with extended boom travelling along a track above and at right angles to the beet piles. From the piles, which are provided with ventilation means, the beets are reclaimed by fluming. The water for the beet handling system (using Elfa equipment) is obtained from a settling tank, the treated water from which passes via an intermediate tank to the pumps distributing it to the various points.

Electronics. I. Zentai. *Cukoripar*, 1977, **30**, 155-158 (*Hungarian*).—The author explains the functions of three components in electronic systems as used in the sugar industry. The components are the triode, the transistor and the Nixie tube (a glow discharge tube which converts impulses into a visual display).

Ignition sources of dust fires and dust explosions in the food industry. R. Wasmund. *Zeitsch. Zuckerind.*, 1977, **102**, 581-589 (*German*).—The survey covers four main groups of ignition sources: thermal, mechanical, electrical and radiation sources. The first group includes naked flames, hot surfaces and spontaneous combustion; the second category consists of sparks caused by friction or impact, and heat generated by rubbing or pressing; the third group covers electric plant, electrostatic charges, lightning strikes and high-frequency discharges, while the fourth category comprises light and heat radiation.

Sucrose loss by beet respiration. R. Vanstallen. *Sucr. Belge*, 1977, **96**, 323-331 (*French*).—By measuring the emission of CO_2 produced by beets during storage it is possible to determine, with good accuracy, the sucrose loss resulting from respiration of the roots. An automatic measuring apparatus permits production of CO_2 by beets stored in large containers to be followed. The variety does not appear to be an important factor in sugar loss from beet by respiration, but the formation of CO_2 is higher when petioles have been left on the beet. Increased loss of sugar by respiration is observed in cases of even slight frost damage. It has been found that treatment of beets with thiabendazole slightly retarded respiration and noticeably reduced sprouting, while no mould formed on the treated beets.

Anaerobic purification of (beet) sugar factory waste water. I. G. Lettinga, A. G. N. Jansen and P. Terpstra. *H_2O*, 1975, **8**, (26), 530-536; through *S.I.A.*, 1977, **39**, Abs. 77-1202.—Tests were carried out in a pilot installation which included a reactor of 61 litres capacity. As well as measuring the purification attainable at various organic and hydraulic loads and the development of the sludge, attempts were made to find which factors were important for starting the fermentation with non-adapted sludge. When non-acidified solutions of beet extract were fed, 90% purification was obtained after 16 days if the initial load was below 0·12 kg COD.kg^{-1} sludge/day. Volatile fatty acids were not all degraded simultaneously. If an inoculate which had been adapted was used, the course of fermentation was good at high initial loads (up to 0·9 kg COD.kg^{-1} per day); with acidified liquid, $<90\%$ purification was obtained with a load of 8-10 kg COD.m^{-3} per day, The specific activity of the sludge was low for non-acidified liquid, but high for acidified liquid. If non-acidified liquid was fed, the maximum load at 30°C for $<90\%$ purification was approx. 4·0-4·5 kg COD.m^{-3} per day.

Anaerobic purification of beet sugar factory waste water. II. G. Lettinga, J. van der Saar and J. van der Ben. *H_2O* 1976, **9**, (2), 38-43; through *S.I.A.*, 1977, **39**, Abs. 77-1203.—In order to study the adaptation of the sludge (see preceding abstract), tests were made on non-adapted sludge and an acidified solution of beet extract. Stable fermentation occurred if (*a*) the initial load of the sludge was $<0{\cdot}14$ kg COD.kg^{-1} sludge per day, and (*b*) the load was increased only after good purification ($>80\%$) had been obtained. If the bacterial material was well adapted, the load could be increased to about 0·7 kg COD.kg^{-1} sludge per day. If the pH of the contents of the reactor was increased to approx. 10·7, fermentation almost stopped. When the pH was brought back to the correct value, it quickly restarted.

Problems of raw material and processing capacities. W. Góralczyk. *Gaz. Cukr.*, 1977, **85**, 172-173 (*Polish*). Because of the disproportion between processing capacity and the quantity of beet delivered to Polish sugar factories, the campaign has to be extended to an average of 125 days, which is beyond the optimum, bearing in mind climatic conditions, so that considerable losses result. While domestic sugar demand and export needs require a 37% increase in output by 1980 compared with 1975, the processing capacity of existing sugar factories will rise by only 18% in the same period as a result of expansion and modernization. A major factor mentioned in respect of raw sugar quality is beet sugar content—the higher the content, the smaller the number of beets needed for processing at constant sugar output. To improve the situation, the recommendation is to improve beet quality through varietal selection, with particular attention to storage properties, to raise the standard of storage at factories, and to make full use of available processing capacity, particularly by applying new techniques.

Factors relating to tasks of the sugar industry. S. Zagrodzki. *Gaz. Cukr.*, 1977, **85**, 173-174 (*Polish*).—The author calls for improvements in the quantity and quality of beets delivered to Polish sugar factories, so that the sugar content is higher and pulp yield lower. The plant population at harvest should be raised from 50-60,000 to 80-100,000 per ha, for which it is important to plough in the autumn to a depth of 40 cm, and use N, P and K fertilizers judiciously. Micro-nutrient application is also very important. Factory production plans

should not be made on the basis of beet area, but should be flexible to allow for weight of beets delivered and their sugar content. More money should be made available for sugar factory expansion and modernization.

Test on determination of the level of unknown sucrose losses during processing. A. Ostaniewicz. *Gaz. Cukr.*, 1977, **85**, 179-180 (*Polish*).—On the assumption that the majority of undetermined sucrose loss in a beet sugar factory results from the action of micro-organisms and enzymes, invert sugar in juices and molasses was determined by the method of the Institut für Zuckerindustrie in Berlin, while lactic acid was determined by gas chromatography. The sucrose loss was then calculated using the formula $R = 0{\cdot}95\ (a - b)$, where R = weight of sucrose decomposed % on beet, a = weight of invert sugar in raw juice % on beet, b = weight of invert sugar in press juice % on beet, and 0·95 is a coefficient relating the weight of invert sugar formed to that of the initial sucrose. Tabulated data demonstrate the clear increase in invert sugar with each month from October to December, inclusive, while the lactic acid increased only slightly from November to December. The total sucrose losses were found to be 0·105, 0·272 and 0·350% on beet in October, November and December.

