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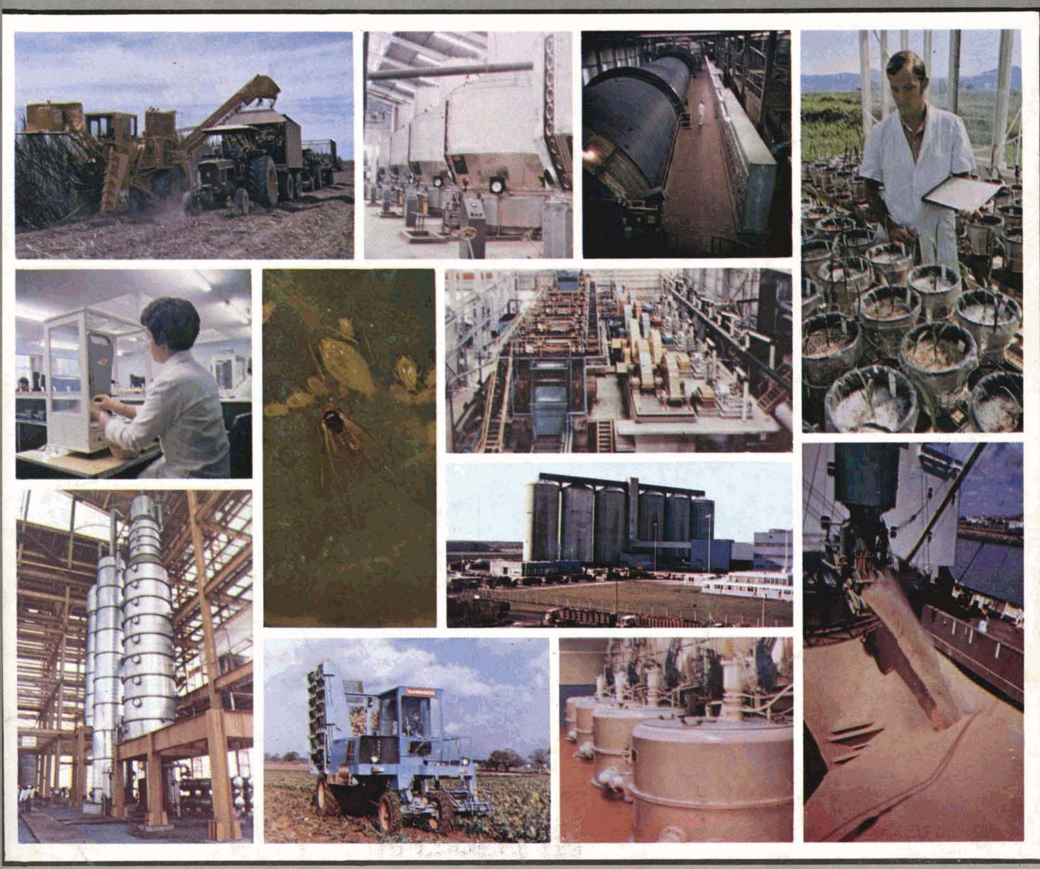

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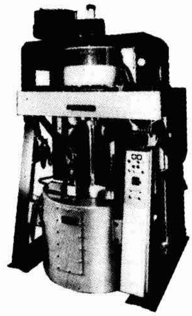

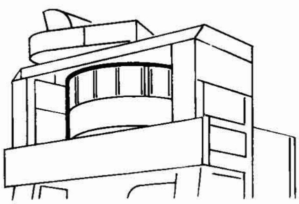

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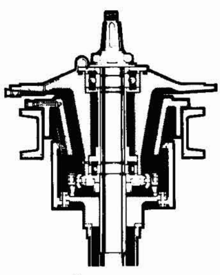

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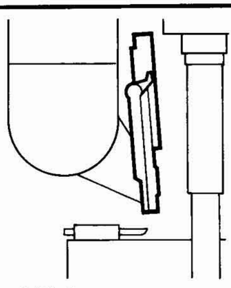

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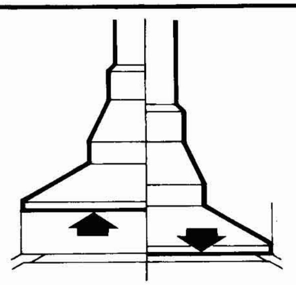

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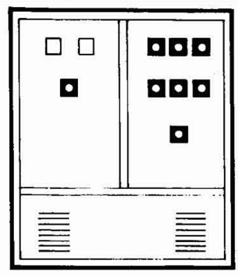

Controls

In 1977 alone, Codistil has designed, built and installed 47 alcohol distilleries, at a rate of 4 per month, all of them large sized, by no means depleting its designing, building and installing capacity.

Codistil distilleries make up for over 80% of the alcohol production capacity installed throughout the country, which in itself grants the Company the title of greatest distillery manufacturer in the world, its tradition being acknowledged in Brazil and many other countries.

Distilleries built by Codistil during 1977

Capacity	Type	Buyer	State/Country
90.000	Anhydrous Alcohol	Mendo Sampaio S.A.	Alagoas
120.000	Anhydrous Fine	Cia. Indl. Agrícola Ometto	São Paulo
120.000	Anhydrous Fine	Ometto Pavan S/A - Açúcar e Álcool	São Paulo
120.000	Anhydrous Alcohol	Usina São Domingos S/A.	São Paulo
60.000	Anhydrous Alcohol	Maracaí S/A - Agrícola e Pecuária	São Paulo
120.000	Anhydrous Alcohol	Usina Catanduva S/A - Aç. Álcool	São Paulo
120.000	Anhydrous Alcohol	Destilaria Miriri S.A.	Paraíba
120.000	Anhydrous Alcohol	Usina Mendonça Agro Indl. Coml.	Minas Gerais
120.000	Anhydrous Alcohol	Cia. Açucareira São Geraldo	São Paulo
120.000	Anhydrous Alcohol	Comercial e Construtora Balbo S.A.	São Paulo
60.000	Anhydrous Fine	Usina Barão de Suassuna S.A.	Pernambuco
60.000	Anhydrous Alcohol	Petrobrás - Petróleo Brasileiro S.A.	Minas Gerais
40.000	Distillation Unit	Açúcar e Álcool Bandeirantes	Paraná
20.000	Anhydrous Alcohol	Irmãos Biagi S.A.	São Paulo
60.000	Anhydrous Alcohol	Usina Santa Rosa S.A.	São Paulo
90.000	Anhydrous Alcohol	Cia. Açucareira de Penápolis	São Paulo
48.000	Distillation Unit	David Módulo & Irmão	São Paulo
90.000	Anhydrous Alcohol	Central Açuc. Santo Antonio S.A.	Alagoas
60.000	Anhydrous Alcohol	Us. São José de Estivas S.A.	São Paulo
30.000	Anhydrous Extra Fine	Cia. Engenho Central Quissaman	Rio de Janeiro
120.000	Anhydrous Alcohol	Usina Cansanção do Sinimbu	Alagoas
30.000	Anhydrous Extra Fine	Cia. Indl. Azucarera San Aurélio	Bolívia
30.000	Distillation Unit	Destilaria Miriri S.A.	Paraíba
90.000	Anhydrous Alcohol	Usina Modelo S/A - Aç. Álcool	São Paulo
60.000	Anhydrous Alcohol	Destilaria Porto Alegre S.A.	Alagoas
90.000	Anhydrous Fine	Dest. Aut. Álcool Maciape Ltda.	Alagoas
90.000	Anhydrous Extra Fine	Agrisa - Agro Indl. São João	Rio de Janeiro
90.000	Anhydrous Extra Fine	Agrisa - Agro Indl. São João	Rio de Janeiro
120.000	Anhydrous Alcohol	Dest. Baía Formosa S.A.	R. G. Norte
90.000	Anhydrous Alcohol	Industrial Porto Rico S.A.	Alagoas
90.000	Anhydrous Alcohol	Irmãos Zanin S.A.	São Paulo
220.000	Anhydrous Fine	Cia. Indl. Agrícola São João	São Paulo
90.000	Anhydrous Alcohol	Destilaria Rio Brilhante	Mato Grosso
120.000	Anhydrous Alcohol	Destilaria Rio Brilhante	Mato Grosso
60.000	Distillation Unit	União São Paulo S.A.	São Paulo
120.000	Anhydrous Alcohol	Usina Santa Adélia S.A.	São Paulo
60.000	Anhydrous Alcohol	Usina Massauassu S.A.	Pernambuco
90.000	Anhydrous Alcohol	Cia. Açuc. Norte de Alagoas	Alagoas
90.000	Anhydrous Alcohol	Cia. Açuc. Norte de Alagoas	Alagoas
120.000	Anhydrous Extra Fine	Agican - Agro Ind. Camaratuba	Paraíba
120.000	Anhydrous Fine	Cia. Indl. Agrícola Ometto	São Paulo
120.000	Anhydrous Alcohol	Penedo Agro Industrial S.A.	Alagoas
40.000	Distillation Unit	Açucareira Bortolo Carolo	São Paulo
90.000	Anhydrous Alcohol	Usina Santa Rita S.A.	São Paulo
120.000	Anhydrous Fine	Ometto Pavan S/A - Açúcar Álcool	São Paulo
60.000	Anhydrous Alcohol	Irmãos Biagi S.A.	São Paulo
20.000	Distillation Unit	Cia. Açucareira Araporã	Goiás

CODISTIL

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DEDINI

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How to teach an old centrifugal new tricks

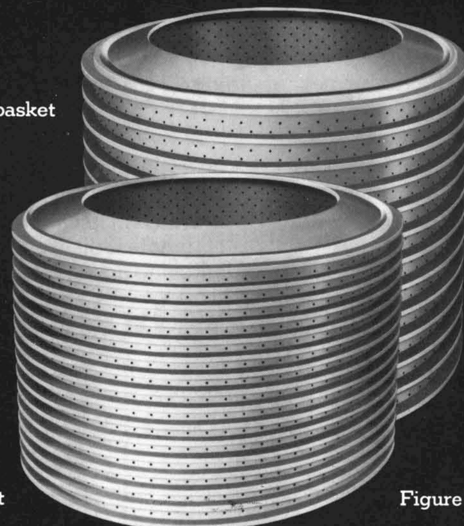
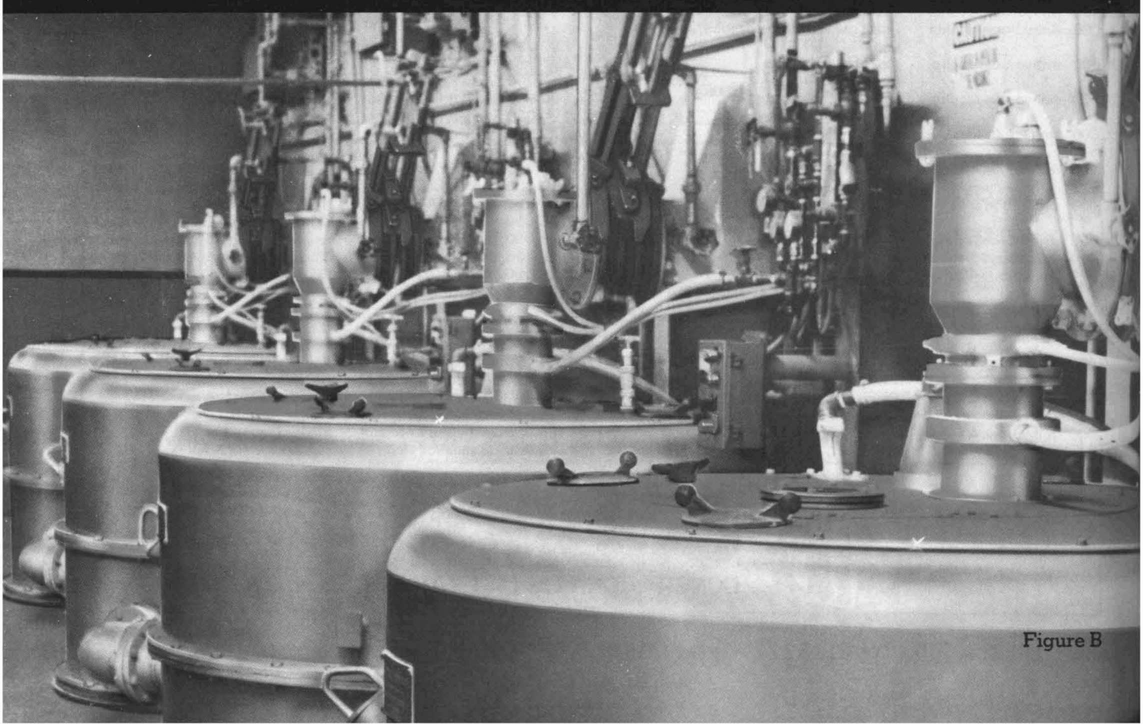


Figure A



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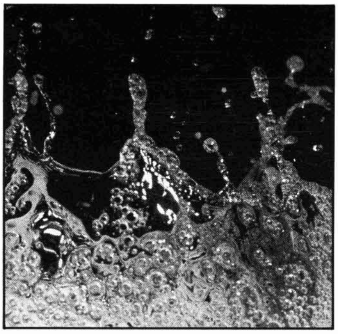
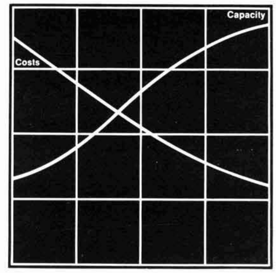
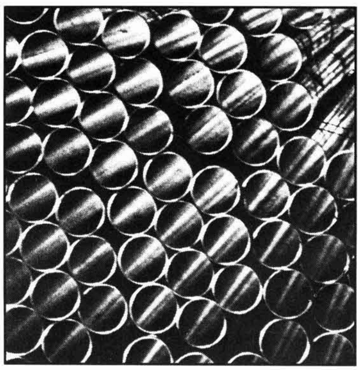
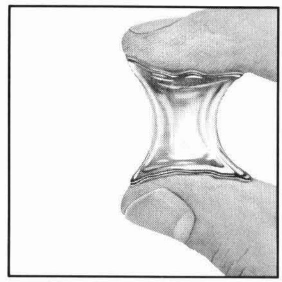
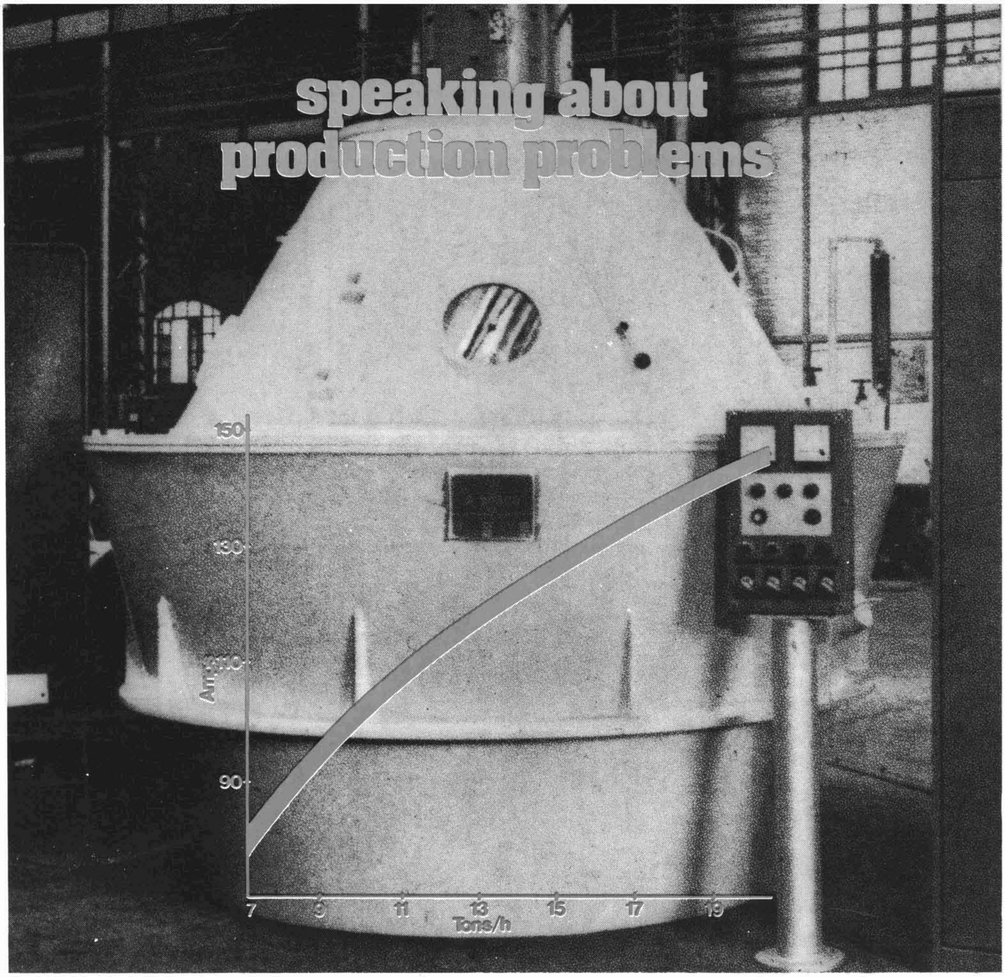



Capacity
Costs







is the centrifugal you are presently using "big" enough for your needs?

When the total production increases, also the number of centrifugals should be increased.
But, we say, it depends how to face the problem and what type of centrifugal to select.
In fact adopting our "B5" continuous centrifugal in your existing production system, it means that all problems, connected with your new installation, operation and maintenance requirements, will be automatically minimized.
The main technical features of our "B5" continuous centrifugal are infact:

- basket, truncated cone type, having a max. O.D. of 1500 mm. (59") and a max. I.D. of 1360 mm. (54") with a tot. filtering area of 167 sq. dm. (2590 sq. inch.), mounted on a pendular suspension which ensures a perfect dynamic stability.
- massecuite feeding into the basket coaxially with the drive shaft and uniform distribution through a proper device, formed by a cylinder and a cone, which rotates together with the basket.
- d.c. electric motor monitored by a "thyristors" type control equipment, capable of adjusting the centrifugation speed within a range of 1100/1800 rpm, in strict relation with whatsoever productive and/or technological requirement.