Present-day content of fertilizer components in sugar factory waste water. K. Skalski. *Gaz. Cukr.*, 1977, **85**, 184-185 (*Polish*).—It has been found that sugar factory effluent contains considerable quantities of N, P and K; N and P contents have risen steadily since 1960, while K has tended to fall, although it is still present in larger amounts than the other two. Main causes of the presence of the three constituents are discussed; they are chiefly beet fertilization and subsequent release of the fertilizer components to the various waste products during processing, concentration of the constituents from farm, domestic and industrial effluent in surface waters at a height above the sugar factory fresh water intake, and eutrophism or process water in reservoirs. N and P are among mineral elements required for biological treatment of waste water, and it has been found that optimum biodegradation takes place at a BOD_5:N ratio of 32:1 and a BOD_5:P ratio of 150:1. Under these conditions, BOD_5 can be markedly reduced.

Methods of automatic massecuite boiling control. Physico-chemical fundamentals. M. Rychlicki. *Gaz. Cukr.*, 1977, **85**, 132-134, 186-188 (*Polish*).—The physico-chemical fundamentals of automatic boiling control based on boiling point elevation, conductivity and viscosity are explained and references made to various well-known techniques and to commercially available systems. Thirty-one references are given to the literature.

Possible means of reducing energy consumption in the sugar house. H. Schiweck. *Zucker*, 1977, **30**, 525-534 (*German*).—Factors influencing the massecuite boiling process, individually and together, are examined; they include pan design, controllable parameters (such as steam pressure in the vapour space, syrup Brix, temperature and feed volume in unit time, massecuite flow, steam conditions in the calandria, and steam pressure and volume in unit time) and process parameters arising out of the factors already mentioned (massecuite temperature at different points, vapour space temperature, and water evaporation rate). The effects of these on boiling are explained by referring to observations of specific pans and operation techniques. The importance is underlined of maintaining the various parameters at constant levels in order to obtain an easily curable massecuite at lowest energy consumption. The crystallization rate governs the boiling rate only in the crystal size range below 50 μm, whereas in the normal crystal size range it is the diffusion coefficient (transfer of sugar molecules to the crystal surface) which is the determining factor. Methods of raising the material transfer rate are examined: (i) boiling at higher temperatures and hence lower mother liquor viscosity—unpractical because of increased coloration, sugar degradation and steam consumption; (ii) reduction of mother liquor viscosity by means of additives, of which, in the experience of Süddeutsche Zucker-AG, only urea has given positive results; (iii) increasing the evaporation rate by raising the temperature difference between calandria steam and massecuite and thus increasing steam bubble agitation—this necessitates higher steam pressure in the calandria, which is generally not possible in white sugar factories; (iv) installing more powerful stirrers, a measure which has the disadvantages of high capital costs and increased power consumption; and (v) increasing the massecuite stirring rate by introducing air below the calandria, as patented by Vasseur[1]. One possible measure which is described is the Tate & Lyle heavy boiling system[2], which permits a considerable reduction in the boiling time. Technologically similar to this is a system involving pre-curing of low-grade massecuite, which would allow 62-63 purity molasses to be recycled to the pan and thereby raise the Brix. The author also calls for greater use of crystallizers to cool high-grade white and raw sugar massecuites as well as low-grade products.

New ion exchange systems for the beet sugar industry. I. Softeners. K. W. R. Schoenrock and A. C. Gupta. *Zucker*, 1977, **30**, 541-547 (*German*).—See *I.S.J.*, 1977, **79**, 82.

Effect of milk-of-lime on the storage behaviour of sugar beet. F. Schlanitz and E. Malits. *Zucker*, 1977, **30**, 547-549 (*German*).—Sugar losses in stored beet take place as a result of bacterial action, metabolic processes and biochemical conversion to dextrose, levulose, raffinose and other sugars. The storage system at Siegendorf is described, and an indication given of the high bacterial content of the flume water, which has a pH of 5·8, a COD of 4500 mg.litre^{-1} and BOD of 3000 mg.litre^{-1}. The beets are sprayed with 3% milk-of-lime before storage. Experiments were carried out on raising the pH of the flume water by liming, thereby preventing microbial growth. Orientation tests were carried out in 1975/76 to determine the effect of lime on beet storage properties. Tabulated data show that treatment of beets stored for 60, 61, 63 and 72 days tended to reduce both pol losses and the increase in reducing matter by comparison with untreated controls. Weight losses were not measured.

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[1] French Pat. 2,171,024.

[2] Lyle: "Technology for sugar refinery workers". 3rd Edn. (Chapman & Hall, London) 1957, pp. 256-259.

LABORATORY STUDIES

Beet reception on the basis of sugar content. Ö. Krieger. *Cukoripar*, 1977, **30**, 138-141 (*Hungarian*).—A brief survey is presented of methods used in countries outside Hungary to sample and analyse beet for sugar and other constituents. Experiments in Hungary are also mentioned; it is stressed that payment for beet on the basis of sucrose content is practical only where automatic tarehouse techniques are used.

Sucrose test strips for the sugar industry. A. Dziengel. *Zeitsch. Zuckerind.*, 1977, **102**, 589-590 (*German*). Details are given of a test strip developed for semi-quantitative determination of sucrose on the basis of sucrose conversion to dextrose by an enzyme and determination of the dextrose by means of the glucose-oxidase-peroxidase method. The strip undergoes colour change from white to green after 15-120 seconds' immersion in the test solution and can measure as little as 0·001% sucrose (w/v). The test reaction is stable within the temperature range 0-80°C, although only brief immersion is advisable at high temperatures in order to avoid thermal denaturing of the enzyme. pH has no effect on accuracy in the range 1-12, while non-sucrose constituents do not influence the results. While the colour change can be compared with standards, it is also possible to arrange different test fields on the same strip, or even to introduce a second, passive colorant which would give mixed coloration and so increase the colour gradations corresponding to different sucrose concentrations The test strip is considered particularly suitable for detection of sucrose traces in condensate or boiler feedwater; comparison with the α-naphthol method has shown the test strip to be more sensitive by a factor of 10.

Granulometric characterization of direct sulphitation white sugar. E. Leon, I. Díaz, R. Morera and M. Alvarez. *ATAC*, 1977, **36**, (2), 48-53 (*Spanish*).—Samples of sugar were sub-sampled and the sub-samples (60 g) washed with 75 cm^3 of sugar-saturated ethanol and then three times with 75 cm^3 of ethanol before drying on a filter paper in an oven at 50-60°C for 15 minutes, the sugar being turned over every 5 minutes. Measurements were made, using standard screens, of the MA and CV of the samples[1], and these are compared. It is concluded that the method gives a sufficiently precise measurement of the granulometric characteristics of the sugar and that the values for direct sulphitation white sugar are very similar to corresponding values for refined sugar.

The density of concentrated sugar solutions. Z. Bubník and P. Kadlec. *Listy Cukr.*, 1977, **93**, 159-166 (*Czech*).—For measurement of sugar solution density a dilatometer has been devised which consists of a 250-cm^3 stoppered flask which is approximately pear-shaped, the narrow part being at the bottom. A capillary is inserted into the end of a 3-mm diameter tube which passes down inside the flask almost to the bottom. (When a capillary was inserted all the way into the flask, a small amount of mercury used for the density determination was ejected when the flask was sealed.) For the measurements, 100-200 g of mercury is fed into the flask, followed by the made-up aqueous solution (if molasses is involved, this should be a 1:1 dilution). The contents are then heated in a water bath at 75°C to establish equilibrium, after which the flask is sealed and the temperature raised until the mercury starts to flow out of the capillary to an analytical balance. The temperature is then raised by 5°C, the discharged mercury allowed to flow to the balance, and the process repeated until a temperature of 95°C, after which the temperature is reduced to 40°C. The flask is then dried and weighed. The volume expansion and hence density of the solution is obtained from the amount of solution and mercury in the flask at equilibrium, from the known density of the mercury and water and from the amount of mercury discharged from the flask. Accuracy is $\pm 0{\cdot}5$ $kg.m^{-3}$ for pure sucrose solution and $\pm 0{\cdot}6$ $kg.m^{-3}$ for raw sugar and molasses solution.

Colorimetric determination of reducing sugars using *o*-nitrobenzoic acid. M. Teodorczyk and R. Soloniewicz. *Chem. Anal.* (Poland), 1977, **22**, (1), 151-154; through *S.I.A.*, 1977, **39**, Abs. 77-1145.—Dextrose and levulose in milligram amounts were determined by reaction with *o*-nitrobenzoic acid in alkaline solution. Optimum results were obtained when the KOH concentration in the final solution was 0·25M and a 20% solution of sodium potassium tartrate was added to minimize the effect of oxygen. The reaction mixture was kept in a water bath at 70°C for 30 min, and the absorbance was measured at 410 nm.

New colour reaction for the determination of reducing sugars. R. Soloniewicz and M. Teodorczyk. *Fresenius' Zeitsch. Anal. Chem.*, 1977, **283**, (4), 304; through *S.I.A.*, 1977, **39**, Abs. 77-1146.—Dextrose, levulose and galactose were determined spectrophotometrically at 650 nm, using as reagent 1,5-dihydroxy-4,8-dinitroanthraquinone-2,6-disulphonic acid.

Nomograph on inversion of sucrose. M. K. Thippeswamy. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.29-M.32 (+ fig.).—A nomogram is reproduced for use in establishing the percentage of sucrose inverted in a solution per hour at a known temperature and pH. Three examples illustrate use of the nomogram.

Probable reason for high unknown losses in the summer season. G. G. Kakade. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India*, 1976, (I), M.45-M.48.—It has been found in some Indian sugar factories that unknown losses are greater in the period from March onwards than in winter months. The increase is attributed to higher ambient temperatures which contribute to a rise in the temperature of juice fed to the weighing tank. The juice is subsequently analysed when its temperature has fallen, so that there is a temperature difference which is not allowed for in Brix determination. A sample juice balance indicates how such a difference can affect the Brix and hence pol in mixed juice % cane and pol % cane. The result is, in the example given, an unknown loss represented by 0·29% extra pol.

[1] Powers: *I.S.J.*, 1948, **50**, 149-150.

Further analysis of undetermined sugar loss. A. R. Sali and V. R. Holkar. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), M.49-M.52.—By substituting values of total non-sugars % cane and the increased value in the factory resulting from unknown losses (mainly due to inversion) in a crystal sugar balance, the authors establish a corrected crystal sugar loss % cane, which is described as "mechanical loss". Deduction of the "mechanical loss" from the total undetermined losses then gives "chemical loss".