Thanks to what above, the "B5" continuous centrifugal guarantees:

- massecuite processing capacities up to 20 Tons/hr, when handling "Low purity" and "intermediate" products.
- improved sugar quality than that of the batch type centrifugals.
- absence of vibrations during operation, thanks to the pendular suspension and other technical devices.
- minimum power consumption.

Our centrifugal is despatched fully tested and assembled and, due to its harmonious self-bearing structure, it starts cutting down costs since time of its installation.

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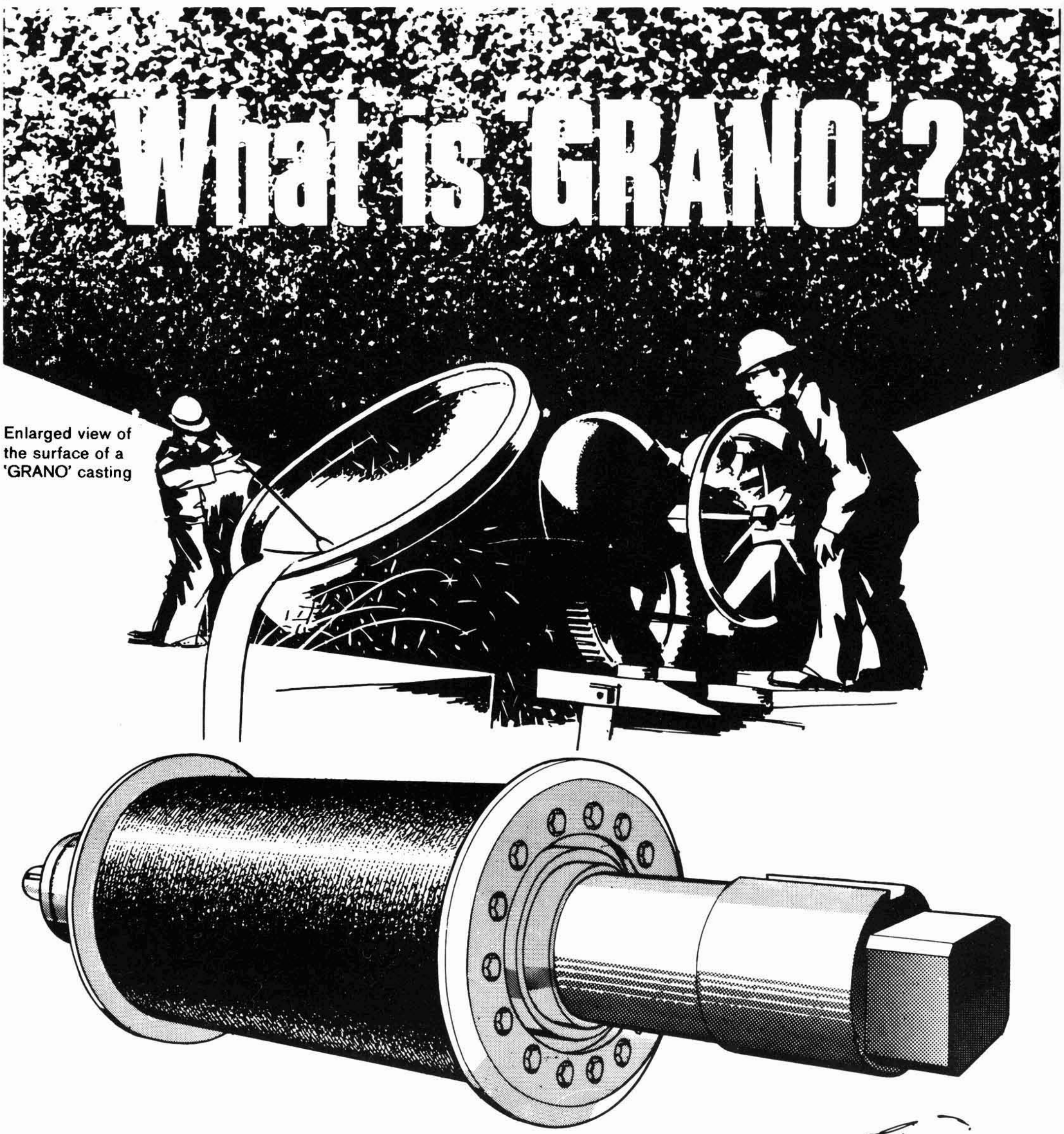
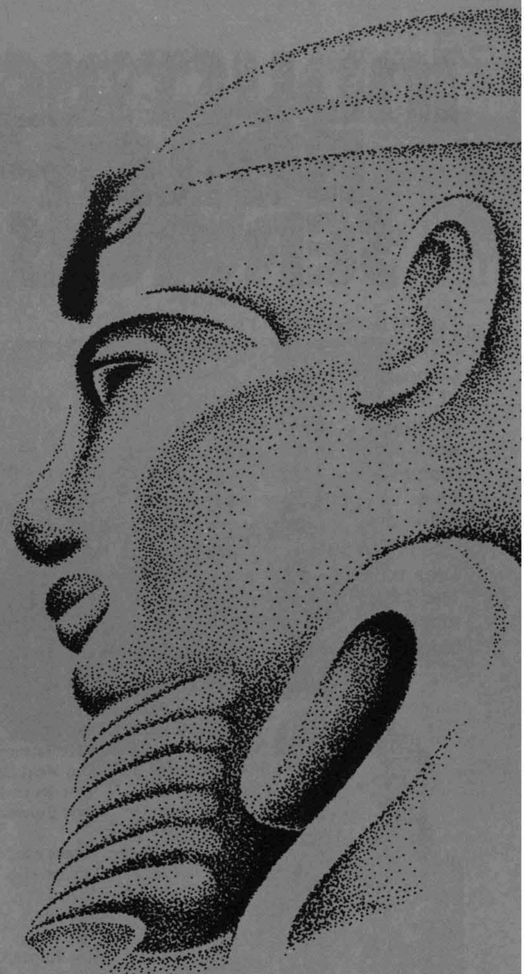


Enlarged view of the surface of a 'GRANO' casting

THINGS ARE HAPPENING IN THE SUDAN



"The food bowl of the Middle East" is how world experts are describing the Sudan. However, to transform the undoubted potential of this vast land into reality requires technical skills, experience and above all stamina and dedication.

Fletcher and Stewart Limited possess just such qualities – qualities which have born fruition in the successful completion of the sugar factory project at Sennar on the banks of the Blue Nile some 300 kms south of Khartoum.
The factory which was supplied and erected against a background of extremely difficult manufacturing, shipping and local construction conditions is further evidence of FS commitment to the developing sugar industry of the world.
FS is now concentrating on the completion of its second turnkey Sudanese factory at Hagar El Asalaya in the White Nile Province which is located approximately 96 kms distant from the Sennar factory.
Although they differ in certain respects, each factory is capable of processing 6500 tons of sugar cane per day and will between them have the capacity to produce 250,000 tons per year of refined sugar.
Things are happening in the Sudan!

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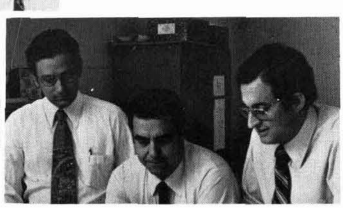

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NOTES AND COMMENTS

Effectiveness of the ISA

The French sugar trading firm, Sucres & Denrées, recently analysed the effectiveness to date of the International Sugar Agreement which entered into force on 1st January 1978, and discussed its future. The views expressed are summarized below:

The impact of the International Agreement has been rather modest. Exporting members used the opportunity of the three months which followed the ratification of the Agreement and during which quotas were not yet in force (October/December 1977), to reduce their stocks to a minimum, with large discounts available for 1977 shipment sugar compared with sugar for 1978 shipment.

Numerous importing countries covered their requirements in advance; in the USA refiners' stocks on 31st December 1977 amounted to 1,873,000 tonnes against 1,055,000 tonnes the year before. In Japan also, imports amounted to an abnormally high figure: 2·7 million tonnes against 2,430,000 tonnes in 1976, while in Canada, purchases by anticipation amounted to 100/200,000 tonnes.

This massive transfer of stocks from exporting countries to importing countries upset the market balance in 1978, thus softening most of the expected impact of export quotas. Considering the effect which quotas will have on supply and demand of raw sugar in 1978, we may mention first that exporting countries have already committed most of their quotas; the large proportion of sales already made so early in the year is the more curious since a new ISA took effect in 1978. But members are aware of the raw sugar surplus and do not seem to believe that the ISO has the "bite" to push prices up significantly.

The policy of importing countries has been just the opposite of that of exporters; they remained almost out of the international market, owing to their anticipated purchases of 1977. Naturally, prices have declined, reflecting this imbalanced statistical situation.

Will the present market trend continue? First, let us take a look at demand prospects on the international market, since the lack of buyers is responsible for the present situation. The drastic decline in American demand during January/February is paradoxically an encouraging factor. Refiners which have bought practically nothing from third countries have therefore reduced their stocks in equally drastic proportions.

In Japan, the import quota fixed by the government for the second quarter is 494,000 tonnes, i.e. 50% higher than the first quarter quota. For June/September, the tonnage is expected to reach 660,000 tonnes. Nevertheless, we must bear in mind that Japan is partly covered by its long-term contracts. The effect of the import quota increase will thus be only very little as far as new purchases are concerned. China could also appear later on the market to cover its second half requirements, particularly if prices remain low.

As a whole, we should expect a gradual recovery of demand from importing countries.

Two factors threaten the market: The first is US policy; the International Trade Commission has delayed until 15th April its recommendation to President Carter concerning the US sugar situation. The ITC could very well recommend that country-byrcountry import quotas be used again; however, the President is not obliged to follow its recommendations. Uncertainty remains the main characteristic of the US market, and the possibility cannot be completely excluded that the USA, after having been the main supporter of the ISA, could abandon it to its fate, in which case, some exporting countries might reconsider their decision to remain members.

The second risk facing the market appears more serious; it concerns the Indian selling policy.

This country holds a quota of 620,000 tonnes, white value, which is still unsold, while traditional outlets for Indian sugar (Indonesia, Egypt, Sudan in particular) have been largely covered by Brazil and the EEC. Moreover, the white sugar premium over raws is presently very low. For these reasons, Indian sugar could become a serious competitor of raw sugar and therefore the Indian policy will be a major raw sugar market factor.

To conclude, we believe that the raw sugar market outlook is not so pessimistic. Of course, with a surplus of some 5 million tonnes, the ISA could not accomplish a miracle. By allowing exporting countries to reduce their stocks during the three months period preceding the entry into force of quotas, the ISA has greatly offset the impact of quotas. The consequences of this situation have been fully felt during the first quarter of 1978. However, we tend to believe that the worst is behind us thanks to the looked-for recovery of demand during the second quarter . . . subject to the Indian sugar policy and the US adhering to the ISA.

Cuban sugar production

F. O. Licht KG recently quoted[1] Moscow sources which indicated that the Cuban sugar crop of 1977/78 was being harvested under better conditions, including better weather, than in the preceding season. However, according to a *Pravda* report, also quoted, Prime Minister Fidel Castro recently stated that, in spite of unfavourable weather conditions, in particular heavy rainfall, 1977/78 sugar production would be high. (The official estimate is 7·3 million tonnes, some 800,000 tonnes higher than that of 1976/77.) This would be sufficient to cover Cuba's free market export quota and to meet long-term export contract commitments to the socialist countries. Moreover, Castro said that Cuba would produce sufficient sugar during the coming years to cover the increasing demand of these countries.

Unofficially, however, the Cubans admit that production will not be far in excess of 6·5 million tonnes and even this figure is questioned, with estimates down to 6 million tonnes[2]. Heavy rain was reported during March, causing total or partial stoppages of the factories, and the Cuban leader has appealed for workers to make a sustained effort to recoup losses by the end of the crop in June[3].

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[1] *International Sugar Rpt.*, 1978, **110**, (4), 20.
[2] *Ibid.*, (7), 17.
[3] *Ibid.*, (9), 14.

UK sugar imports and exports

Statistics of imports and exports by the UK in 1977 have been published and are reproduced elsewhere in this issue. Imports have continued to fall, by 11% compared with 1976. Exports have fallen even more drastically and are less than half of the 1975 figure.

C. Czarnikow Ltd.[1] comment: "At a time of falling prices, a surplus of white sugar and a consequent narrowing in the raw/white differential there were few opportunities for in-transit refiners to develop competitive business last year and in the circumstances it may be that the total quantity exported can be considered satisfactory. Nevertheless, viewed in the context of the recent past, shipments of only 164,000 tons, the lowest quantity since 1946, must be disappointing. Though, as usual, British sugar found its way to a large number of countries in 1977, four countries, Switzerland, Norway, Nigeria and Tunisia, accounted for nearly 70% of the total.

"No doubt reflecting both the lower level of exports and also the improved domestic beet crop, the tonnage of sugar imported into the United Kingdom also fell in 1977. As usual, by far the largest quantity originated in Mauritius, with the total for the second year in succession falling just short of 500,000 tons. The Lomé Convention, which has succeeded the Commonwealth Sugar Agreement, has ensured a continuation of the preferential market in the UK for a group of developing countries. These arrangements, however, also ensure that sugar from non-preferential origins can only be imported when it is to be utilized in the production of refined sugar for export. It may be noted that two regular suppliers, the Dominican Republic and Cuba, disappeared from the list of origins last year.

"It will be interesting to see how the pattern of imports and exports develops during 1978, the first year of the new ISA. The EEC is not a member of the Agreement and the various limitations on the import of sugar by member countries from non-members will, of course, apply to the UK."

World sugar prices

Towards the end of March the market started to revive after a long period of dull conditions, with the LDP rising to £103 per ton after the gradual slide from £106 at the end of February to a low of £94. The most important factors have been the reports from Cuba of continuing bad weather and the difficulties it is causing for the sugar cane harvest, and a start to resumption of purchases by US refiners after they have cleared a large part of the stocks they acquired in the last few weeks of 1977 before the new ISA came into effect.

The white sugar market has fluctuated and, from a level of £115 at the end of February, the LDP(W) had sunk to £95 by March 22 and had only recovered to £102 by the end of March. The USSR and China appear to have withdrawn from the market although there is buying interest from smaller importers; however, the EEC has continued to authorize exports in spite of an indication that policy was to be aligned with the objects of the new Agreement. India, too, is a potential supplier whose selling activities are sufficiently unclear as to cause uncertainty in the market.

EEC sugar exports and the International Sugar Agreement[2]

The EEC will probably export up to a record 2,800,000 tonnes of white sugar this season out of its expected surplus of 3,800,000 tonnes, according to the EEC Farm Commissioner, Finn Olav Gunderlach. He told the European Parliament that his recent talks with major parties to the International Sugar Agreement and discussions in Washington in March with the US Secretary of Agriculture, Bob Bergland, have opened the way for the EEC to start formal talks very quickly on joining the ISA. He said the Community must show discipline in its own production in parallel with the ISA members in order to remain credible, adding that the EEC farm ministers must agree to the Commission's proposal to reduce the B sugar quota to 20% of the A quota, from 35% at present. This was rejected by all nine farm ministers last year, but Mr. Gundelach said he now thinks only France is resisting the move and will not be able to hold out for long.

Informed Commission sources said the Commission feels the large amounts of sugar which have qualified recently for export refunds at the weekly EEC export tenders have not disturbed the market. However, sugar prices have fallen and the Commission will keep a close watch on the price level during the rest of the season up to the end of June, they said.

Mr. Gundelach said the EEC's ability to export sugar will shrink dramatically if it does not reach agreement with the ISA. "I attach great importance to the possibility of being able to export reasonable quantities of sugar in the future for the sake of maintaining employment in the industry", he said. Mr. Gundelach said the EEC is still a net exporter of sugar despite the 1·3 million tonnes of raw sugar it had agreed to import each year for seven years under the sugar protocol attached to the Lomé Convention it signed with 53 developing African, Caribbean and Pacific countries. He told Parliament the sugar protocol was signed three years ago when it seemed there would be a world-wide sugar shortage. "We will, of course, honour our legal commitment under Lomé, but I hope those mistakes made by my predecessors will not be repeated", he said.

US sugar hearings

The International Trade Commission held further hearings in Washington in February and March and received testimony from producers, refiners' representatives, Congressmen, etc. At the conclusion of the hearings the Commission found that imports were hurting the domestic sugar producers and that it would make recommendations to the President by 15th April. Previous recommendations for a return to the country-by-country quota system employed under the old Sugar Act had been rejected completely by the Administration and President Carter has shown his wish for adherence to the International Agreement. Two Senators told the Senate Agriculture Committee, however, that they would impede consideration of the Agreement until the Administration submitted a programme for a total domestic sweetener policy which would supplement the ISA and help domestic sugar producers, taking into consideration the corn sweetener industry.

[1] *Sugar Review*, 1978, (1375), 29–30.
[2] *Public Ledger*, 18th March 1978.

Industrial experiments with a new carbonatation system

By R. HULPIAU, R. PIECK, M. RENS and L. SUE
(Raffinerie Tirlemontoise S.A., Tienen, Belgium B-3300)

Paper presented to Int. Sugar Tech. Staff Conf., Irish Sugar Co. Ltd., 1977

PART I

Introduction

STATIC mixers are used in the sugar industry for mixing water and acid for diffusion supply water and for mixing liquids before density measurements, as well as for other purposes. Trials made in 1974 using Kenics static mixers had shown that the use of these mixers could achieve nearly 100% CO_2 utilization efficiency when pure CO_2 was used for carbonatation. Further trials were made so as to determine the effect of gas CO_2 content (using pure and industrial gas), rate of juice recirculation and number of mixing elements.

When it was decided to increase the capacity of the Genappe sugar factory the lime kiln, of only 110 m^3 capacity, was inadequate for a desired beet daily slice of 8000 tonnes. To avoid the large investment (of about 40,000,000 Belgian francs) necessary for a new kiln, it was decided to carry out an industrial trial with static mixers, buying pure CO_2 and lime. The Genappe factory has now worked for two years with this system.