Preservation of sugar cane juice. I. A search for a new preservative for thin juices. S. Bose, K. C. Gupta and S. Mukherjee. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), M.71-M.78.—Mercuric chloride is used by most Indian factories as a preservative for mill juice during storage before analysis. However, because of its high cost, its replacement with a cheaper but equally effective preservative is desirable. Investigations were carried out with salicylic acid, hexamethylene tetramine, sodium metabisulphite, phenol, ammonium bifluoride and cetyl pyridinium chloride as well as mercuric chloride; results are tabulated, showing the Brix, pol, purity, reducing sugars and (in some cases) pH after a given time up to a maximum of 8 hours. None of the chemicals tested was found to be as effective as mercuric chloride, but it did prove possible to achieve a reduction in the quantity of $HgCl_2$ to 0·1 g/2000 cm^3 juice while still achieving highly satisfactory results.

Spectrophotometric and chromatographic studies on the kinetics of the production of melanoidins by the reaction of reducing sugars with amino acids. S. K. D. Agarwal and P. C. Johary. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.35-G.48 (+ figs.). Dextrose and levulose were reacted, individually, with glycine, α- and β-alanine, valine and γ-aminobutyric acid, and the reaction kinetics studied spectrophotometrically in the ultra-violet or visible bands as well as by descending paper chromatography with 2:2:1 butanol:ethanol:water. The resultant colouring matter was also examined during and after dialysis through a cellulosic tubular membrane. The spectrophotometric studies showed that the melanoidins formed by the Maillard reaction had absorption maxima in the range 410-460 nm depending on concentration. Measurement of colour development at 420, 490 and 560 nm and temperatures of 90, 95 and 100°C showed that it was very slow initially. An induction period was indicated in all the reactions, but was hardly evident with reactions involving β-alanine and γ-aminobutyric acid. The period fell with rise in temperature and was more evident at higher wavelengths. The rate of colour development depended on the nature of the reactants; levulose reactions produced more colour than did dextrose reactions. The fastest reaction occurred with γ-aminobutyric acid and the slowest with glycine. The R_f values of compounds formed by the reactions were established; a common feature was the presence of compounds having zero value which reacted with ninhydrin, indicating the presence of N. Reaction between dextrose and γ-aminobutyric acid led to formation of levulose similarly to the conversion of e.g. dextrose to an equilibrium mixture of dextrose, levulose and mannose in the Lobry de Bruyn transformation in the presence of dilute alkalis. Polysaccharides were formed as well as amino compounds during colour formation, both low M.W. and high M.W. saccharides being detected by spraying with silver nitrate. Colouring matter formed by reaction between dextrose and γ-aminobutyric acid and having a peak absorption at 295 nm was dialysed for seven days, during which period the peak diminished and finally disappeared, while a new one occurred at 260 nm and became more prominent until finally showing a sharp fall in intensity; the final dark solution left on the membrane did not show any peak.

Studies on removal of dextran by dextranase. R. Bhatnagar and K. A. Prabhu. *Proc. 41st Ann. Conv. Sugar Tech. Assoc. India,* 1976, (I), G.99-G.106.—The dextran-utilizing properties of *Aspergillus flavus,* which contains dextranase (as do a number of fungi of the same genus), were studied. (Earlier investigations had involved *A. niger* as well, but *A. flavus* was found to be more active.) While the fungus hydrolysed dextran (produced by *Leuconostoc mesenteroides*) under static conditions, shaking gave even greater hydrolysing power.

Study on molasses composition. II. Occurrence of saccharinic acids in molasses. L. Skála and M. Friml. *Listy Cukr.,* 1977, **93,** 201-204 (*Czech*).—Two methods were tested for isolation of α-D-glucosaccharinic acid as a lactone from molasses. Carboxylic acids were first extracted from the dilute molasses in stages with ether, and the composite extract evaporated to dryness before dissolution in water. The solution was then concentrated and heated at 70-80°C before passage through basic anion exchange resin in OH^- form to remove strong and moderately strong acids. The eluate obtained from the column was separated into two aliquots. One was adsorbed on "Amberlite IR-410" anion exchange resin in carbonate form and eluted with ammonium carbonate, which was then removed with cation exchange resin in H^+ form. The aqueous eluate from this was then subjected to crystallization to remove impurities in the mother liquor, the crystals then being dissolved in ethyl alcohol and finally subjected to preparative thin-layer chromatography. This method was better than one involving isolation of the acid as its barium salt which was then dissolved in water and the solution treated with cation exchange resin in H^+ form. At various stages in both methods, thin-layer chromatography on silica gel was also used for quantitative determination of the various molasses components as well as the saccharinic acid, which was isolated at a maximum of 0·13% on dry matter.

Study of starch in sugar and intermediate products. A. C. Chatterjee, S. R. Kalaswad and B. R. Math. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.29-G.35 (+ fig.).—Details are given of a photocolorimetric technique for starch determination in raw sugar on the basis of the original Balch method, and a description is also given of the procedure for preparation of a standard starch curve. Results for a number of sugar grades and intermediate products are discussed. The maximum quantity (242·4 ppm) was found in crusher juice, followed by syrup, mixed juice and raw sugar (108·8 ppm). White sugar of varying grades contained 29-73 ppm. The coarser grained sugars contained more starch than did the smaller grained sugars (this applied to both white and raw sugars).

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BY-PRODUCTS

Sweets for starters. A. Vlitos. *Chem. in Britain,* 1977, **13,** 340-345.—While, up to now, the economics of production have not favoured the use of sucrose as a chemical feedstock where petrochemicals have been available for manufacture of a wide range of derivatives, the change brought about by OPEC in the price structure of petrochemicals such as naphtha, ethylene and its derivatives has made the future use of sucrose more likely. It is considered that applications of sucrose chemicals (of which there are probably at least 100 "on the shelf" which have not been tested for potential applications) are best established by the user industry, since the sugar industry is not well suited to this purpose. The history of the development of "Tal" sucrose surfactant, which now has fifteen possible applications, is briefly described, and its typical composition and properties given. Reference is also made to the possible use of microbes such as *Azotobacter* sp. and *Xanthomonas* sp. to produce alginic acid and xanthan, respectively, from molasses or sucrose for use in the food industry and oil drilling. The possible production of ethylene from molasses is also considered. (See also *I.S.J.,* 1975, **77,** 323-326.)

Why the grass is always greener for Matthew Waterhouse's pedigree Ayrshires. D. Charlesworth. *British Sugar Beet Rev.,* 1977, **45,** (3), 23-24.—Mr. Waterhouse farms 202 ha in Yorkshire and runs a herd of 350 Ayrshire cattle, 120 of which are milkers. More than 80 ha is grassland (mostly 3- to 4-year leys) to which 510-1020 tonnes of sugar factory "lime" (filter cake) is applied annually during the summer when the land is dry. This encourages growth and maintains the green colour of the grass. Mr. Waterhouse grows beet on 10 ha of land, and takes all his beet pulp allocation (plus an extra 50 tonnes a year which he buys) for cattle feed. In addition, young heifers are grazed on the beet tops throughout the winter.

Alcoholic fermentation of molasses from deteriorated cane. A. A. Grancelli. *La Ind. Azuc.,* 1977, **84,** 220-224 (*Spanish*).—Changes in the ash and gums content of molasses observed during 1974 and 1975 were related to deterioration following drought and a prolonged period of cane storage between burning and crushing. Foam formation in stored molasses was also observed and is discussed as a consequence of deterioration. Molasses from deteriorated cane needs a high consumption of acid for pH adjustment, and this gives rise to a high salts content which hinders fermentation. Cellular reproduction of the yeast is reduced as is its fermentative power. Flocculation of the yeast occurs as a consequence of the gums and dextran content, and dextran also reduces the alcohol yield, probably because it affects the viscosity of the fermentation medium. During distillation the gums result in excessive foaming, while the high salts content produces heavy scale formation.

The composition of vinasse and effects of its application as a fertilizer to sugar cane. A. A. Rodella and S. E. Ferrari. *Brasil Açuc.,* 1977, **90,** 380-387 (*Portuguese*).—The mineral contents of 30 vinasse samples from different distilleries were analysed and are tabulated. The N content as $(NH_4)_2SO_4$ varied between 2·5 and 9·0 kg.m^{-3}, averaging 4·8, while K as KCl varied between 4·1 and 13·6, averaging 8·1 kg.m^{-3}; P as triple superphosphate varied between 0·1 and 0·6, averaging 0·2 kg.m^{-3}. This variability inhibits use of vinasse as fertilizer; however, conductimetric ash was found to be reasonably well correlated with the K content and could be used to assess the value of the vinasse for this nutrient. Use of vinasse as a fertilizer raised the ash and K content of raw juice, clear juice and molasses, and its use should not be such as to provide excessive amounts.

Dry pulp and energy savings. M. Demaud and M. Taccard. *Ind. Alim. Agric.,* 1977, **94,** 737-747 (*French*). The physico-chemical, economic, environmental and energy consumption aspects of beet pulp pressing and drying are discussed. The effects of pH, temperature and diffuser type on pressing are examined, and possible ways of improving pressing efficiency are described: reimbibition of the pulp with press water so as to avoid formation of air pockets, and addition of SO_2 or aluminium sulphate. Methods of increasing drying efficiency are also discussed. Mention is made of recovery by condensation of latent heat from the water vapour driven off the pulp, and its use to reheat the air used to extract water from the pulp in a pre-dryer; the process is considered too costly, while not completely solving the problem of treating hot condensate containing dust and acids.

Trials of the ammonification process for distillery effluent treatment. D. S. Dahiya, C. S. Bhatt, K. A. Prabhu and L. Viswanathan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.,* 1975, (I), G.69-G.75 (+ fig.). Trials on the distillery effluent treatment process developed at the National Sugar Institute[1,2] are reported. The ammonifying bacteria were cultured on distillery spent wash of 3-3·5°Bx to which urea and phosphate had been added at the rates of 5000 and 300 ppm, respectively. The culture was then transferred to storage pits containing the effluent and gradually built up. The reduction in organic acids reached a maximum after 7-8 days, after which further 2:1 diluted spent wash was added, and the urea and phosphate replaced with waste wet yeast sludge from the fermenters. Once the pits were full, a continuous stream of spent wash was admitted to the first pit, and steam-treated wet yeast sludge added to the different pits at regular intervals at the rate of 0·1% (w/v) on wash. Retention time in the pits was four days. BOD reduction was about 80% to a final content of about 3000 ppm, while the COD was reduced from 88-124,000 ppm to 4-5200 ppm. Total N, P_2O_5, K_2O, ash and both total and volatile solids were reduced. The treated effluent was free of disagreeable odour and could be used for irrigation.

[1] Dahiya & Prabhu: *I.S.J.,* 1974, **76,** 90.
[2] Prabhu & Prakash: *ibid.*

TRADE NOTICES

Filter press. P & S Filtration Ltd., Broadway Mill, Haslingden, Rossendale, Lancs., England BB4 4EJ.

P & S Filtration Ltd., well known as makers of textile filter media for more than 150 years, announce the introduction of a filter press, the "PSP 1300". This is opened and closed by a single hydraulic cylinder which is charged from a variable-displacement piston pump; when the press is fully closed, the pump unit automatically cuts out and the pressure is maintained by means of an accumulator. During filtration, automatic allowance is made for any expansion or contraction of the filter plates resulting from extremes of temperature occurring during filtration. This minimizes maintenance and downtime and greatly increases press, plate and cloth life. A reversible hydraulic motor fed from the main circuit drives the "shuttle" which operates with a reciprocating action on the side bars. An important safety feature of the filter press is an interlocking system coupled with an Irwin Sick optical safety curtain which prevents opening of the press during filtration. Plate construction can be varied according to customer and product requirements, polypropylene plates being recommended for a wide range of applications. A range of more than 200 filter fabrics, both natural and man-made, is available.