Description of static mixers

Static mixers rely for their operation on the sequential splitting of the two components to be mixed with recombination arranged systematically by the nature of the flow ducting. In this way efficient mixing can be accomplished. A particularly successful yet simple static mixer has been developed in recent years by the Kenics Corporation, USA. The essential features whereby particularly efficient mixing of the two streams is achieved may be seen by reference to Fig. 1.

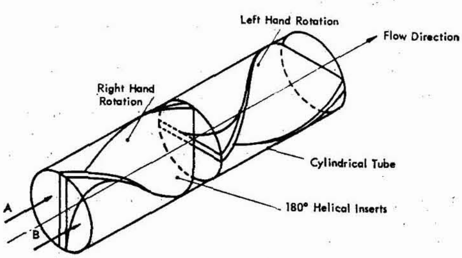


Fig. 1

Metallic or plastic strips are twisted through 180° to form helical elements of either right-hand or left-hand rotation. Alternate right-hand and left-hand elements are joined so that their respective leading and trailing edges are mutually perpendicular and the assembly of elements is inserted axially inside a tube which has a bore diameter nominally equal to the width of the elements.

If two liquids, respectively designed *A* and *B*, are separately injected into the semicircular passages formed on either side of the first element, then the two streams rotate, owing to the physical constraint of the helix as they flow along the tube.

In the first element, therefore, half of the total channel is filled with fluid *A* and the other with fluid *B*. On entering the second element each semi-circular stream is split, owing to the perpendicular orientation of adjacent elements. Splitting of layers is repeated at the interface between adjacent elements so that the number of layers of both fluids in each semicircular passage is doubled by each element. Thus, a mixer containing ten elements would produce 2^{10} (or 1024) alternate layers of fluids *A* and *B* in each semicircular passage at exit from the mixer. It is not difficult to visualize that these layers of fluid become sufficiently thin in practice to produce virtually perfect mixing.

It is necessary to note carefully that the alternation of the right- and left-hand helical elements and its effect on streamline curvature is an essential feature of the device. Indeed, the device does not function as a mixer if all elements have the same rotational mode, even though their edges are mutually perpendicular.

Although this flow system was originally conceived to fulfil a straightforward mixing function, the well-known analogy which exists between the transport of momentum, mass and energy immediately suggests that the enhanced mixing should also significantly improve the heat and mass transfer characteristics of a tube fitted with these elements. It should be noted, of course, that the penalty incurred in practice as a result of the mixing action is an increase in flow resistance for the tube.

Preliminary investigations

The pilot plant shown in Fig. 2 was installed.

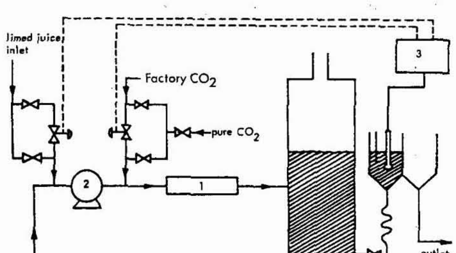


Fig. 2. Key: (1) Kenics static mixer, 2 in diameter, 11 elements, type 2103220. (2) "Monopump" type CD80R4, 7·5 hp motor. (3) Controller for regulation of flow of limed juice, pH and CO_2 admission

The first trials were carried out with a recycle juice flow rate of about 9 $m^3.hr^{-1}$. The results are recorded in Table I.

Filtration rates are given in Table II.

After second carbonatation in the laboratory, the juices had the characteristics shown in Table III.

The variation of CO_2 absorption with different rates of recycle flow was studied in the following way: while maintaining a constant inlet flow we changed the recycle rate and noted the drop in pressure and CO_2 content of the outlet gas after carbonatation. Results for a flow of limed juice of 0·125 $m^3.hr^{-1}$ were as follows:

Recycle rate, $m^3.hr^{-1}$	4	5·9	7·5	9	10·3	11·4
Back pressure, $kg.cm^{-2}$	0·1	0·2	0·3	0·4	0·5	0·6
% CO_2 in outlet gas (inlet 29%)	15·5	12·7	6·5	2	1	0·5

These results and those for limed juice flows of 0·25 and 0·45 $m^3.hr^{-1}$ are shown in Fig. 3.

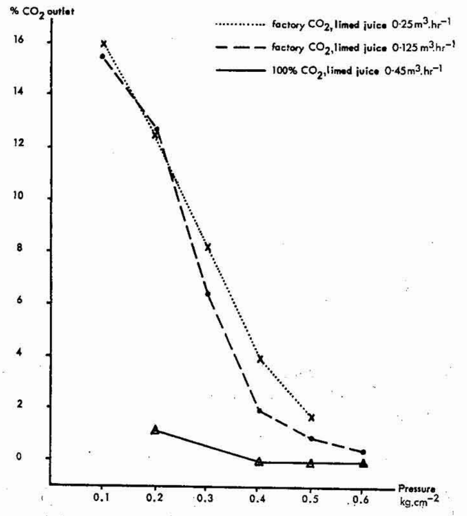


Fig. 3

Observations

From Table I we see that, if high enough pressure (0·5 $kg.cm^{-1}$) is applied at the inlet of the Kenics, the efficiency of CO_2 utilization is greater than 91% when factory gas is used and reaches approximately 100% when pure undiluted CO_2 is used. With pure CO_2 the inlet flow of limed juice could well be increased from 0·12 to 0·42 and 0·56 $m^3.hr^{-1}$. When this was done we noted that the outlet temperature rose to 20°C higher than the inlet temperature. This increase in temperature is due to (*a*) heat evolved by the exothermic formation of $CaCO_3$ and (*b*) heat generated by the power of the recirculating pump.

The rates of filtration were similar to those in the factory (averaging 0·085 to 0·110 $sec.cm^{-1}$), which means that the strong mixing effect in the Kenics does not destroy the structure of the $CaCO_3$. The chemical quality of the juice after second carbonatation was similar to that obtained with laboratory carbonatation of industrial juice. Some scaling was observed in the mixers after a week of operation.

In the trial on variation of recycle flow (Fig. 3) it was shown that the efficiency of CO_2 absorption is related to the back pressure at the inlet of the static mixer. When pure CO_2 is used, this back pressure is lower than with industrial gas.

Table I

Duration of trial, hr	*Limed juice alkalinity, g CaO/100 cm³*	*Carb. juice alkalinity, g CaO/100 cm³*	*Carb. juice temperature, °C*	*Flow of limed juice, $m^3 hr^{-1}$*	*Kenics inlet pressure, $kg.cm^{-2}$*	*CO_2 content Inlet %*	*CO_2 content Outlet %*	*CO_2 efficiency, %*
34	1·62	0·098	78·9	0·12	0·49	29	3·6	91
10	1·34	0·104	79·6	0·12	0·50	27·5	1·1	97
10	1·36	0·101	79·7	0·112	0·55	30	2·75	93
6	1·30	0·105	92·3	0·42	0·50	100	0·4	99·6
2	1·19	0·103	92·7	0·42	0·50	100	0·3	99·7
5	1·21	0·122	93·6	0·56	0·59	100	0·3	99·7

Table II

Volume, cm³	*Kenics*	*Factory*	*Kenics*	*Factory*	*Kenics*	*Factory*
	seconds					
200	4	4	7	10	8	8
400	15	15	21	30	25	27
600	25	25	44	53	46	48
800	37	37	64	75	64	68
1000	53	50	85	100	86	87
Alkalinity, g CaO/100 cm³	0·092	0·101	0·093	0·082	0·101	0·107

Table III

	Kenics	*Factory*	*Kenics*	*Factory*	*Kenics*	*Factory*	*Kenics*	*Factory*
°Brix	14·12	13·74	12·54	12·58	13·17	13·72	13·89	14·38
Purity	90·65	90·25	90·31	89·80	90·09	90·05	90·93	91·10
CaO % Brix	0·092	0·102	0·130	0·124	0·129	0·135	0·135	0·091
Alkalinity	0·018	0·015	0·017	0·014	0·015	0·016	0·020	0·019
pH	9·0	8·9	9·15	9·12	9·15	9·15	9·3	9·3
Colour % Brix	210	199	237	255	237	221	232	211

Additional studies

Further trials were made to learn the effect of:

- the ratio of volumes of gas and liquid $V_g:V_l$,
- the recycle rate,
- the inlet pressure,
- the flow rate in the mixer,
- the carbonatation alkalinity, and
- the CO_2 utilization efficiency.

We carried out first and second carbonatation trials using either pure CO_2 or factory-made CO_2. As mixing devices we used an 11-element Kenics mixer of 2 inches diameter, a 6-element Kenics mixer of 2 inches diameter, and a 3-in venturi mixer.

The maximum flow of the pilot plant was 2·0 $m^3.hr^{-1}$. It was provided with a compressor so as to be able to use pressures above 0·7 $kg.cm^{-2}$ when factory-made CO_2 was used (see Fig. 4). The results are recorded in Tables IV–X.

Calculations were as follows:

Alkalinity of juice in contact with CO_2 =

$$\frac{(\text{Alk.limed jce.} \times \text{vol.limed jce.}) + (\text{Vol.recirc.jce.} \times \text{alk.carb. jce.})}{\text{Total liquid volume}}$$

CO_2 *efficiency* (E%) =

$$\frac{(\text{inlet \% } CO_2 - \text{outlet \% } CO_2) \times 10^4}{\text{inlet \% } CO_2 \times (100 - \text{outlet \% } CO_2)}$$

When pure CO_2 is used this formula cannot be used; the flow of CO_2 must then be measured at the outlet.

Theoretical volume of CO_2 (V_g) =

$$\frac{146 \times \text{lmd.jce.flow } (m^3.hr^{-1}) \times \text{Alk.(g CaO/100cm}^3) \times (273 + T°C)}{\text{Efficiency (\%)} \times \text{Abs. pressure } (kg.cm^{-2}) \times \text{inlet \% } CO_2} \; m^3$$

When pure CO_2 was used we assumed an efficiency of 100%.

Recycle volume ratio: This is the ratio of total liquid flow (V_l) to the flow of limed juice.

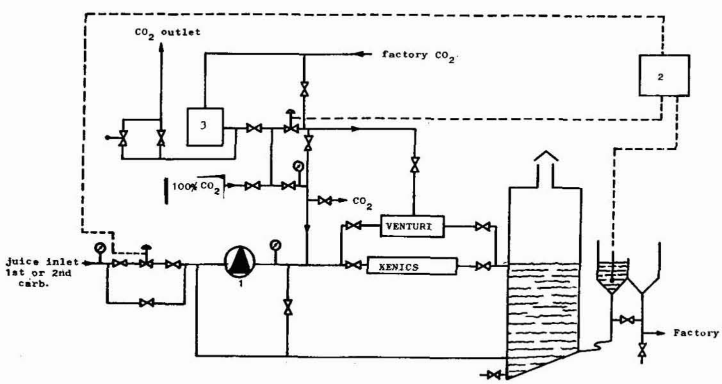


Fig. 4

Key: 1. "Monopump" 2. Flow regulator 3. Compressor

Observations

First carbonatation

If we compare the results achieved with the Kenics mixers, we note that, in the case of factory-made gas, to achieve an efficiency of 96%, the ratio V_g:V_l must be lower than 0·4 and lower than 0·8 for an efficiency of 90%. To alter the ratio V_g:V_l we changed either the recycle ratio or the inlet pressure at the Kenics, or both (trials 1-5 and 31-34).

A comparison may be drawn between the 11-element and 6-element Kenics mixers as follows:

	Recycle volume, ratio	*Absolute pressure, kg.cm*$^{-2}$	*Efficiency, %*
11 elements	30—35	1·8—1·95	95
	75—80	1·5—1·55	95
6 elements	14	1·9	Approx. 100
	22	1·6	Approx. 100

The use of a Kenics mixer with 6 elements is more interesting because less power is needed. We also see that the recycle ratio is always higher than in a normal carbonatation, even in the most favourable cases. Furthermore, the alkalinity of the carbonatated juice when CO_2 is applied is about 0·120 to 0·200 g CaO/100 cm^3; this is lower than with a normal carbonatation tank (0·250–0·500 g/100 cm^3) but the difference does not seem to reduce efficiency.

As we could not calculate the flow of outlet gas in the case of pure CO_2 we could not calculate its utilization efficiency. However, we could estimate what it was when

Table IV. First carbonatation using factory CO_2 and an 11-element Kenics mixer

Trial No.	*Temperature, °C*	*Limed juice flow,* $m^3.hr^{-1}$	*Recycle volume ratio*	V_l $m^3.hr^{-1}$	V_g $m^3.hr^{-1}$	$\frac{V_g}{V_l}$	*Limed juice alkalinity, CaO/100 cm*^{3}	*Carb. juice alkalinity, CaO/100 cm*^{3}	*% CO_2 at inlet*	*% CO_2 at outlet*	*Efficiency, %*	*Absolute pressure, kg.cm*$^{-2}$	*Linear speed, m.sec*$^{-1}$
1	62	0·3	22·3	6·68	2·88	0·43	1·15	0·152	30	0·0	100	1·95	1·37
2	55	0·3	32·3	9·68	3·46	0·36	1·35	0·142	32	1·25	97·3	1·80	1·88
3	63	0·3	33·4	10·02	3·15	0·32	1·20	0·136	30	1·15	97·1	1·97	1·88
4	80	0·12	75·2	9·02	1·92	0·21	1·24	0·117	27·5	1·10	97·0	1·50	1·56
5	63	0·3	32·3	9·68	3·30	0·34	1·20	0·137	30	2·50	94·0	1·90	1·85
6	80	0·112	80·5	9·02	1·68	0·19	1·16	0·116	30	2·75	93·0	1·55	1·53
7	58	0·4	24·2	9·68	5·52	0·57	1·50	0·162	32	4·00	91·1	1·80	2·17
8	79	0·12	75·2	9·02	2·39	0·26	1·52	0·120	29	3·60	91·0	1·49	1·63
9	58	0·3	13·9	4·17	3·17	0·76	1·20	0·186	31	4·00	90·7	1·95	1·05
10	58	0·25	42·1	10·52	5·00	0·47	1·80	0·143	30	4·00	90·3	1·80	2·22
11	61	0·5	18·0	9·02	9·27	1·03	1·60	0·189	30	5·00	87·7	1·60	2·61
12	65	0·5	17·4	8·68	7·01	0·81	1·37	0·179	32	7·00	84·0	1·80	2·24
13	58	0·25	37·4	9·35	5·71	0·61	1·90	0·151	30	6·50	83·8	1·60	2·15
14	61	0·8	12·3	9·85	15·86	1·61	1·75	0·242	30	8·00	79·7	1·80	3·67
15	67	0·5	13·4	6·68	7·29	1·09	1·30	0·197	31	8·50	79·3	1·80	2·00
16	63	0·3	26·7	8·02	5·04	0·63	1·45	0·154	30	8·50	78·3	1·80	1·87
17	66	0·5	17·7	8·85	7·82	0·88	1·37	0·178	31	9·00	78·0	1·80	2·38
18	60	0·3	13·9	4·17	4·82	1·16	1·20	0·186	31	9·00	78·0	1·50	1·29
19	62	0·3	22·3	6·68	4·91	0·74	1·20	0·154	30	10·00	74·1	1·60	1·66
20	67	0·5	10·0	5·01	8·13	1·62	1·35	0·244	31	10·50	73·9	1·80	1·88
21	67	0·5	16·7	8·35	8·90	1·07	1·45	0·187	31	11·00	72·5	1·80	2·46
22	67	0·5	10·0	5·01	9·70	1·93	1·25	0·234	31	14·00	63·8	1·62	2·10
23	66	0·5	6·7	3·34	10·78	3·23	1·40	0·310	31	16·00	57·6	1·80	2·02
24	58	0·25	14·7	3·67	14·29	3·89	1·90	0·229	32	20·00	46·9	1·20	2·57
25	62	0·5	6·0	3·00	30·98	10·33	1·90	0·416	30	20·00	41·7	1·20	2·57
26	65	0·5	5·3	2·67	20·25	7·59	1·25	0·334	31	21·00	40·8	1·20	3·28
27	65	0·5	8·4	4·18	27·98	6·70	1·65	0·298	31	23·00	33·5	1·40	4·59

the CO_2 content was checked in the top of the recycling vessel; we found that the CO_2 content at the outlet is lowest when the ratio V_g:V_l is about 0·2. This ratio was given by a recycle ratio of 14 to 22 times and a pressure of 1·5–2·0 kg.cm^{-2} (trials 39–45). As anticipated, carbonatation with pure CO_2 gave better results.

Second carbonatation

If we consider second carbonatation results we see that an efficiency higher than 95% can be obtained if V_g:V_l is less than 0·1 (trials 56–60). For a 6-element Kenics mixer the following data may be extracted from the results of the trials:

Recycle volume ratio	*Absolute pressure, kg.cm^{-2}*	*Efficiency, %*
6—8·5	1·2—1·35	95—100
14—22	1·1—1·2	97—100

If a high recycle ratio is required, this may be due to the low alkalinity in the carbonatation and also to the fact that the pilot plant could only operate with a maximim flow of 2·0 m^3.hr^{-1}, which is not enough to achieve the required pressure at the inlet of the mixer. For good conditions in such a case the flow of juice should be at least 10 m^3.hr^{-1}.

Table V. First carbonatation using pure CO_2 and an 11-element Kenics mixer

28	94	0·56	16·1	9·02	2·10	0·23	1·11	0·169	100	0·30	±100	1·59	1·59
29	93	0·42	21·5	9·02	1·63	0·18	1·09	0·151	100	0·30	±100	1·50	1·52
30	92	0·42	21·5	9·02	1·79	0·20	1·20	0·156	100	0·40	±100	1·50	1·59

Table VI. First carbonatation using factory CO_2 and a 6-element Kenics mixer

Trial No.	*Temperature, °C*	*Limed juice flow, m^3.hr^{-1}*	*Recycle volume ratio*	*V_l m^3.hr^{-1}*	*V_g m^3.hr^{-1}*	*$\frac{V_g}{V_l}$*	*Limed juice alkalinity, g CaO/100 cm^3*	*Carb. juice alkalinity, g CaO/100 cm^3*	*% CO_2 at inlet*	*% CO_2 at outlet*	*Efficiency %*	*Absolute pressure, kg.cm^{-2}*	*Linear speed, m.sec^{-1}*
31	59	0·3	13·9	4·20	3·06	0·73	1·20	0·186	30	0	100	1·90	1·04
32	67	0·3	22·3	6·68	6·52	0·98	2·10	0·194	30	0	100	1·60	1·89
33	60	0·3	33·4	10·02	3·34	0·33	1·10	0·133	30	0	100	1·60	1·91
34	59	0·3	13·9	4·20	2·97	0·71	1·05	0·176	30	2	95·2	1·80	1·02
35	64	0·3	33·4	10·02	4·39	0·44	1·15	0·134	30	4·5	89·0	1·45	2·06
36	61	0·3	13·9	4·20	4·25	1·01	1·15	0·183	30	7	82·4	1·60	1·21
37	67	0·3	22·3	6·68	8·59	1·29	1·60	0·172	30	11	71·2	1·30	2·18
38	61	0·3	13·9	4·20	8·46	2·01	1·10	0·179	30	19	45·3	1·40	1·81

Table VII. First carbonatation using pure CO_2 and a 6-element Kenics mixer

39	56	0·3	13·9	4·20	1·61	0·38	1·90	0·236	100	0	1·70	1·70	0·83
40	67	0·75	21·1	15·90	2·42	0·15	1·30	0·161	100	0		2·00	2·62
41	58	0·3	22·3	6·70	1·20	0·18	1·25	0·156	100	0		1·52	1·13
42a	63	0·3	33·4	10·00	1·32	0·13	1·35	0·140	100	0		1·50	1·62
42b	61	0·5	16·0	8·00	1·32	0·17	1·62	—	100	0		3·00	1·33
43	55	0·45	14·8	6·68	1·17	0·17	1·30	0·192	100	1		2·40	1·12
44	67	0·75	20·7	15·50	2·67	0·17	1·40	0·168	100	4		1·95	2·60
45	56	0·3	13·9	4·20	1·71	0·41	1·90	0·236	100	4·5		1·60	0·84
46	67	0·75	20·5	15·40	2·74	0·18	1·40	0·168	100	8		1·90	2·59
47	63	0·3	22·3	6·70	1·53	0·23	1·30	0·158	100	10		1·25	1·18
48	58	0·3	8·9	2·70	1·41	0·52	1·95	0·296	100	13		1·80	0·59
49	56	0·45	14·8	6·68	1·23	0·18	1·25	0·184	100	14		2·20	1·13
50	68	0·9	17·1	15·40	3·10	0·20	1·35	0·179	100	16·5		1·95	2·64
51	56	0·3	8·9	2·70	1·16	0·43	1·85	0·308	100	20		2·30	0·55
52	59	0·45	9·3	4·175	1·90	0·46	1·40	0·251	100	20		1·60	0·87
53	58	0·45	9·3	4·175	1·22	0·29	1·35	0·245	100	20		2·40	0·77
54	57	0·3	8·9	2·70	1·67	0·62	1·85	0·308	100	21		1·60	0·62
55	58	0·3	13·9	4·20	1·87	0,44	1·80	0·229	100	21		1·40	0·87

Table VIII. Second carbonatation using factory CO_2 and a 6-element Kenics mixer

Trial No.	*Temperature, °C*	*Feed juice flow, m^3.hr^{-1}*	*Feed juice alkalinity, g CaO/100 cm^3*	*Recycle volume ratio*	*V_l, m^3.hr^{-1}*	*V_g, m^3.hr^{-1}*	*$\frac{V_g}{V_l}$*	*% CO_2 at inlet*	*% CO_2 at outlet*	*Efficiency, %*	*Absolute pressure, kg.cm^{-2}*	*Linear speed, m.sec^{-1}*
56	61	0·8	0·032	6·3	5·01	0·308	0·061	30	0	100	1·35	0·76
57	63	0·8	0·046	8·4	6·68	0·446	0·067	30	0	100	1·35	1·02
58	59	0·3	0·042	22·3	6·68	0·185	0·028	30	0	100	1·10	0·98
59	61	0·5	0·042	13·4	6·68	0·280	0·042	30	1·0	97·6	1·25	0·99
60	62	0·8	0·043	6·3	5·01	0·491	0·098	30	2·0	95·2	1·20	0·79
61	65	0·8	0·047	8·4	6·68	0·542	0·081	30	3·6	91·3	1·25	1·03
62	60	0·8	0·039	4·2	3·34	0·470	0·141	30	8	79·7	1·35	0·544
63	59	0·3	0·042	13·9	4·175	0·258	0·062	30	8·25	79·0	1·00	0·633
64	60	0·3	0·046	8·9	2·67	0·532	0·199	30	20	42·0	1·00	0·457

Table IX. First carbonatation using factory CO_2 and a 3-inch venturi mixer

65	59	0·2	1·60	33·4	10·02	2·495	0·250	30	10	74·0	1·90	
66	61	0·3	1·70	33·4	10·02	8·36	0·834	30	17	52·2	1·90	
67	60	0·3	1·80	22·3	6·68	10·97	1·642	30	20	42	1·90	
68	61	0·2	1·65	22·3	6·68	6·72	1·006	30	20	42	2·80	

Table X. Second carbonatation using factory CO_2 and a 3-inch venturi mixer

69	71	1·0	0·026	5·01	5·01	0·294	0·059	30	0·6	98·6	1·50	
70	72	1·0	0·050	5·01	5·01	0·537	0·107	30	1·0	97·64	1·60	
71	73	0·68	0·056	4·91	3·34	0·817	0·245	30	6	85·11	1·35	
72	71	0·4	0·049	8·35	3·34	0·297	0·089	30	6	85·11	1·30	
73	74	1·5	0·026	3·35	5·01	0·551	0·110	30	8	79·71	1·50	
74	74	1·0	0·062	3·34	3·34	1·228	0·368	30	14	62·00	1·375	

The venturi-type mixer gave poor results in first carbonatation with factory gas. The 3-inch type was perhaps not suitable for the tests. For second carbonatation the venturi results are better, an efficiency of 97% being achieved with 500% recycling and an absolute pressure of 1·5-1·6 $kg.cm^{-2}$.

To conclude, we know that an efficiency higher than 95% can be achieved but that the gain in efficiency can only be obtained with certain recycle ratios and feed pressures, which means use of additional power. The 6-element Kenics mixer seems to give better results for lower power consumption.

(To be continued)

Sugar crystallization as a continuous flow process

By R. BROADFOOT* and E. T. WHITE†

Introduction

THE crystallization of sugar in vacuum evaporation vessels remains as the only major unit operation in the raw sugar industry undertaken as a batch process. During the past decade several continuous flow systems have been installed in European sugar refineries and beet sugar factories with reported success[1,2]. More recently, continuous pans have been installed in four cane sugar factories in Mauritius, Réunion and South Africa[3,4].

The Sugar Research Institute has been following closely the development of continuous sugar boiling throughout this time and for the past three years has been actively engaged in research into developing a unit suitable for the Australian sugar industry. However, continuous sugar crystallization offers two potential disadvantages compared with batch operation. First, because of the inherently wider residence time distribution of the material compared with batch operation, the size distribution of the crystals produced tends to be more widespread. As far as the Australian industry is concerned, it is essential that the quality standard with respect to size distribution be maintained. Second, situations occasionally arise when severe and rapid fouling of the calandria heating surface occurs with subsequent reduction in production rate. The steps required to regain maximum production rate would be much more time- and labour-consuming for a continuous system than for a batch unit. For these reasons, batch sugar crystallization has continued to be favoured.

However, the efficiencies of continuous operation have made the proposition more attractive as operation and labour costs rise. Research has therefore been directed to devising a continuous boiling scheme which will negate these disadvantages.

Batch boiling scheme

It is the objective of the pan station to obtain the maximum economical recovery of sucrose from the syrup by converting the dissolved sugar into regularly-shaped crystals of good quality and suitable size distribution. Conversion in a single growth stage without recycling of molasses would require operation at a product crystal content of 85%. However, in order to achieve adequate circulation and uniform mixing of the vessel contents, an upper limit on the crystal content within a single stage exists. This requires, therefore, that the crystal growth be conducted over several stages.

Numerous arrangements may be employed to achieve crystallization in batch vessels but the system most commonly used in the Australian industry is indicated in Fig. 1.

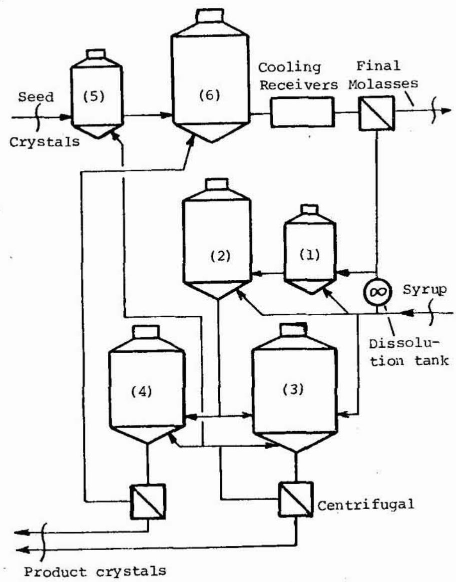


Fig. 1. Flow scheme for batch crystallization

Seed crystals (typically of mean size 10µm) are grown in a low-purity molasses during two stages (pans 5 and 6) to approximately 250 µm mean size. Further crystallization is achieved in cooled receivers prior to passage to centrifugal separators. Some of the crystal produced is used as seed for growth in the magma pans, while the excess is dissolved and blended with the syrup feed. The magma crystal is grown on the high-purity syrup in a further two stages of growth to approximately 520 µm (pans 1 and 2). The massecuite from No. 2 pan is split to allow further crystal growth (pans 3 and 4). The sugar produced in these two pans is of shipment sugar quality and typically has a mean size of 750 µm and for batch boilings a coefficient of variation (CV) of 0·2. In each of the three strike stages the end condition is determined when the fluidity of the boiling massecuite is so reduced as to prevent uniform conditions in the pan from being maintained.

* Sugar Research Institute, Mackay, Queensland.
† University of Queensland, Brisbane, Queensland.

[1] Windal: *Sugar J.*, 1971, **34**, (4), 15–19.
[2] Barkow & Witte: *Zucker*, 1971, **24**, 687–699, 715-725, 733–738.
[3] Rivière & Pithois: *Sugar y Azúcar*, 1976, **71**, (12), 48–58.
[4] Langreney: *I.S.J.*, 1977, **79**, 310–314.

For each batch the limitation in volume expansion above the footing volume restricts the final crystal size from each unit to about 1·5 times the original seed size. It is therefore necessary that a batch crystallizer stage be composed of compatible pan sizes by which pan full contents form footing volumes for subsequent pans, e.g. pan 2 provides footings for pans 3 and 4. A complex time scheduling programme must therefore be closely adhered to in order to achieve the maximum performance from such an installation.

Operational constraints

Two boundaries exist below which the operating conditions should be maintained:

(*a*) secondary nucleation will result if an upper limit of supersaturation is exceeded. This boundary has been defined for cane syrup under Queensland conditions by Wright[5];

(*b*) circulation will be impaired if the operating crystal content becomes excessive. The location of this boundary is not well defined, being a function of several factors. The limit decreases with decreasing purity, i.e. increasing viscosity of the mother liquor, and an estimate is shown in Fig. 2.

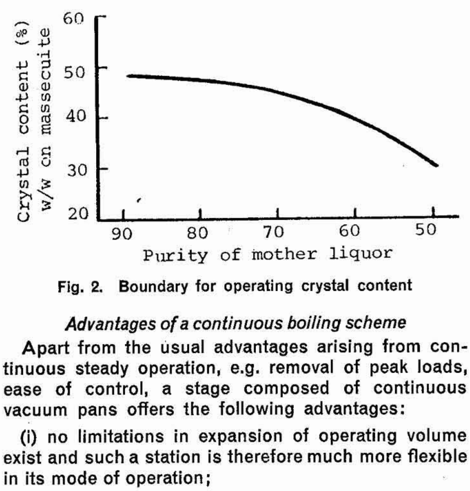


Fig. 2. Boundary for operating crystal content

Advantages of a continuous boiling scheme

Apart from the usual advantages arising from continuous steady operation, e.g. removal of peak loads, ease of control, a stage composed of continuous vacuum pans offers the following advantages:

(i) no limitations in expansion of operating volume exist and such a station is therefore much more flexible in its mode of operation;

(ii) it is possible to design each unit so that the ratio of the heating surface area to the crystal surface area remains constant for growth at constant mother liquor purity. This means each element of the crystallizer can be designed to operate at the maximum growth rate condition. This is not possible in a batch crystallizer as the heating surface area is fixed and the crystal surface area increases throughout the strike;

(iii) the boiling level above the calandria remains constant throughout the vessel and is usually limited to about 0·3 m above the top tube plate. Hence, adverse effects of a large hydrostatic head above the calandria are overcome and by necessity the circulation path for each element of massecuite is more positive. In batch boiling, increasing hydrostatic head towards the end of the strike slows the circulation of the pan and reduces the heat transfer coefficient of the calandria. The conditions of the boiling massecuite in a continuous pan are therefore expected to be more uniform;

(iv) the crystal residence time is greater than the nominal residence time, i.e. boiling volume/production rate, in a continuous vessel because the molasses is fed gradually along the length of the unit. For batch boiling the two are the same. Hence, a greater throughput rate per unit of installed volume is to be expected;

(v) an overall reduction in the steam consumption should result owing to:

(*a*) removal of batch scheduling problems which necessitates the occasional idling of pans on water;

(*b*) the fact that steam flow varies considerably during batch boiling and excessive usage can result if the flow is not controlled. A continuous pan in which the installed heating surface area and the operating crystal surface area are "matched" through all stages of growth should offer the most efficient usage of steam for evaporation.

Flow scheme for continuous boiling station

Continuous flow crystallization allows several of the constraints imposed on the batch boiling scheme to be relaxed. Most important is the ability to increase the size of the seed crystal to any product size in a single vessel.

The ideal flow system for continuous crystallization in which maximum production rate/unit volume can be achieved is the plug-flow vessel. The crystal size distribution would be identical to batch grown crystals and would be the least widespread for any continuous flow pattern. However, the evaporation required to maintain a supersaturated condition necessitates good mixing of the material and the advantages of plug flow can best be approached by series flow through well-mixed cells. The greater the number of such cells for any production requirement, the closer the approach to the ideal continuous evaporative crystallizer.

For the flow sheet analysis a final molasses purity‡ of 45% is chosen. The purity of mother liquor leaving the low grade pan is usually about 50% with the remaining five units of sugar recovery being achieved in the cooling receivers.

Because of the limitation on the maximum operating crystal content of the massecuite, the crystallization must be conducted in a series of stages with intermediate centrifugalling or recycling of molasses, or both. The flexibility of continuous operation allows the condition at which each stage is terminated to be chosen at will. In fact, the total crystallization could be conducted in a single stage with a large recycle of molasses to limit the crystal content of the massecuite. However, the recycle of a large amount of low-purity molasses would result in an inefficient use of installed volume. Alternatively, for no recycling of molasses to any stage, a minimum of four units would be required to achieve the crystallization. Between these two limits innumerable combinations exist involving two and three stages with some recycling of molasses.

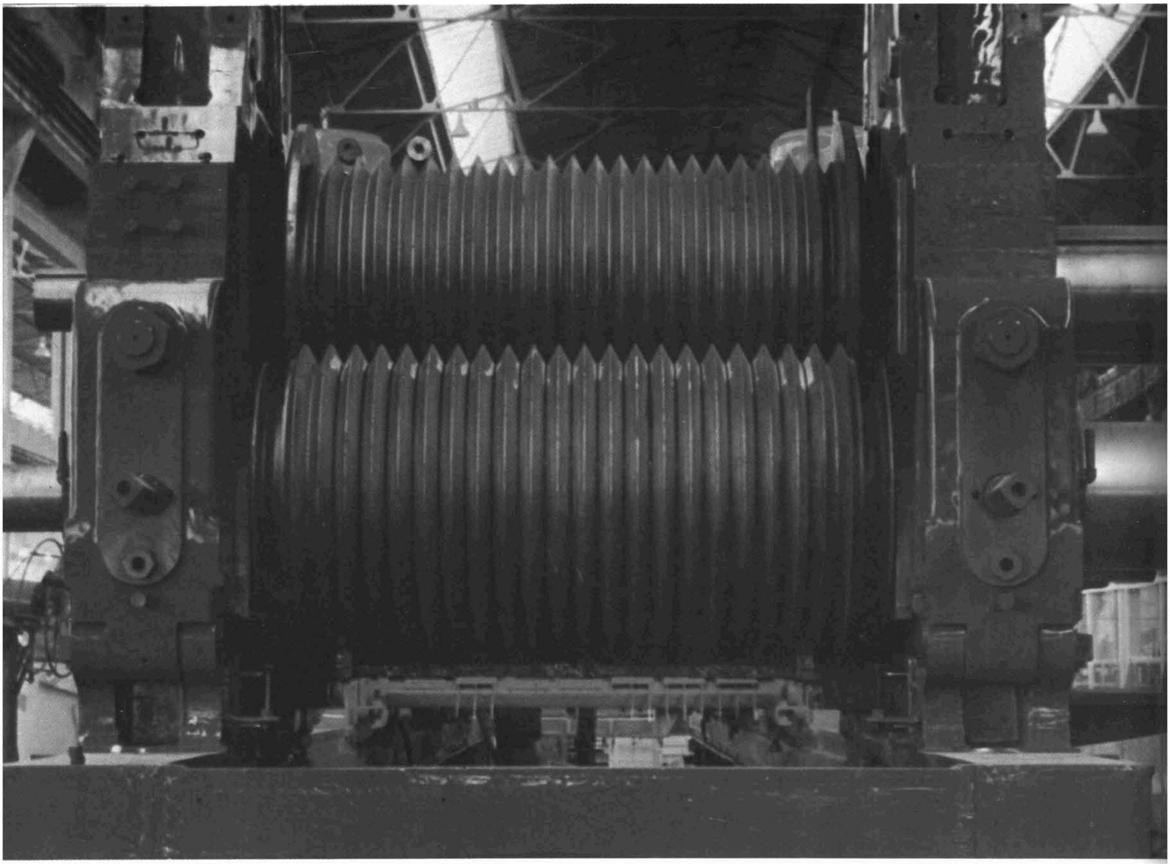
The problem of determining the "optimum" arrangement can be simplified considerably if the principles determined by Batterham, Frew & Wright[6] in their work on optimal control of a batch high-grade strike are adopted. These principles detailed by Frew[7] will achieve

[5] Ph.D. Thesis, University of Queensland, 1971.