Pump protection. Mono Pumps Ltd., Mono House, Sekforde St., Clerkenwell Green, London, England EC1R 0HE.

The new "Sensaflo" pump protection unit available from Mono Pumps Ltd. has been developed to prevent damage to pump components when running dry. It is an externally-mounted flow sensing transducer system which generates a signal in response to an interruption in product flow; the signal can be used to switch off the pump motor, sound an alarm or start/stop associated process equipment. The system continuously monitors flow conditions within the pump and has been specially designed to combine robustness with optimum sensitivity under arduous working conditions.

Chromatographic separation of molasses. Finnish Sugar Co. Ltd., SF-02460 Kantvik, Finland.

The Finnsugar-Pfeifer & Langen process for sugar extraction from molasses (beet or cane)[1] uses cation exchange resin in alkali metal form which acts as an adsorbent material for molecular fractionation, so that very little regenerant is required. Pre-treated, diluted molasses is fed to the top of the column, followed by eluant, both solutions passing down through the bed under gravity in a plugwise flow, during which the fractionation takes place. The sucrose and other carbohydrates are adsorbed by the resin and their passage through the column retarded. The ionized compounds, i.e. the bulk of the non-sugars, are not adsorbed to any great extent and pass through the column essentially unhindered. The sucrose fraction leaves the column after the non-sugars fraction, while, in the case of cane molasses, the reducing sugars constitute a third fraction. The process is a "continuous batch" one, with several successive batches in the same column simultaneously. Column operation is automatically controlled by a micro-processor. Up to 95% of the molasses total sugars can be recovered. Details of the process and an article on cane molasses treatment (by Hongisto & Heikkilä) are available from Finnsugar Engineering at the above address.

PUBLICATIONS RECEIVED

British Gear Manufacturers Association Buyers' Guide. British Gear Manufacturers Association, P.O. Box 121, Sheffield, England S10 2HN.

The BGMA Buyers' Guide, available free from the Association, gives details of British Standards and the Association's Technical Memoranda relating to gears, couplings, cutting and grinding tools, etc. Individual companies belonging to the BGMA are indexed under product headings, with separate details of their addresses and product ranges.

Temperature measurement and control. Foxboro-Yoxall Ltd., Redhill, Surrey, England RH1 2HL.

A new 16-page brochure (Bulletin F-20) gives information on Foxboro temperature measurement and control instrumentation products covering temperatures in the range from —270°C to +1700°C and including sensors, resistance temperature converters, indicators, recorders, transmitters and controllers. The brochure covers both traditional equipment such as thermocouples and complex process computer applications typified by the SPEC 200 monitoring and control equipment.

"Black makes white". Norit N.V., Postbus 105, 3800 AC Amersfoort, Holland.

This is the title of a brochure available from Norit which describes how activated carbon works, how it is made and its many applications. The colourful brochure is worded in a simple style and concludes with information on Norit; illustrations depict the various activities at this, one of the largest active carbon producers in the world.

"Your guide to sugar beet fertilizers". Fisons Ltd., Fertilizer Division, Harvest House, Felixstowe, Suffolk, England IP11 7LP.

A 24-page collection of articles is devoted to showing how Fisons fertilizers can be used by the beet farmer to greatest advantage. The articles are: "How much N for beet?", "When to apply N", "Fertilizers for the Fens", "Why quality fertilizers?", "Magnesium for sugar beet", "Sugar beet on heavy land", "Boron deficiency", "Phosphate—can it be applied in the autumn?", "Beet tops—renewed interest as feed", "Sodium and potash", "Soil analysis", and "Weed control in sugar beet". Recommended quantities of fertilizers, according to soil type and in the presence or absence of sodium, are tabulated, and a final page is devoted to conversion of units to the metric system.

Carbon regeneration furnace.—Neptune Nichols Ltd. has received an order from Tate & Lyle Engineering Ltd. for the supply of an active carbon regeneration furnace to be erected at the refinery under construction at Bukidnon in the Philippines. The Nichols-Herreshoff multiple-hearth furnace ordered has the advantages of stage-to-stage processing of the carbon, very good temperature control, high thermal efficiency and hence high level of carbon reactivation, and minimum carbon loss.

Boiler order.—NEI International Combustion Ltd. have won an order worth £1·2 million for the supply of a boiler to produce 50 tonnes of steam per hour. It is to be erected in a new refinery under construction by Fletcher and Stewart Ltd. in Batangas Province, in the Philippines, and will be provided with a bagasse-fired furnace.

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[1] *I.S.J.*, 1977, **79**, 100–104, 131–134.

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

East German sugar imports and exports[1]

	1977	1976	1975
	tonnes, raw value		
Imports			
Argentina	5,974	0	0
Cuba	227,983	183,898	166,322
Denmark	0	5,442	0
	233,957	189,340	166,322
Exports			
Algeria	9,663	0	0
Belgium	0	0	163
Bulgaria	1,087	0	5,435
Cyprus	0	0	630
Egypt	21,979	21,692	998
Gambia	0	739	163
Germany, West	23,913	25,647	19,350
Greece	0	0	11,288
Hungary	0	0	609
Iceland	0	0	286
Indonesia	14,837	0	0
Ivory Coast	0	0	652
Lebanon	5,543	0	0
Nigeria	0	0	2,207
Rumania	0	0	3,940
Sierra Leone	0	815	902
Somalia	2,717	0	0
Sudan	11,739	0	0
Tunisia	0	0	5,435
USSR	0	18,478	0
Yugoslavia	0	0	10,869
Other countries	0	109	672
	91,478	67,480	63,599

Cane sugar refiners short course.—A two-week course of study was offered in July for provision of training at Nicholls State University, Thibodaux, Louisiana, for students sponsored by sugar refining companies. With instructors of high repute from the US sugar industry, the course covers most aspects of refinery operation including US legal regulations. The cost for the 1978 course was $600. Those interested in a possible 1979 course should write to Dr. Robert Falgout at the University.