‡ True purity defined as sucrose % total dry substance is used throughout.

[6] *Proc. 15th Congr. I.S.S.C.T.*, 1974, 1326–1338.

[7] *Ind. Eng. Chem., Process Des. Develop.*, 1973, **12**, (4), 460–467.



Trapiches Zanini, el dulce sabor del suceso.

La tecnología Farrel incorporada a los equipos Zanini está presente en los mayores centrales azucareros del mundo. Los trapiches Zanini - Farrel ya demostraron su eficiencia y rentabilidad en el Brasil, Argentina, México, Estados Unidos, Venezuela, República Dominicana, Colombia y otros países.

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a specified amount of growth in a batch pan in minimum time while still honouring the operating constraints. Applying these principles to the flow sheet analysis then:

(*a*) operation through all stages should be at the supersaturation boundary;

(*b*) for the case of multiple feed streams to any one stage, the streams should be fed in order of descending purities. When the supply quota of one feed stream is exhausted, the next feed molasses is withheld until either of the following occurs:

(i) the crystal content boundary is reached;

(ii) the mother liquor purity falls below the purity of the next available feed molasses;

(*c*) recycle molasses is fed only when all higher purity feed has been exhausted and when the crystal content constraint has become active. This is because the purity of recycle molasses is less than the purity of the mother liquor at any point through the stage. Subsequent addition of recycle molasses should maintain the crystal content at the upper limit;

(*d*) a stage of crystallization should not be terminated unless the supply quota of all molasses feed (including recycle) has been exhausted and the crystal content constraint has become active. Unless the massecuite is centrifugalled, further growth will cause the crystal content constraint to be violated.

With these principles in mind several feasible flow schemes incorporating continuous stages of growth have been investigated. Each stage could represent any one of a plug-flow crystallizer, a single well-mixed vessel, or a multi-cell unit of well-mixed sections. As part of the selection of the most economically attractive flow scheme, plug-flow crystallizers operating in conditions to achieve the required crystal deposition in minimum volume have been considered. This objective is assumed to correspond to the minimum capital cost for the crystallizer vessel. A mathematical model of plug-flow crystallization has been developed to investigate the various schemes. Fig. 3 shows the layout for the continuous station considered most efficient. Stream quantities shown are based on production from 100

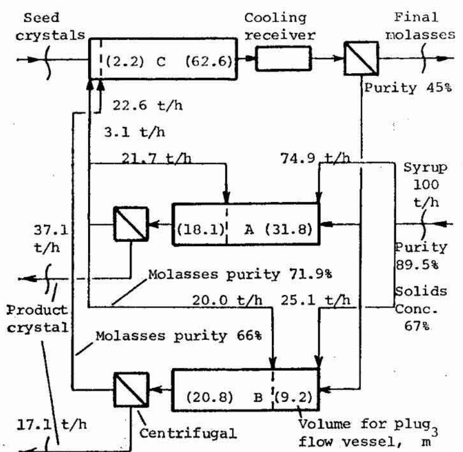

Fig. 3. Flow sheet for continuous crystallization

tonnes.hr^{-1} of syrup feed of 89·5 true purity and 67% dry substance. The individual volumes for each feed section for optimal operation are indicated.

The system is not unlike the present batch scheme except that the total crystallization is conducted in three stages compared with the present six. One intermediate crystal/mother liquor separation is required. Shipment sugar crystals are produced in two individual stages to overcome inefficiencies resulting from the recycle of a large amount of low-purity molasses which would otherwise be necessary. The three stages are designated *A*, *B* and *C* in order of descending purities of the process massecuites.

In stage *C*, operation below the crystal content boundary during the feeding of molasses minimizes the crystallizer volume, i.e. a greater advantage exists by operating at a higher mother liquor purity than by maximizing the crystal surface area. Once the feed is completed, further growth increases the crystal content to the fluidity constraint. For stages *A* and *B*, optimal operation was achieved by following the maximum crystal content profile at all times.

Some practical difficulties have been experienced in establishing a suitable seed crystal of consistent quality in a continuous unit. It is envisaged that the initial feed section of stage *C* would then best be conducted in a batch pan. The remaining crystallization stages have been investigated for continuous multi-cell operation.

Simulation of multi-cell crystallization

A mathematical model has been developed to allow performance prediction and design calculations to be undertaken[8]. The model applies to a vessel in which each cell behaves as a single well-mixed unit to which massecuite and molasses are added at constant rates and in which evaporated water and massecuite are produced. For a series of cells in the vessel the calculations are performed sequentially for each well-mixed vessel in turn. The steady-state model involves:

(*a*) material balances on each species, viz. sucrose, impurities and water;

(*b*) moments relations which predict the changes in the size distribution;

(*c*) growth rate data to predict the crystal growth rate under different operating conditions. Size dispersion data are also required to account for the spread of crystal sizes encountered with sugar crystallization. Experimental evidence of Wright & White[9] has indicated that sugar crystals subjected to the same macro-environment will grow at differing rates.

Steady operation is assumed at a boiling temperature of 65°C and a supersaturation equivalent to 60% of the threshold limit of nucleation. The correlations used for saturation conditions, nucleation threshold limit, growth rate and size dispersion are those proposed by Wright[5]. The model includes non-linear expressions and an iterative solution is necessary.

The crystallizer volume required for a given production in a multi-cell unit depends on the number of cells, the distribution of the feed molasses, and the operating crystal content. Each stage of crystallization in Fig. 3 (other than batch operation to establish the seed in stage *C*) has been investigated for a ten-cell unit.

[8] Broadfoot & White: *Proc. Queensland Soc. Sugar Cane Tech.*, 1975, **42**, 235–244.
[9] *ibid.*, 1969, **36**, 299–309.

A direct search optimization programme has been written using the Hooke and Jeeves ridge-following technique to aid in the selection of individual cell volumes and operating conditions which minimize the total installed pan volume. For the low-purity *C*-stage, operation has been studied for differing numbers of cells accepting molasses feed. Fig. 4 (a) shows a plot of the required volume at various crystal contents in the feed section. The minimum volume is obtained for six cells taking the total molasses feed with operation at 19% crystal content. In the remaining four cells subsequent growth increases the crystal content to the boundary. This operation requires a crystallizer with a volume of 69·0 m^3 which compares with the minimum plug-flow volume of 62·6 m^3.

Minimum volume is achieved in stages *A* and *B* for operation throughout at the crystal content boundary. Fig. 4 (b) shows the effect of the allocation of the two feed streams between differing numbers of cells. It can be seen that an optimum arrangement exists for each stage. The total volume required approaches to within 10% of that for optimal plug-flow conditions.

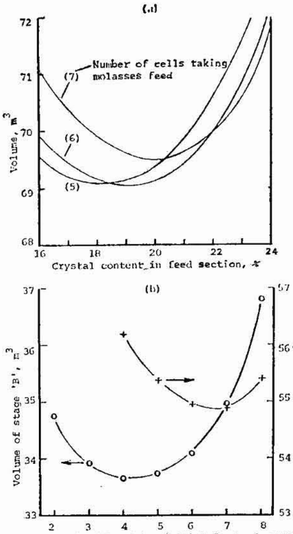

Fig. 4. Behaviour of ten-cell crystallizers
(*a*) Stage *C*; (*b*) Stages *A* and *B*

The coefficient of variation of the product crystals is 0·25 which is slightly more widespread than for total batch production (CV of approximately 0·20). Increasing the number of cells would yield a narrower size distribution though the incremental benefit decreases at increasing numbers, e.g. 12 cells in stages *A* and *B* would reduce the CV to 0·24 and it would require as many as 24 cells to achieve a CV of less than 0·22. It may therefore be necessary to develop a technique to remove the fines component before a sugar of comparable quality can be produced.

Experimental programme

The Sugar Research Institute has concentrated its experimental investigations into the continuous boiling of low-grade massecuites (purity range 60-66%) because the size distribution of these crystals is less critical.

Initially, a single cell of a proposed design for a continuous pan was constructed and its performance investigated under factory conditions. The cell was of rectangular cross-section and contained a tubed calandria. The heating surface:volume ratio was 9·9 m^{-1} which is about twice that usual in batch pans. The design boiling level was 0·3 m above the back of the sloping top tube plate and, at this level, the capacity of the unit was 2·95 m^3. The unit exhibited a good circulation pattern which was determined by tracking the path of a small radio transmitter moving freely in the massecuite. The residence time distribution of the crystals through the cell was measured by the response to an impulse dose of lithium tracer and approximated closely to the exponential response from a single well-mixed vessel. The heat transfer coefficient of the unit was approximately double that achieved in conventional batch calandria pans during the boiling of massecuites of high solids concentration.

Following the favourable performance of the single cell, two more units of a similar design were installed. A horizontal batch pan was partitioned to provide three intermediate compartments making a total of six cells with a volume of 18·8 m^3. The plant layout for the factory trials is shown in Fig. 5. Details of the experimental programme have been reported by Broadfoot *et al.*[10].

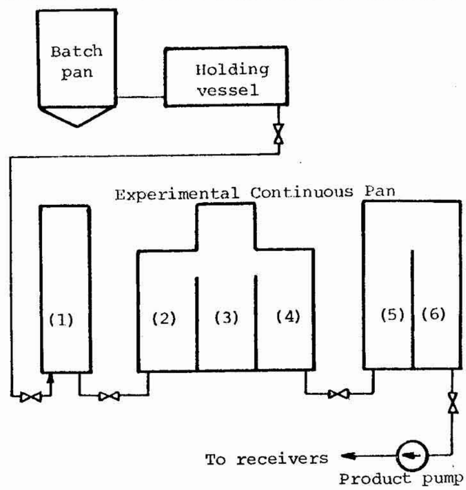

Fig. 5. Plant layout for factory trials

Seed material was grown in a batch pan to about 125 μm and transferred to the seed holding vessel from which it was metered to cell 1. Molasses feed to cells 1-5 was regulated by on-off conductivity control. Cell 6 was maintained at the product concentration by regulating water feed to the unit. The steam rate was set according to the current feed molasses supply. An eccentric lobe pump fitted with a variable speed drive unit removed product massecuite from the pan. The pump-out rate was regulated automatically according to the level of massecuite in the unit as measured by a d.p. transmitter. The rate of seed addition was varied manually to a desired ratio of the product rate (usually 1:2·5).

The test unit was capable of handling the total low-grade massecuite production of the factory and produced a good quality massecuite from batch grown seed.

[10] Broadfoot, Wright, Miller & Steindl: *Ibid.*, 1976, **43**, 171–177.

The average production rate during the trials corresponded to a nominal residence time of 4·3 hours compared with typical batch cycle times of 5·5 to 6 hours in the same factory. This represents a saving in installed volume of 22 to 28% per unit of production rate. During a period of adequate feed molasses supply, an equivalent saving of 35 to 40% was achieved.

The crystal in the product material was free of conglomerates and the mean size averaged 195 μm and CV 0·27. Despite the wider spread of crystal sizes than usual for batch boiling of low-grade massecuites, no difficulties were experienced in subsequent batch processing stages.

During extended production periods no significant deterioration of heat transfer from the calandria was observed. It is anticipated that the high heating surface: volume ratio provides some insurance against the effect of heat transfer fouling. In recent years, advances have been made into characterizing the compounds in molasses which escalate fouling[11]. The use of the enzyme dextranase in earlier processing stages has diminished the problem.

Conclusions

Continuous crystallization of raw sugar can best be undertaken in units consisting of well-mixed cells. Such operation potentially offers significant advantages and experimental factory studies have confirmed this. However, the crystal size distribution tends to be more widespread than for batch boiling. As techniques are developed to overcome this disadvantage, continuous stations are expected to be favoured.

Acknowledgments

The authors wish to thank Dr. P. G. Wright of the Sugar Research Institute for his assistance and Evans Deakin Industries Ltd., Brisbane, who installed the experimental crystallizer.

Summary

The crystallization of raw sugar in batch vessels is described and the advantages of continuous operation discussed. Continuous crystallization has been studied for both plug-flow and multi-unit well-mixed vessel systems, and operating conditions determined for each which achieve crystallization in the minimum volume. Factory trials which have been undertaken in a multi-unit system are also described; such a system does not produce as narrow a crystal size spread as batch pans though, with careful design, product of reasonable quality can be achieved.

La cristallisation du sucre comme procédé de circulation continue

La cristallisation du sucre brut dans des appareils discontinus est décrite et les avantages du travail continu sont discutés. La cristallisation continue a été étudiée à la fois pour des systèmes à circulation naturelle et en plusieurs unités à malaxage; on a déterminé les conditions d'exploitation sous lesquelles la cristallisation est réalisée dans le volume minimum. Des essais industriels entrepris dans un système à plusieurs unités sont également décrits; dans un système de ce genre l'éventail de la granulométrie des cristaux est plus large qu'avec des appareils discontinus quoique, avec une conception soignée, on peut obtenir un produit de qualité raisonnable.

Die Kristallisation des Zuckers als kontinuierliches Verfahren

Die Verfasser beschreiben die diskontinuierliche Kristallisation von Rohzucker und diskutieren die Vorteile der kontinuierlichen Arbeitsweise. Die kontinuierliche Kristallisation wurde sowohl in untereinander verbundenen Einzelapparaten als auch in Rührkesselkaskaden untersucht. Für jede der beiden Techniken werden die Betriebsbedingungen festgelegt, bei welchen die Kristallisation bei minimalem Volumen erreicht wird. Weiter werden Fabrikversuche in einer Rührkesselkaskade beschrieben. In einem derartigen System fallen die Kristalle nicht in einer so engen Korngrössenverteilung an wie beim diskontinuierlichen Verfahren; bei einer gut durchdachten Konstruktion kann jedoch ein Produkt annehmbarer Qualität erhalten werden.

La cristalización de azúcar en operación contínua

La cristalización de azúcar crudo en vasos por carga se describe y los ventajes de operación contínua se discute. Se ha estudiado cristalización contínua para sistemas de flujo natural y de multi-unidades de vasos con mezclado bueno, y se ha determinado para cada una condiciones de operación que alcanza cristalización en el volumen mínimo. Se describen ensayos en una fábrica que se han hecho con una sistema de multi-unidades; tal sistema no produce tan estrecho un alcanze de tamaño de cristales como tachos por carga. Sin embargo, con diseño cuidado, un producto de calidad aceptable puede obtenerse. □

[11] Inkerman & James: *ibid.*, 307–315.

Physiological evaluation of sugar cane germplasm for frost resistance

By ONKAR SINGH and R. S. KANWAR
(PAU Sugar Cane Research Station, Jullundur, Punjab, India)

Introduction

THE phenomenon of frost occurrence during winter months in North India is quite common, although the intensity and duration may vary from year to year and place to place. During some years the intensity of frost has been very severe. For instance, the cane crop in Punjab experienced unprecedented frost in 1964 and 1973, the temperature dipping as low as −1·5°C in the months of January and February, which badly damaged mill and seed cane, resulting in low sugar recovery and seed scarcity for the next planting. Other workers[1–7] have reported physical injury to the cane crop by freezing

[1] Breaux: *Sugar y Azúcar*, 1975, **70**, (6), 63.
[2] Bull & Glasziou: Personal communication, 1975.
[3] Gill & Singh: *Indian Sugar*, 1972, **22**, 627–632.
[4] Irvine & Dunckelman: *Proc. Amer. Soc. Sugar Cane Tech.*, 1971, 115–117.
[5] Khanna: *Indian J. Sugar Cane Res. & Dev.*, 1958, **2**, 106.
[6] Miller: *Sugar y Azúcar*, 1976, **71**, (7), 25–26.
[7] Singh & Babu: *Indian Sugar*, 1971, **21**, 679–684.

temperatures. Cultivation of frost-resistant varieties is the only assured means of saving the crop from frost injury, although adoption of some cultural practices can assist.

In order to develop frost-resistant varieties in the Punjab, the screening of germplasm for frost resistance both under field and laboratory conditions has been intensified. In this paper the results of screening the available germplasm under field conditions are reported.

Materials and methods

The germplasm consisted of Co canes and selections made from the seedlings raised at Jullundur from the fluff of bi-parent crosses made at the Sugar Cane Breeding Institute at Coimbatore. The criteria used for evaluation were:

Category	*Physical injury*	*Tissue injury index*	*Bud viability index*
Resistant strains (leaves absolutely green)	1	0·00–0·40	0·81–1·00
Tolerant strains (Desiccation of leaf tips)	2	0·41–0·60	0·61–0·80
Moderately resistant strains (Desiccation of half the leaf blade)	3	0·61–0·80	0·41–0·60
Susceptible strains (Desiccation of more than half the leaf blade)	4	0·81–1·00	0·00–0·40

Physical injury: This was assessed by visual observations recording foliar damage in the field one month after the frosty period on 7.3.1977. The winter season of 1976-77 experienced 52 frosty nights with varying intensities and duration of frost. The evaluation was done on a points basis.

Tissue injury: This was determined as the Tissue Injury Index (TII); the leaching technique[8] with a few modifications was adopted, keeping in view the existing facilities and local crop situation. The technique is based on the principle that plasma membranes lose their semi-permeability owing to low temperature stress. The leaf sample (3rd leaf from the top) of each genotype was washed with distilled water and blotted to dryness. The leaf was cut into pieces of about 0·5 cm side length. A 1-g sample was then placed in 25 cm^3 of double-distilled deionized water and shaken at room temperature for 1 hour. The extract was decanted and its conductance measured in $mmho.cm^{-1}$. These samples were then frozen at —2·5°C for 6 hours, placed back in the original extract and shaken once more for 1 hour. The final conductance was measured and the TII calculated as under:

$$TII = C_1/C_2$$

where C_1 = electric conductance of cell sap before freezing of the leaf sample; C_2 = electric conductance of cell sap after freezing of the leaf sample.

Bud injury: This was estimated in terms of the Bud Viability Index (BVI); 50 two-budded setts from each variety were subjected to a temperature of —2·5°C for 6 hours in a deep-freezer and planted in the field. The same number of untreated setts was also planted. After the completion of germination, the BVI was calculated as under:

$$BVI = G_1/G_2$$

where G_1 = % germination of freezer-treated setts; G_2 = % germination of untreated fresh setts.

Results and discussion

The results are presented in Tables I and II, and show that there was considerable variation in the reaction of different strains to the freezing temperature. Of the strains studied, 9 were resistant to bud as well as tissue injury, 35 were resistant to bud injury only, 5 were tolerant to bud injury as well as tissue injury, 17 were tolerant to bud injury only, 28 were tolerant to tissue injury only, 13 were moderately resistant to bud as well as tissue injury, 10 were moderately resistant to bud injury only, 30 were moderately resistant to tissue injury only, 9 were susceptible to bud as well as tissue injury, 10 were susceptible to bud injury only, and 15 were susceptible to tissue injury only. Earlier works[2–8] have also reported physical injury to the cane crop by freezing temperatures.

Table I. Reaction of different strains to low temperature

Nature of damage	*Resistant*	*Tolerant*	*Moderately tolerant*	*Susceptible*
Tissue+Bud injury	S 419/72, S 533/72, S 55/74, S 105/74, S 178/74, S 202/74, S 78/74, S 578/74, S 723/74	CoJ 64, S 242/72, S 117/74, S 142/74, S 374/74	Co 975, CoJ 46, CoJ 58, Co 7222, S 17/71, S 482/72, S 521/72, S 1057/72, S 4/73, S 15/73, S 221/74, S 527/74, S 909/74	Co 7221, S 15/70, S 50/71, S 64/71, S 354/73, S 1020/73, S 1213/73, S 1233/73, S 113/74,
Bud injury	Co 1148, CoJ 67, Co 6904, Co 6914, Co 7107, Co 7205, Co 7211, S 15/71, S 33/71, S 14/72, S 237/72, S 404/72, S 406/72, S 410/72, S 445/72, S 448/72, S 498/72, S 544/72, S 557/72, S 653/72, S 662/72, S 733/72, S 351/73, S 932/73, S 107/74, S 135/74, S 323/74, S 373/74, S 441/74, S 562/74, S 638/74, S 654/74, S 700/74, S 721/74	Co 7202, Co 7219, CoJ 70, CoJ 72, S 98/70, S 99/70, S 222/72, S 415/72, S 490/72, S 503/72, S 527/72, S 582/72, S 591/72, S 53/73, S 1024/73, S 154/74, S 915/74	Co 1158, Co 7102, Co 7203, S 206/72, S 695/72, S 696/72, S 408/73, S 747/73, S 1289/73, S 129/74	Co 7210, S 15/71, S 67/71, S 787/73, S 1031/73, S 2/74, S 12/74, S 17/74, S 750/74, S 791/74
Tissue injury	S 419/72, S 533/72, S 55/74, S 105/74, S 178/74, S 202/74, S 78/74, S 578/74, S 723/74	Co 1148, CoJ 67, Co 6914, Co 7107, Co 7203, Co 7205, S 67/71, S 14/72, S 404/72, S 410/72, S 445/72, S 448/72, S 544/72, S 557/72, S 653/72, S 695/72, S 696/72, S 733/72, S 351/73, S 1031/73, S 1289/73, S 12/74, S 129/74, S 562/74, S 638/74, S 719/74, S 721/74, S 750/74	Co 6904, Co 7202, Co 7210, Co 7211, CoJ 72, S 98/70, S 99/70, S 52/71, S 237/72, S 406/72, S 415/72, S 490/72, S 498/72, S 503/72, S 582/72, S 591/72, S 847/73, S 932/73, S 1024/73, S 2/74, S 17/74, S 107/74, S 135/74, S 154/74, S 323/74, S 441/74, S 650/74, S 654/74, S 700/74, S 915/74	Co 1158, Co 7102, Co 7104, Co 7219, CoJ 70, S 12/71, S 33/71, S 206/72, S 222/72, S 527/72, S 662/72, S 53/73, S 408/73, S 747/73, S 373/74

[8] Sukumaran & Weiser: *Plant Physiol.*, 1972, **50**, 564–567.

SIEMENS

Better control of the sugar boiling process

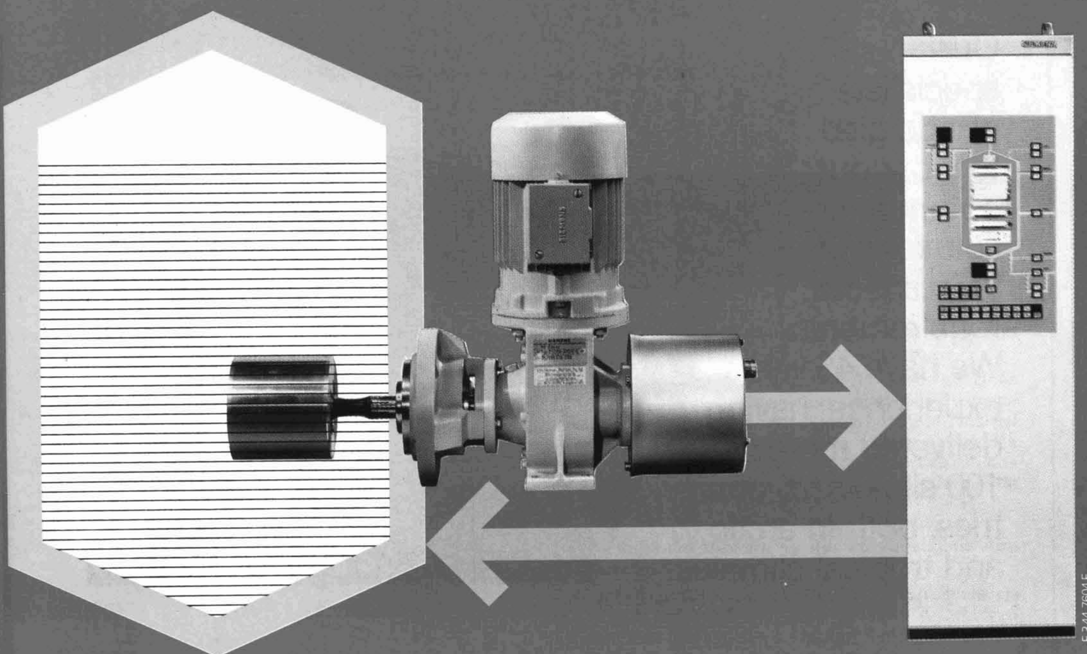

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Table II. Relative reaction of sugar cane germplasm to frost injury

Sugar cane varieties	*Physical injury to leaves*	*Tissue injury index (TII)*	*Bud viability index (BVI)*
Approved			
Co 975	3	0·66	0·55
Co 1158	4	0·87	0·50
CoJ 58	2	0·63	0·44
CoJ 67	2	0·60	0·83
Co 1148	2	0·43	1·00
CoJ 46	3	0·65	0·60
CoJ 64	2	0·58	0·67
Promising Coimbatore-bred canes			
Co 6904	3	0·67	0·86
Co 7102	4	0·86	0·42
Co 7107	1	0·55	1·00
Co 7203	2	0·57	0·56
Co 7210	3	0·74	0·40
Co 7219	4	0·92	0·75
Co 7222	3	0·68	0·50
CoJ 72	3	0·77	0·65
Co 6914	2	0·58	1·00
Co 7104	4	0·83	0·86
Co 7202	3	0·70	0·80
Co 7205	2	0·59	1·00
Co 7211	3	0·68	0·86
Co 7221	4	0·85	0·17
CoJ 70	4	0·85	0·65
Selections			
S 15/70	4	0·86	0·35
S 99/70	3	0·74	0·63
S 17/71	3	0·73	0·52
S 50/71	4	0·85	0·33
S 64/71	4	0·92	0·33
S 14/72	1	0·58	0·91
S 222/72	4	0·88	0·71
S 242/72	2	0·58	0·80
S 406/72	2	0·64	0·83
S 415/72	2	0·64	0·72
S 448/72	2	0·58	1·00
S 482/72	3	0·70	0·60
S 498/72	3	0·65	1·00
S 521/72	3	0·66	0·50
S 98/70	2	0·63	0·68
S 12/71	4	0·90	1·00
S 33/71	4	0·86	1·00
S 52/71	3	0·63	0·40
S 67/71	3	0·60	0·33
S 206/72	4	0·85	0·50
S 237/72	3	0·66	1·00
S 404/72	1	0·55	0·83
S 410/72	2	0·54	1·00
S 445/72	1	0·56	0·82
S 449/72	1	0·37	0·90
S 490/72	3	0·72	0·62
S 503/72	3	0·65	0·75
S 527/72	4	0·88	0·80
S 533/72	1	0·35	1·00
S 557/72	2	0·55	1·00
S 591/72	2	0·67	0·64
S 662/72	4	0·87	1·00
S 696/72	2	0·55	0·50
S 1057/72	3	0·65	0·50
S 15/73	3	0·62	0·50
S 351/73	2	0·54	1·00
S 408/73	4	0·82	0·59
S 847/73	3	0·63	0·14
S 1020/73	4	0·90	0·20
S 1031/73	2	0·58	0·00
S 1233/63	4	0·84	0·00
S 2/74	3	0·68	0·33
S 17/74	2	0·63	0·10
S 105/74	1	0·32	1·00
S 113/74	4	0·82	0·33
S 129/74	2	0·58	0·55
S 142/74	2	0·53	0·71
S 178/74	1	0·40	1·00
S 221/74	3	0·62	0·60
S 323/74	3	0·72	0·88
S 374/74	2	0·52	0·80
S 527/74	3	0·72	0·60
S 578/74	1	0·35	1·00
S 650/74	3	0·72	0·00
S 700/74	3	0·68	1·00
Selections			
S 721/74	2	0·58	0·83
S 750/74	1	0·45	0·00
S 915/74	3	0·70	0·71
S 544/72	1	0·56	0·90
S 582/72	3	0·70	0·80
S 653/72	1	0·55	0·93
S 695/72	2	0·58	0·50
S 733/72	2	0·55	1·00
S 4/73	3	0·72	0·60
S 53/73	4	0·83	0·75
S 354/73	4	0·86	0·36
S 747/73	4	0·83	0·56
S 932/73	3	0·65	1·00
S 1024/73	3	0·62	0·63
S 1213/73	4	0·90	0·00
S 1289/73	2	0·58	0·60
S 12/74	2	0·60	0·33
S 55/74	1	0·33	1·00
S 107/74	2	0·62	0·88
S 117/74	1	0·45	0·80
S 135/74	3	0·70	1·00
S 154/74	3	0·65	0·75
S 202/74	1	0·40	1·00
S 278/74	1	0·40	1·00
S 373/74	4	0·83	0·88
S 441/74	3	0·67	1·00
S 562/74	2	0·58	0·83
S 638/74	2	0·58	1·00
S 654/74	3	0·68	1·00
S 719/74	2	0·60	0·00
S 723/74	1	0·32	1·00
S 909/74	3	0·65	0·50

Summary

Results are reported of screening tests conducted on setts from a large number of Indian cane varieties under field conditions. The effect of frost was determined in terms of physical injury (established visually), tissue injury and bud viability. The results are tabulated.

Evaluation physiologique de la résistance au gel du plasma des germes de canne à sucre.

On publie les résultats d'essais d'élimination effectués sur des pieds d'un grand nombre de variétés de canne indienne plantés dans les champs. L'effet du gel a été déterminé en termes de dégâts phisiques (établis visuellement), dégâts aux tissus et viabilité des bourgeons. Les résultats sont repris sous forme de tableau.

Physiologische Bewertung der Frostresistenz von Zuckerrohr-Keimplasma

Mitgeteilt werden die Ergebnisse von Ausleseverfahren, die mit Setzlingen einer grossen Anzahl von auf dem Feld gepflanzten indischen Rohrsorten durchgeführt wurden. Die Auswirkungen des Frosts wurden anhand der äusserlichen (sichtbaren) Beschädigungen, der Beschädigungen des Zellgewebes und der Lebensfähigkeit des Keims bestimmt. Die Ergebnisse sind tabelliert.

Evaluación fisiológica de germoplasma de caña de azúcar para resistencia a helada

Se presentan resultas de ensayos de selección para trozos de muchas variedades de caña de la India que se han planteado en el campo. El efecto de la helada se ha determinado en términos de daño físico (establecido visualmente), daño al tejido y viabilidad del brote. Las resultas se presentan en forma tabular. □

SUGAR CANE AGRONOMY

The moisture control service and its phases of investigation. A. Vasquez V. and A. Hoekstra. *Bol. Técn. Divn. Técn. Inst. Central Invest Azuc.*, 1975, **4**, (3/4), 83–115 (*Spanish*).—The concept of the soil as a reservoir of water from which the cane plant can draw, and the relationships between water and soil are discussed as a theoretical basis on which the soil moisture service of the Peruvian sugar industry controls irrigation in order to achieve the greatest benefit in terms of profitability.

Changes in juice quality of flowering canes with time. A. T. Barredo. *Crystallizer*, 1977, **2**, (2), 12–13. Juice analysis from flowering stalks of two Philippine cane varieties showed that the recoverable sugar content in one did not change between tassel initiation and 3 months after tassel emergence while, in the second variety, recoverable sugar increased to tip emergence and thereafter decreased. Tasselling might therefore not have adverse effects on all varieties or at all times, although this was the case with a third variety. Internode expansion still continued with flowering cane, so that it is recommended that harvesting of young flowering cane be delayed as much as 2 months. With mature cane, flowering may be beneficial if harvesting is complete before full tassel emergence is reached.

Chemical methods of assessing available phosphorus from phosphate fertilizer materials. E. M. Tianco. *Crystallizer*, 1977, **2**, (2), 13.—Neutral ammonium acetate extraction of phosphate from rock phosphate fertilizer does not give a true estimate of the amount available to the plant, and a series of tests were made using some organic acid solution extractants and correlating the results with P uptake by cane. Best overall correlation was with 2% citric acid solution at a 1:500 soil:extractant ratio.

The influence of immediate and delayed cane seedpiece treatments on germination. F. C. Barredo. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 253–258.—Cane setts were planted 1, 5, 9 and 13 days after cutting, with some treated with fungicide immediately after cutting or just before planting; comparison was made with untreated controls. Germination of the cane treated immediately after cutting increased with time before planting, whereas germination of the control setts and those treated just before planting decreased.

Weed control with some herbicides in sugar cane fields at VMC farms. P. H. Porquez, J. N. Gibe and F. I. Ledesma. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 290–301.—Four pre-emergence and four post-emergence herbicides were tested, using manual weeding and no weeding as the control treatments. In most pre-emergence experiments, the overall effect (which is a measure relating mortality to weed abundance) of all chemicals was similar to that of the standard chemical "Pesco 18-15", but in one, owing to inadequate soil moisture, results were all poor and a number of treatments gave better results than the standard. In regard to duration of effective control, two mixtures of "Asulox 40" and "Actril D" gave best results with a number of treatments including "EL 103", which gave shorter but better effective control than the standard treatment. An "Asulox 40"/"Actril D" mixture gave better and more lasting control than the standard post-emergence treatment with "Karmex"+"Pesco 18-15", while the duration of control by a mixture of "EL 103" and "Pesco 18-15" was also greater. The weed species controlled by the various treatments are indicated.

Farm demonstration on rock phosphate application. E. B. Puyaoan and V. L. Ebron. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 302–307.—Application of rock phosphate in farms in three deficient areas demonstrated the resulting production of more and healthier roots, better tillering capacity, better cane quality and better juice quality.

Phosphate availability from raw and acidulated rock phosphate. W. G. Espada and C. S. Gotera. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 308–322.—Rock phosphate, treated with various proportions of phosphoric acid, was applied to an acidic sandy loam soil at a rate of 90 ppm total P_2O_5 and moist-incubated for 70 days in a greenhouse. With higher levels of acid, the available P (as measured by Truog, Olsen and Bray extraction methods) was higher, but at quasi-equilibrium the available P in soils fertilized with 20% acid-treated rock was close to that in the 50% and 100% experiments.

Cane yield and N-P-K uptake of Phil 56-226 under different fertilization levels and moisture regimes. N. C. Fernandez and F. P. Villamayor. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 331–350.—A lysimeter study is reported on two soils—a sandy loam and a clay loam—using different fertilization levels and moisture regimes. Variation of cane yield was overridingly influenced by soil type × irrigation, fertilization levels of 200-100-500 and 200-200-500 kg N-P_2O_5-K_2O not producing significantly different yields. When optimum irrigation was applied, differences in cane yield between the soils were not significant. Nitrogen uptake varied under the influence of irrigation, but P_2O_5 uptake did not, although the phosphate content of the cane juice showed wide variation. Phosphate uptake differed between soils, however. Potassium in the juice depended mainly on soil type.

Maximizing fertilizer efficiency. A. P. Tianco. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 431–442. Perfect fertilizer efficiency is such that plant nutrients are applied in such chemical and physical form and at such times and placements that the maximum yield is obtained with the minimum possible amount of fertilizer. Factors to be studied in achieving as high an efficiency as possible include soil testing, nature of the fertilizer placement, time of application, use of sugar factory and field residues as fertilizer supplements, the law of limiting factors and the law of diminishing returns.