The future uses of sugar.—This is the title of an informal talk given by Dr. A. J. Vlitos of Tate & Lyle Research & Development, before Corporate Members of the West Indian Committee which discusses the development of sugar usage as a chemical feedstock. The text has now been published by the Committee and is available from them at 48 Albemarle Street, London W1X 4AR, at a price of £1.70 or $4.00 U.S.

Japan loan to Queensland Sugar Board[2].—The Queensland Sugar Board has signed a 3900 million yen loan agreement with a Japanese banking syndicate led by the Bank of Tokyo. The loan, guaranteed by the Queensland Government, carries interest at 7·1% and repayment will be at the end of four years from funds received from raw sugar exports to Japan. It will provide funds to finance part of the $A120 million project to expand sugar storage and improve port facilities in Queensland.

Pakistan research into frost-resistant cane varieties. The US Dept. of Agriculture is providing a Rs. 3,000,000 fund (equivalent to $301,000) for research at the Punjab Agricultural Research Institute, Lyallpur, and the Sugarcane Research Station, Mardan, into the development of hardy cane varieties resistant to frost and also to saline conditions and drought. Another object is to seek techniques for recognizing visible characteristics associated with cold tolerance.

New Yugoslavia sugar factory[3].—A new sugar factory, to produce 71,000 tonnes of sugar per annum, is being built at a cost of 720 million dinars, at Padinska Skela. Start-up is scheduled for September 1979. The plant will use mostly Yugoslav-made equipment, but some specialized equipment may be imported.

Guyana sugar statistics[4]

	1977		1976	
	tonnes, raw value			
Initial stocks		10,314		10,312
Production		253,127		342,770
		263,441		353,082
Exports				
Algeria	5,673		44,364	
Canada	21,271		5,650	
China	856		9,779	
Leeward & Windward Is.	321		3,197	
Surinam	0		180	
UK	177,543		191,938	
USA	11,528		50,079	
Other countries	417		907	
		217,609		306,094
Consumption		35,747		36,674
Final stocks		10,085		10,314

Sweden sugar imports and exports, 1977[5].—Imports of sugar into Sweden in 1977 totalled 59,438 tonnes, raw value, as against 133,065 tonnes in 1976. Almost all the 1976 imports—127,418 tonnes—came from Cuba but only 12,537 tonnes came from that origin in 1977, 20,268 tonnes coming from Brazil, 11,521 from the Dominican Republic, 8987 tonnes from West Germany and 5718 tonnes from Poland. As against only 29 tonnes in 1976, exports in 1977 rose to 22,241 tonnes, principal destinations being Iran (12,825 tonnes), Algeria (4718 tonnes) and Morocco (4673 tonnes).

EEC-ACP sugar price agreement.—It was announced on the 23rd June that the European Economic Community and the African, Caribbean and Pacific countries supplying sugar to the Community had reached agreement on prices to be paid for the 1·3 million tonnes of ACP supplies. A 2% rise in the guaranteed price has been accepted for the 1978/79 season and is the same as the increase obtained by European beet producers. The new price is almost twice the average London Terminal daily price in June and will run for 12 months from 1st July. The storage levy for the ACP sugar has been reduced from 7·10 to 6·50 U.A. per tonne, white value.

Finland beet sugar campaign, 1977/78[6].—In the 1977/78 campaign, the Finnish sugar industry sliced a total of 554,463 tonnes of beet to produce 54,179 tonnes of white sugar, 10,991 tonnes of raw sugar and 22,853 tonnes of molasses.

Sri Lanka sugar imports[7].—Imports of sugar by Sri Lanka rose from 50,860 tonnes, raw value, in 1976 to 101,293 tonnes in 1977. In 1976, 37,169 tonnes were supplied by Thailand and 13,151 tonnes by India, the remaining 540 tonnes being of EEC origin; in 1977, however, the principal origins were India (27,530 tonnes), Brazil (21,000 tonnes), Thailand (19,500 tonnes), Taiwan (18,000 tonnes) and Poland (12,554 tonnes).

Chile sugar import requirement in 1978[8].—A spokesman for the state-owned company Industria Azucarera Nacional S.A. has stated that Chile will have to import 250,000 tonnes of raw cane sugar this year to offset a shortfall in domestic output. Beet sugar production was down substantially this year at barely 180,000 tonnes from last year's 289,000 tonnes which had covered 90% of domestic requirements. This was because of a reduction in sowings as a result of lower sugar prices in foreign markets.

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[1] *I.S.O. Stat. Bull.*, 1978, **37**, (4), 48–49.
[2] *Queensland Newsletter*, 14th June 1978.
[3] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (17), 12.
[4] *I.S.O. Stat. Bull.*, 1978, **37**, (4), 51–52.
[5] C. Czarnikow Ltd., *Sugar Review*, 1978, (1383), 95.
[6] *Zuckerind.*, 1978, **103**, 439.
[7] C. Czarnikow Ltd., *Sugar Review*, 1978, (1388), 95.
[8] *Public Ledger*, 6th May 1978.