Weeds and trends in their control. S. R. Obien. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 443–464.—The crop losses due to weed competition and the reasons why weeds are difficult to control are discussed. The basic principles and methods of weed control are mentioned as are the functions of herbicides. Trends in weed control are described, both conventional (use of chemicals in existing manner, spot treatment, soil incorporation, etc.) and unconventional (use of crop protecting chemicals as antidotes against less selective herbicides, adsorption on active carbon, etc.). Practices in the Philippines are described with reference to the literature.

Assessment of "Polaris", a sugar cane ripening chemical, on field scale. D. Eastwood. *J.A.S.T.J.*, 1974, **35,** 34–45.—Trials were carried out during the late part of the 1973 crop and early and late crop periods of 1974 at Jamaica Sugar Estates (a high-rainfall area with poor ripening conditions) and Monymusk and Innswood Estate (irrigated estates with better ripening conditions). In the trials at Jamaica Sugar Estates, "Polaris"-treated cane showed increased pol, slightly decreased tonnage and increased available sucrose per acre, ranging from 2·06% to 27·18%. At Monymusk and Innswood, no marked ripening responses were obtained. Effects of the chemical included desiccation of the leaves; in the case of irrigated cane, the treatment coincided with the normal "drying-off" before harvest, which might explain the lack of response.

Plant nutrients of filter cake from five Jamaican sugar factories. D. Eastwood. *J.A.S.T.J.*, 1974, **35,** 51–55.—Analyses have been made of filter cake from five sugar factories in Jamaica. On the basis of the usual rate of application, the K content will have little significance, while Mg and trace elements are likely to be of limited value. The Ca content is most likely to be effective for correcting low soil pH, and only phosphate in the filter cake is of nutritional significance. The N content is appreciable but not likely to be of benefit to the crop, a proposition supported by leaf N measurements in cane provided with cake and untreated.

The role of "fall" planting in managing an irrigated cane farm. M. B. Farrison. *J.A.S.T.J.*, 1974, **35,** 55–64. Experience at Bernard Lodge over 10 years is used for examination of the desirability and extent of planting of cane in the second half of the year as well as in the first in order to maximize production of sugar per acre per month; it is concluded that under the conditions at Bernard Lodge this is achieved by 12% "fall" planting.

The effect of residual trash on cane yield under a pre-harvest burning system. M. Shaw and P. McConnell. *J.A.S.T.J.*, 1974, **35,** 65–70.—To examine the effects of trash blanketing, clean and trash rows in the same fields were compared as to yield and in some cases showed a significant gain with the trash, but in one case a significantly higher yield without. Further trials showed that the clean rows gave lower yield where re-growth started before the middle of May and higher yield where re-growth started later. The effect was associated with rainfall, and the trash apparently helped under the drier conditions but had a depressive effect under wet conditions. It is recommended that the trash be preserved in dry areas (and "trash" varieties grown in them), while for areas receiving heavy rain from mid-May onwards, the trash should be removed by burning.

Furrow design criteria and related crop water use on a sandy loam soil. L. Ramdial. *J.A.S.T.J.*, 1974, **35,** 70–77.—Experiments were conducted to evaluate crop water use efficiency for varying furrow slopes (0·30% and 0·40%), stream sizes of 80, 120 and 160 US gal.min^{-1} and furrow lengths of 2, 4 and 6 chains. Measurements were made of cane yield, rainfall, deep percolation losses and the water applied, for a plant crop and first ratoon. Greater yields were given in both crops by the larger stream size, with the steeper slope producing more cane. Longer furrows were more productive than short in plant cane, but *vice-versa* in ratoon. The larger the stream size, the greater was the amount of water supplied and the deep percolation losses, especially for ratoon cane at the 4-chain furrow length. Crop water use (tons cane per acre.inch) was high, ranging from 0·58 to 0·98 for plant cane and 1·27–1·69 for the first ratoons. Long furrow runs and large stream sizes gave the highest water use efficiency and are therefore recommended.

Some soil/plant moisture relationships of the sugar cane plant. L. Ramdial. *J.A.S.T.J.*, 1974, **35,** 77–87. Three plots, with 6 rows of cane 5 ft apart and 4 chains long, were supplied with irrigation water at stream sizes of 80, 120 and 160 US gal.min^{-1}. The slope of the field was 0·4%. Irrigation inputs, daily rainfall and cane yield were recorded. In each plot were located 9 neutron probe access tubes in groups of three along the plot, each group including one in the centre of the bank and the others in the centres of adjacent furrows, forming a line. The tubes were inserted to a depth of 2 metres, and moisture contents were read at depths of 20 cm to 150 cm, at 10-cm intervals. Measurements were recorded and fed to a computer which gave a print-out showing the volumetric water content for each 10-cm soil layer, from which water distribution throughout the soil profile, evapotranspiration, rooting depth, deep percolation losses and moisture re-distribution after irrigation could be obtained. The replenishment of water deficits by irrigation was demonstrated before July; after this, rainfall was sufficient. Root establishment was indicated to 60 cm during irrigation and reached 70 cm by December. Storage variation occurred within the profile owing to differences in the nature of the soil, with better retention by clay layers. Losses by deep percolation proved to be high—two-thirds for the larger stream sizes and half for the smallest which, however, gave lowest cane yield. Total moisture loss during the period of no rainfall was measured and attributed to evapotranspiration. It averaged 0·26 cm.day^{-1} before and after closure of the canopy.

A farm field history chart for work planning and control. R. D. Truen. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 5–6.—As an aid to estate management, a chart is developed on which it is possible to see easily the stage reached in cultivation. All the fields on the farm are allocated sections, and the various operations (fertilizer application, herbicide spraying, cultivation, etc.) identified by different colour codes with pins indicating planned operations, strips representing work in progress and squares indicating work completed. The history and progress of operations can be easily followed and controlled.

Results of recent experiments on chemical ripening of sugar cane. H. Rostron. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 30–35.—Initial screening of six potential chemical ripeners reduced them to two, viz. "Embark" (3M Company) and Am 74/A382 (Amchem Products Inc.), which were further tested against "Ethrel" (Amchem Products Inc.) as standard. At equivalent application rates, Am 74/A382 was more effective than "Ethrel". With young, rapidly growing cane, all three chemicals produced similar substantial increases in recoverable sugar yield per hectare, but with older and lower-yielding cane "Embark" was either not effective or less so than "Ethrel". Variation in response to spraying of the chemicals at different times emphasized the importance of the physiological state of the cane. Response to the chemicals could be seen up to 18 or 19 weeks after application, although it had begun to diminish after 14 weeks. Application of oil or urea with "Ethrel" did not improve the response to it.

Results of three post-emergence herbicide screening trials conducted in 1974 and 1975. P. E. T. Turner. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 36–41. Trials for evaluation of seven new post-emergence herbicides are described. "Velpar" alone, "Velpar" plus "Diuron", and "Bentazon" plus "Diuron" were active on *Cyperus esculentus* and broad-leaved weeds. WL63611 and "Terbutryne" plus 2,4-D showed some activity against broad-leaved weeds and a slight effect on grasses. "Dowco 291" and "Tordon 472" were ineffective against all weed species present, while "Dowco 233" was active only against *C. rotundus* but not acceptably so. The currently recommended treatment with "Diuron" plus "Paraquat" was the most effective with *C. esculentus* and grasses. "Diuron" plus "Sencor", and "Diuron" plus "Ioxynil" plus 2,4-D were active against *C. esculentus*, grasses and broad-leaved weeds, and were superior for these to "Diuron" plus 2,4-D (or MCPA) or "Ametryne" plus 2,4-D (or MCPA). The most effective treatments for *C. rotundus* control were "Dowco 233" and "Diuron" plus "Paraquat". "Diuron" plus "Ioxynil" plus 2,4-D and "Asulam" plus "Ioxynil" plus 2,4-D were effective at rates higher than those at present recommended.

Reclamation of a saline sodic soil in the Nkwaleni Valley. M. A. Johnston. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 42–46.—With inadequate drainage for irrigation excesses in certain areas, groundwater salts rose to the surface and accumulated. To reclaim this soil, drainage was improved and additionally areas were treated with gypsum (31 tonnes.ha^{-1}) and sulphur (6 tonnes.ha^{-1}). Both treatments were more beneficial than drainage alone, but the differences were sometimes less than anticipated. Average yields for plant cane and first ratoons in the gypsum, sulphur and control areas were 100, 99 and 82 tonnes.ha^{-1}, respectively.

Soils modified with polymer emulsions as substitutes for polyethylene sheet. R. T. Bishop. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 57–61.—Application of polyethylene sheet over rows of cane planted under cool conditions prevented moisture loss and increased soil temperatures to give earlier tillering and raise yield by 21–29 tonnes.ha^{-1}. Experiments have been carried out using emulsions of various vinyl and acrylic polymers and copolymers. Application imparted water repellency to sand and to soil. The emulsions reduced evaporation and raised temperatures in wet soils, and reduce leaching losses from the fertilizer. Early shoot counts from four separate replicated field experiments planted in autumn and winter with modified soil barriers at or below the surface showed that less than 25 kg.ha^{-1} of dry polymer increased the number of shoots by 268%, 47% and 39% in dry land conditions and 21% in irrigated cane when compared with the respective control plots. Earlier tillering was achieved by lining of furrow sides to divert water (as rain) to cane planted in the centre of the furrow.

Effect of time of sampling on the diagnosis of the N, P, K, Ca and Mg requirements of sugar cane by the DRIS approach. E. R. Beaufils and M. E. Sumner. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 62–67.—Using the DRIS method[1] with soil and leaf analysis from a 3^4 N-P-K lime factorial experiment, sampled at 3, 6, 12 and 18 months, it was demonstrated that the technique has an advantage over the threshold value approach to diagnosis in that it can be used to make valid diagnoses throughout the growth of the crop. This is very important in practice, as it makes it possible to sample the crop over a greatly extended period.

Irrigation and drainage of sugar cane. Intensive farming creates problems. N. E. Hewitt. *Producers' Rev.*, 1977, **67**, (5), 23–27.—Establishment of cane lands, especially in the far north of Queensland, has sometimes been done without sufficient attention to drainage and flood protection, and a Government-sponsored survey has shown that some 40,000 ha of currently assigned cane land could benefit to varying extents by improved drainage. This would cost some $A 9·5 million and involve an annual maintenance cost of $A 650,000. The Irrigation Commission is concerned with a number of drainage and irrigation schemes, and progress on these is described. Only about 30% of the irrigated cane area of 74,000 ha is safeguarded by water conservation works such as dams; the remainder is dependent on water availability from rivers, and this is highly variable, as exemplified by the flow in the Burdekin River, which can vary from 185,000,000 m^3 in one year to 150 times that figure.

Energy and sugar cane production. C. C. Wang. *Taiwan Sugar*, 1977, **24**, 340–342.—The energy consumption of various crops, as reported in the literature, is discussed and special attention given to sugar cane which is cited as the only crop to produce its own fuel for its processing. The fuel oil equivalent of cane and bagasse is given as 6 and 4½ times by weight, respectively. Under conditions in Taiwan, production of energy in the form of sugar requires little money and little land, by comparison with other crops such as potatoes, corn or wheat, while molasses fermentation provides another energy source in the form of alcohol. The main advantage of sugar cane as an energy source is its annual replenishment, compared with non-replaceable fossil fuels.

Ripening factors in sugar cane. J. Fernandes. *Brasil Açuc.*, 1977, **89**, 116–122 (*Portuguese*).—It is pointed out that growth and ripening of cane are simultaneous rather than consecutive but that the predominance of these effects is very much subject to cycles governed by climatic conditions. The action of chemical ripeners and problems in their use are discussed.

[1] *I.S.J.*, 1976, **78**, 147.

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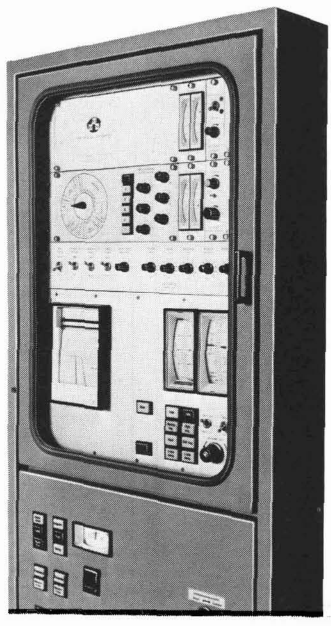

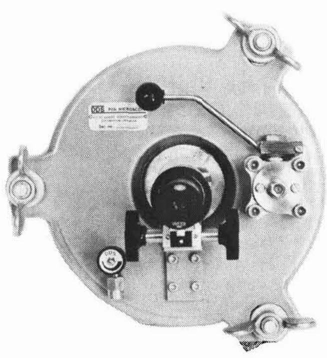

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CANE PESTS AND DISEASES

Army worm outbreaks warning. A. J. M. Carnegie. *S. African Sugar J.*, 1977, **61**, 151.—Large numbers of the army worm moth (*Spodoptera exempta* Walker) were recorded in light traps during April 1977 and a warning given that the caterpillar infestation might be high in May. Control with "Sevin", "Malathion" or "Tiodan" is easy, and these chemicals may be placed on the ground in a band between the cane and an adjacent host crop; if the latter is exhausted before the caterpillars reach maturity, they may migrate to the cane field and the pesticide will kill many by contact before they can damage the crop.

A "Temik" applicator for trashed fields. Anon. *S. African Sugar J.*, 1977, **61**, 181.—An implement is described which, mounted on a tractor, may be used for applying this nematicide. A tine shank lifts the trash blanket which is cut by a high-speed disc. At the same time the tine cuts a 50 mm deep furrow for "Temik" supplied through an application unit mounted on the tractor.

Screening sugar cane clones for resistance to pineapple disease. H. U. Ahmed, M. A. Khan and M. I. H. Mian. *Sugarcane Pathologists' Newsletter*, 1977, (18), 8-9. In resistance trials, sets of 20 varieties were punctured and inoculated with a mycelial block containing spores and agar medium. After planting in sand, the germinated cane was observed and the reactions recorded. Of the 20, 17 varieties were classified as resistant, 2 intermediate and only one—Q 69—as susceptible.

A note on the occurrence of *Striga densiflora* in Bangladesh. H. U. Ahmed and M. I. H. Mian. *Sugarcane Pathologists' Newsletter*, 1977, (18), 10-11.—The presence of this parasite was first observed 40 years ago. No control measures have been attempted, and the area infested has grown markedly; in some areas cane growing has been abandoned because of its effects.

Influence of sugar cane mosaic virus on the activity of nitrate reductase in maize leaves. R. D. Joshi and J. Prakash. *Sugarcane Pathologists' Newsletter*, 1977, (18), 19-20.—As a consequence of infection with the B and F strains of the mosaic virus on another host plant—*Zea mays*—the nitrate reductase increased markedly up to 18 days and 24 days, respectively (owing to speedy synthesis of amino-acids required for multiplication of the virus) and then decreased very quickly.

***Aspergillus flavus* pathogenic on the Pyrilla leafhopper of sugar cane.** D. G. Hapase and M. B. Bachchhav. *Sugarcane Pathologists' Newsletter*, 1977, (18), 21.—During an infestation of *Pyrilla perpusilla* in India, dead nymphs and adults were examined and found to be infected with *A. flavus*. Its pathogenicity was tested by spraying healthy Pyrilla specimens with a spore suspension; mortality was 97-100% after 7 days. Studies are being made to see if it can be used in the field for control of the leafhopper.

Transovarial transmission of the Fiji disease virus in *Perkinsiella saccharicida* Kirk. V. C. S. Chang. *Sugarcane Pathologists' Newsletter*, 1977, (18), 22-23.—One hundred female *P. saccharicida*, from colonies maintained on diseased cane, were confined to six young plants for oviposition, the eggs collected and kept in Petri dishes. The newly hatched nymphs were transferred to virus-free cane plants and kept in the truncated centre leaves for 5 and 14 days. The first group of plants showed no symptoms, but the second group did, showing that the disease was transmitted through the egg and also that the incubation period was longer than 5 days.

Use of aerated steam as a possible method for the control of sugar cane mosaic and ratoon stunting disease. R. J. Steib and O. M. Cifuentes. *Sugarcane Pathologists' Newsletter*, 1977, (18), 24-27.—Tests have been made on control of mosaic and ratoon stunting—the only two major cane diseases in Louisiana—by use of aerated steam at 56°C for 2½ and 3 hr and at 57°C for 1½ and 2 hr, comparing disease incidence and germination. Disease control was better at the longer times with both temperatures but germination was severely affected. Field germination, however, was better than greenhouse results, and it is considered that aerated steam treatment has been readily accepted in Louisiana because of total mechanization of the operation. An acceptable stand can be obtained by planting stalks with a 40-50% overlap instead of a 10-15% overlap, and even a 30-40% reduction in germination will be accepted.

Nematode population in relation to premature drying of sugar cane leaves during the summer months. F. C. Barredo. *Crystallizer*, 1977, **2**, (2), 12-13.—Soil sample examination confirmed that there were high nematode populations in parts of cane fields where the cane appeared to have suffered unusually greatly from sun scorching under dry summer conditions. The genera isolated have been previously described as harmful to cane. The study did not show the level at which nematode population affected the cane leaves, and more work is required to discover this.

Pest control. L. J. Dosio. *La Ind. Azuc.*, 1977, **84**, 138-139 (*Spanish*).—Losses attributable to pests and diseases in Argentina are estimated at 30% of the potential production, and it is emphasized that, even under bad economic conditions, this should be reduced by a combination of agronomic measures in respect of soil cultivation, seed cane selection, etc., as well as judicious use of pesticides.

Incidence of sugar cane pests and diseases in four mill districts in the Visayas. R. V. Estioko, H. H. Las Piñas and M. Alba. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 174-183.—Varieties grown to the extent of 10% or more in each district were surveyed; they were Phil 56226, Phil 58260, Phil 5333 and H 37-1933. About 3% of each area was surveyed for plant cane and 3% for ratoons, and observations made on the types and degree of infection by diseases and infestation by pests. There were three major diseases—smut, leaf scorch and yellow spot—and nine others of minor significance. Among pests, woolly aphid, shoot borers (grey, white, striped and pink) and rats were major problems, top borers and scale insects being minor pests.