Poland sugar exports, 1977[1]

	1977	1976	1975
	tonnes, raw value		
Algeria	58,962	6,012	651
Dubai	489	934	325
Germany, West	1,761	12,636	1,635
Hungary	0	12,554	0
Indonesia	43,118	0	0
Iran	11,367	0	0
Iraq	0	24,368	0
Jordan	0	13,641	0
Kuwait	460	920	325
Lebanon	0	0	4,330
Liberia	16	1,139	415
Libya	100,395	109,373	31,979
Morocco	5,413	0	0
Nigeria	435	434	2,165
Norway	5,111	7,091	135
Saudi Arabia	0	3,242	0
Spain	0	2,151	3,541
Sri Lanka	12,504	0	0
Sweden	2,835	0	0
Switzerland	0	1,083	13,527
Syria	22,245	15,210	10,160
Tunisia	0	11,367	0
USSR	5,641	114,759	0
Yemen	0	7,849	0
Yemen Dem. Rep.	0	5,684	0
Other countries	216	1,458	3,064
Total	270,968	351,905	72,252

Sugar beet cell culture research.—Michigan State University researchers have received a fund of $90,000 from the US Department of Agriculture to develop techniques for tissue culture of sugar beets. The three-year project is to develop methods for regenerating entire beet plants from cells or small clumps of cells collected from beet plant materials. Once the technique is established it will be possible to evaluate plant materials for disease resistance and other characteristics much faster and easier. Thousands of plants can be evaluated in a small space in the laboratory. The technique may speed up breeding work for improved sugar beets by three or four times.

Drought and Australian sugar production[2].—Drought in parts of Queensland is reported to be helping the Australian sugar industry's planned cut in production for 1978. The drought is worst around the Isis district in central coastal Queensland but some southern areas are also dry. The drought effects are only ancillary, however, to the deliberate cut in production which is being made to conform to ISA requirements, achieved by methods such as lowering fertilizer and irrigation water usage. It is too early to predict the size of the current cane crop which began in June, but the industry should have little difficulty keeping within the 2·9 million tonnes mill peaks for Queensland and New South Wales set by the Sugar Board. Mill peaks are production quotas for 94 net titre raws allotted to mills; above-peak output this year will receive the penalty payments of only $A1 per tonne set for raws in excess of Sugar Board requirements. Production at mill peak levels would provide enough raws for the domestic market, the ISA export quota (85% of Australia's 2·35 million tonnes annual basic export tonnage) and its contribution of about 154,000 tonnes to ISA stocks. Last year's mill peaks were also 2·9 million tonnes but the Board was able to find markets for the 3·34 million tonnes actually produced. Australia exported 2·80 million tonnes, tel quel, in 1977 against 2·47 million tonnes in 1976.

Mexico sugar prospects[3].—Sugar production in Mexico in 1977/78 is estimated at 2,750,000 tonnes, compared with 2,540,000 tonnes in 1976/77. Six sugar factories are to be built in south-east Mexico, using 85% locally-manufactured equipment, to raise output in the area from 110,000 to 560,000 tonnes, giving employment to some 25,000 people. It is expected that exports of sugar will be resumed shortly, following the halt since May 1975 caused by domestic shortages. The Comisión Nacional de la Industria Azucarera forecasts an exportable surplus of 78,000 tonnes, raw value, in 1977/78, with Mexico's International Sugar Agreement quota at 75,000 tonnes.

Colombia sugar statistics

	1977		1976	
		tonnes, raw value		
Initial stocks		19,999		29,834
Production		853,366		969,701
Imports:				
Argentina	24,697			
Cuba	39,188			
Ecuador	5,859			
EEC	25,521			
Peru	4,502			
		99,767		0
		973,132		964,466
Consumption		911,225		844,247
Exports:				
Chile			12,177	
USA			88,043	
		0		100,220
Final stocks		61,907		19,999

New South Wales sugar factories future[5].—CSR Ltd. have announced a decision to withdraw from New South Wales where the company owns three sugar mills. New South Wales cane growers, who met in May to determine the future of their industry, agreed to buy the three mills for $A6,200,000[6]. The growers have formed a cooperative to buy the mills and the N.S.W. Government has offered a loan of $A3,100,000; it is hoped this will be matched by the Federal Government. CSR had made it clear that, if the sale proposal were rejected, it would close the three mills (Broadwater, Condong and Harwood) by 30th June; with the sale approved, however, CSR will provide staff and other assistance to the cooperative for the operation of the mills. Owing to climatic conditions, the small size of the factories (daily processing capacities between 2800 and 3100 tonnes) and the problem of keeping up a cane supply in a mixed farming area, the mills have not proved attractive for CSR. New South Wales sugar production accounts for about 4% of total Australian output.

New Spanish sugar factory[7].—A new beet sugar factory has been built by Azucarera del Esla, a cooperative society. The factory, which cost 3·9 million pesetas, has a daily slice of 5500 tonnes and can produce 65,000 tonnes of sugar per year as well as 25,000 tonnes of molasses.

Denmark beet campaign results, 1977/78[8].—The six sugar factories in Denmark operated for an average of 105 days during the 1977/78 campaign and sliced a total of 3,638,616 tonnes of beet, to produce 520,900 tonnes of white sugar and 172,600 tonnes of molasses.

New Indian sugar project[9].—Consideration is being given by the Andhra Pradesh State Government to a Rs. 250 million (US $30 million) complex for the Metapalli-Jagitial area of Karimnagar District, to include a distillery and a paper and animal fodder manufacturing unit in addition to a modern sugar factory.

Indian sugar production increase[10].—Owing to a severe fall in gur prices in the Shrirampur area of Maharashtra, and diversion of cane from the closed gur factories to sugar factories, coupled with an abundant cane crop, almost all the factories will have had to extend their season by 6–8 weeks, to the end of May. As a consequence, sugar output of the 18 mills in the Ahmednagar district will be some 30% higher than in 1976/77.

[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (15), S11.
[2] *Public Ledger*, 13th May 1978.
[3] *Bank of London & S. America Review*, 1978, **12**, 206–207.
[4] C. Czarnikow Ltd., *Sugar Review*, 1978, (1387), 91.
[5] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (15), 14.
[6] *Queensland Newsletter*, 31st May 1978.
[7] *Sucr. Belge*, 1978, **97**, 163.
[8] *Zuckerind.*, 1978, **103**, 349.
[9] *Westway Newsletter*, 1978, (54), 10.
[10] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (14), 21.

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