Good agricultural practice in the use of pesticides. E. D. Magallona. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 465-469.—Through lack of an alternative, it is likely that use of chemicals to control pests will continue in the Philippines for the foreseeable future. It is necessary to protect the environment from potential harm from e.g. persistent pesticides by limiting the use of chemicals to the minimum required.

The toxicity of some agrochemicals to *Pheidol* sp. (Hymenoptera:Formicadae), a common ant in Natal cane fields. G. W. Leslie. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 21-23.—Ants may influence populations of the borer *Eldana saccharina*, and studies were therefore made to determine the toxicity to an ant species (probably *P. megacephala* F.) of four herbicides ("Roundup", 2,4-D, MCPA and "Paraquat") and the nematicide "Aldicarb" ("Temik"). Most killed between 10 and 20% of the ants under the conditions employed, but "Temik" and MCPA killed 90% and 4%, respectively. Spraying practices, absorption of the chemical by plants and volatilization could all serve to reduce the quantity of active chemical to which the ants might be exposed, however.

Current situation regarding the borer *Eldana saccharina* Walker (Lepidoptera:Pyralididae). A. J. M. Carnegie. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 24-26.—Inspection teams have surveyed the cane at six Natal mills supplied from infested areas, and field surveys have also shown that in 1976/77 the pattern and degree of infestation was little different from those of 1975/76. It is concluded that natural controlling factors are having an influence while, where recommended practices (avoidance of standover cane, cutting at or below ground level, and leaving no plant residues in the field to harbour borers) are followed, an improvement has resulted.

Sugar cane smut in South Africa: current control recommendations. R. A. Bailey. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 47-50.—In the northern, irrigated parts of the South African cane area, smut is widespread but of low incidence. It is a threat, however, to continued cultivation of the susceptible dominant variety N:Co 376 and other varieties. Recommended control measures include production of disease-free seed cane and roguing or eradication of affected fields; spot application of "Roundup" has proved a rapid and effective method of roguing infected stools.

Further evaluation of fungicides for control of pineapple disease of sugar cane. G. R. Bechet. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 51-54. Trials were carried out on a number of new non-mercurial fungicides into which setts were dipped and bud and sett germination assessed three months after planting. "Bavistin" at 0·75 g/1000 cm^3 gave the best control, while "Tecto" at 4 cm^3 and "Benlate" at 1·0 g per 1000 cm^3 also gave very good control. Higher rates of "Bavistin" and "Benlate" were less effective. "Funginex" at 4 and 8 cm^3/1000 cm^3, "Topsin" at 2 g/1000 cm^3 and "Panoctine" at 2 and 4 cm^3/1000 cm^3 effectively controlled the disease, the last two not as well as observed previously. "Fongerene" at up to 2 g/1000 cm^3, "Bayleton" at up to 1 g/1000 cm^3 and "Aretan" at up to 3 g/1000 cm^3 performed poorly.

The systemic distribution and relative occurrence of bacteria in sugar cane varieties affected by ratoon stunting disease. R. A. Bailey. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 55-56.—The systemic distribution of diagnostic bacteria in cane varieties differing in reaction to ratoon stunting disease is described. Bacteria have been observed by phase contrast microscopy in all parts of the cane plant but are most readily observed in mature stalk tissues. The numbers of bacteria present in comparative preparations from three varieties were directly related to the severity of the varietal reaction to the disease.

Identification of sugar cane mosaic virus infecting cane in the Lower Rio Grande Valley of Texas. B. Villalon. *Plant Disease Reporter*, 1977, **61**, 503-508.—The cane fields of the Rio Grande Valley in south Texas were surveyed over three years (1974/76) and plants showing mosaic-like symptoms examined closely. Host range studies, serology and electron microscopy on extracts from the apparently mosaic-diseased cane confirmed that strain H of the disease is, in fact, present and widely distributed in the valley where all the cane varieties grown are imported and are all mosaic-susceptible.

Effects of temperatures on the cultural characteristics of the two races of *Ustilago scitaminea* Sydow in Taiwan. W. H. Hsieh and C. S. Lee. *Rpt. Taiwan Sugar Research Inst.*, 1977, (76), 53-57 (*Chinese*).—Cultural characteristics at different temperatures of single teliospores or sporidia of *U. scitaminea*, the causal organism of smut, can be used to distinguish the two strains of the fungus found in Taiwan. With one strain, culture at 26°C turns the white mycelium-type colonies cream after 21 days, while the other remains white. In the second, however, at 30-34°C dark brown colonies and mycelia occurred 2 and 7 days after incubation, whereas colonies of the first strain remained creamy and no mycelium developed. These characteristics applied to samples of the two strains from different sources.

Studies on *Bracon hebetor* Say. W. Y. Cheng and H. H. Hung. *Rpt. Taiwan Sugar Research Inst.*, 1977, (76), 59-71 (*Chinese*).—The morphology and biology are reported of *B. hebetor*, a wasp which is an ectoparasite of the larval stage of *Corcyra cephalonica* Stainton, currently mass-reared as a laboratory host of *Trichogramma australicum* Girault, a predator of three cane borers found in Taiwan.

Ratoon stunting and grassy shoot diseases of sugar cane. Anon. *Leaflet* (Directorate of Sugar Cane Dev., Min. of Agric. and Irrigation, India), 4 pp.—This small leaflet records the prevalence in the various states of the two diseases, describes the symptoms exhibited by diseased cane and lists control measures to be adopted.

CANE BREEDING AND VARIETIES

Wide choice of varieties in the Isis mill area. C. D. Jones. *Cane Growers' Quarterly Bull.*, 1977, **40**, 130–132. Information is given on N:Co 310, Q 86, Q 90, Q 93 and Q 95 varieties as well as briefer mention of a number of other varieties on the official approved list which are grown only to a small extent by comparison with Q 86, Q 93 and N:Co 310, which between them represent over 78% of the crop in the Isis area. This area is unlike others in south Queensland because it is not dominated by one single variety. Details are also given of two new varieties, Q 87 and Q 103.

Sugar cane varieties in the Central and Rohilkand ranges of U.P. and their performance under various agro-climatic conditions. M. L. Agarwal, R. S. Dixit, D. N. Gupta, K. M. Bhardwaj and N. P. Singh. *Proc. 40th Ann. Conv. Sugar Tech. Assoc. India*, 1974, (II), Ag. 11–Ag. 31.—The two areas, totalling 449,000 ha, have a range of agro-climatic conditions with temperatures ranging from 4°C minimum to 40°C maximum, and topography from alluvial plains to foothills. Waterlogging occurs in places. Part is sandy loam and part loamy sand, but there are extensive tracts of newly reclaimed forest soils. The varieties recommended for the areas, a total of 15, were grown over five years in trials under autumn and spring planting conditions, under waterlogged conditions, and grown to ratoons. The results are tabulated in detail, and it is concluded that early varieties CoS 510 and BO 47 are preferable while, of mid-late varieties, Co 1148, Co 1158, Co 6425 and BO 54 are preferable, each being best under specific conditions.

Cane breeding and varieties in Réunion. *C.E.R.F. Rpt.*, 1976, 1-26 (*French*).—During 1976, 304 parental combinations were made and 82,560 seedlings transplanted in the nursery, although more than 25,000 died in the greenhouse as a consequence of attack by *Helminthosporium* and *Fusarium* fungi. Studies are being made on mechanical "defuzzing" to separate the seed proper which is less vulnerable and may be stored more easily. Much information is tabulated on the quality and yield of selections from crosses in 1972 and earlier with ratoon crop data for 1971 and earlier. Crosses in course of pre-industrial multiplication include RP 347/67 (H 32-8560× R 445 cross), RP 119/66—a variety superior to the standard S 17 but susceptible to smut, and RP 99/66, a variety inferior to S 17 but growing well at higher altitudes.

Genetic modification of sugar cane and cassava cells through protoplast and anther culture. M. C. Liu and W. H. Chen. *Taiwan Sugar*, 1977, **24**, 304–311. A new technique for improvement of cultivated plants is the induced fusion of isolated protoplasts and the regeneration of whole plants from the fused protoplasts. Such parasexual hybridization appears to overcome incompatibility between species and varieties but has been limited to plants such as tobacco, petunias, etc. Protoplasts have been isolated from young cane leaves and fusion procedures have been worked out. A programme of research is set out for fusion of cane protoplasts with others isolated from legumes (and also fusion of cassava and legume protoplasts), with illustrations of isolates and fusions obtained in preliminary studies.

Characteristics of five newly released sugar cane varieties. E. P. Lapastora, F. A. Aala, L. C. Cosico and B. E. Magajes. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 113–121.—Five new varieties were released for 1975 by the Philippine Sugar Institute, viz. Phil 6421, 6425, 6429, 6553 and 6559. Their yields are comparable to the major but smut-susceptible Phil 56226 and they are resistant to smut, downy mildew and leaf scorch.

Performance of some Phil hydrids in Luzon. E. V. Vergara, K. L. Tefora, S. M. Villasanta, A. de Guzman and I. L. Jimenez. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 122–128.—Four new varieties were tested against Phil 56226 and Phil 58260 as controls in six different areas of Luzon, and the results are tabulated. The susceptibility of the varieties to yellow spot, downy mildew, red rot and mosaic varied with location, as did yield of cane and sugar. In most areas, however, Phil 62120 gave the highest yields, with Phil 6112, Phil 6019 and Phil 56226 best in three others.

Recent experiments in the cane breeding glasshouse at the Experiment Station. K. J. Nuss. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 27-29. Marcotting involves cutting a cane stalk near ground level, placing the cut end in a nutrient solution and, above this, attaching a metal cylinder filled with potting soil. Roots grow into this soil and, after two weeks, the stalks can be cut again below the cylinder and growth maintained by watering. Only some 40% of flower initials survive, however, and this can be increased by a "sleeving" technique whereby a black polyethylene tube of similar size to the metal cylinder (40×15 cm) is placed on the stalk by pulling the leaves through it, tying the bottom end about 20 cm above ground level, filling with moist potting soil and tying the top of the sleeve to the stalk. At the pre-determined stage of flowering (when roots should have developed in the soil) the stalk is cut below the sleeve and this placed in a metal cylinder, the top opened and the soil watered regularly. Further improvement is given by placing the cut end of the stalk in a nutrient solution. The effect of temperature on flowering was studied, and it was found that higher temperatures (⩾21°C) caused varieties to flower 62 days earlier than the same varieties did when kept under normal conditions (15·3°C).

Sampling technique of sugar cane juice analysis. H. V. L. Bathla, S. P. Jaiswal and R. S. Kanwar. *Cane Grower's Bull.*, 1977, **4**, (1), 13-14.—During varietal selection it is important to be able to obtain a representative juice sample of minimum size, and trials were carried out to determine the coefficient of variation for sampling from 1, 2, 3, 4, 5 and 6 clumps in a plot, 30 plots being examined. The results showed that the optimum number of clumps was 4.

SUGAR BEET AGRONOMY

Nitrogen sources in the soil. E. A. Watermann. *Die Zuckerrübe*, 1977, **26**, (4), 23-24 (*German*).—Soil N sources are briefly indicated. While most soil N (in the top soil 95% of the total) is organic, e.g. as plant and animal matter or their degradation products, only that present in groundwater or adsorbed by the soil is available to plants. Of the inorganic forms of N, nitrate N is, in most cases, only present in groundwater, while ammonium N is mostly adsorbed on clay minerals. The nitrogen cycle is explained, and conditions favouring nitrification and mineralization are listed, wherein it is stated that the conditions apply mostly in soils of medium grain size; in sand or clay the bacterial action on N can be limited by too low a pH (below 6) and poor ventilation. The dry solids and total N contents of various crop residues and organic fertilizers are tabulated as well as their C:N ratios. The difficulty of predicting N requirements of sugar beet is discussed. As an example, it is shown that at an organic matter content of about 2% and a C:N ratio of 10:1 in the top 25 cm of soil, there is about 7500 kg of N per ha, of which 1-3% (perhaps even more) can be mineralized during the growth period, representing release of 75-225 kg N per ha from organically bound forms. Application of the N_{min} method to beet is described, in which the soil mineral N content (N_{min}) in the top 100 cm of soil is determined in the spring and the N requirement established as the difference: calculated N requirement — determined N_{min} — calculated N delivery from the soil.

Handling soil samples. Anon. *Upbeet*, 1977, **65**, (2), 12-13.—Soil samples, if dried immediately, retain stable N contents; if kept moist, they show considerable increases in nitrate N values (e.g. from 25 to 63 ppm during 7 days) and this can produce large variations in fertilizer requirement indications, so that the fertilizer recommendation is not appropriate to the true soil N status. It is recommended that, if drying within 12 hours is not possible, the sample be frozen; by this means, the nitrate N content will vary only insignificantly.

The importance of organic matter for the nutrient status in sugar beet soils. H. Bronner. *Zucker*, 1977, **30**, 352-356 (*German*).—The amounts of organic matter and total N in beet soils are on average smaller on farms where there is no cattle raising than where regular dressings of farmyard manure are applied. It has been found that increase in the humus content within the normal range of 1·5-2·5% is accompanied by an increase in soil phosphate, copper, zinc, manganese and other trace elements. In addition, tests have revealed a correlation between humus content and readily soluble N under constant soil and weather conditions. While a high humus content is associated with high N availability, and hence a high beet yield, beet quality will be adversely affected. Two methods are described for determination of humus quality: (i) determination of water-soluble carbohydrate (dextrose), which characterizes the amount of energy readily available to the soil bacteria, and (ii) measurement of hydrolysable N. The methods indicate the N dynamics of a soil and permit calculation of N fertilizer requirements as well as showing what other soil improvement measures are necessary. Advice is given on treatment of soils having given characteristics.

Beet agricultural research in France. Anon. *Ann. Rpt. Inst. Tech. Franç. Betterave Indust.*, 1976, 282 pp (*French*).—A detailed account is given of the studies carried out by the Institut Technique Française de la Betterave Industrielle during 1976, under the headings: "Spring work" (soil and seedbed preparation, sowing and comparison of drills, placement of micro-granular insecticides and elimination of bolted weed beet); "Harvest" (harvesting, leaf and crown removal, tests on the Laforge rotary blade topper, influence of speed, etc., on harvesting, etc.); "Agronomy" (beet varietal performance in 1976, tests on the performance of herbicides provisionally authorized for sale, split application after emergence, selectivity of post-emergence herbicides, yellows control measures, research on new herbicides, controlled irrigation tests, development of nitric and ammoniacal nitrogen, and studies on the influence of various cultural and varietal factors on juice impurities —K, Na and amino N—and the technical quality of the sugar beet); and "Parasitism" (tests on seed disinfection, control of animal pests, beet yellows and fungal diseases).

The oligo-elements in agriculture. R. Piot. *Le Betteravier*, 1977, **11**, (110), 18-19; (111), 16-17 (*French*).—The oligo-elements or micronutrients are those required in small quantities for plant growth but which in large quantities are often toxic. The principal ones are B, Mn, Cu, Zn and Mo, and the quantities of certain of these removed by the beet crop, and their content in agricultural soils are examined. Only part of the elements present is available to the plant, and a number of factors influence this availability, such as soil pH, aeration and moisture content with regard to Mn. Means of avoiding both insufficiency and excess of Mn are discussed, as are similar considerations in respect of B, Cu, Zn, Mo and Co.

First year results of the sugar beet trials in the Natal Midlands. N. G. Inman-Bamber. *Proc. 51st Congr. S. African Sugar Tech. Assoc.*, 1977, 7-11.—Results are presented of the first year of three years trials. Beet seed was sown at intervals between October and March at four localities and root growth and sucrose content monitored over the succeeding period to August. Root growth ceased in May but sucrose content continued to rise. Cercospora leaf spot appears to be a main problem, although root rot, nematodes and white grubs (*Adoretus fasculus*) were also a problem. The average sugar yield was 9·5 $tonnes.ha^{-1}$ in a range of 6·8-15·3 $tonnes.\ ha^{-1}$. Planting in December and January allowed development of roots to harvestable size and enabled the crop to withstand leaf spot infection better than spring planting; however, soil moisture during the intervening period might be a limiting factor.

The operating quality of precision drills and sugar beet harvesters. W. Brinkmann. *Zucker*, 1977, **30**, 396-404 (*German*).—Reference is made to the considerable gaps that occurred in beet rows in the spring of

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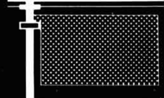

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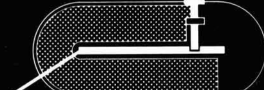

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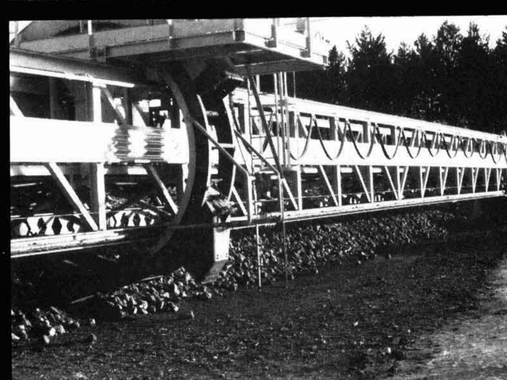

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1976; it is pointed out that there were not only the result of frost but were also caused by water deficiency. The author looks at ways in which seedbed preparation can be improved so as to increase water availability to the beet seed. The pressure applied by the drill rollers in order to press the seed into the soil was not sufficient to allow water to reach the seed under dry conditions. In the conventional system, the seeds are sown in a 3-cm deep top layer of loosened soil and water reaches the roots from the lower unworked soil by capillary action. However, it has been found that a 6-10 cm layer of secondary worked soil forms between the seedbed and the unworked soil and quickly dries out, so that the water from the unworked soil cannot reach the roots. It is therefore suggested that between the top 3-cm layer of loosened soil and the unworked sub-soil there should be a layer of soil which is reconsolidated after or during seedbed preparation to give an aggregate density comparable to that of a naturally settled soil. This would provide the capillary action necessary to raise the water to the roots. Comparisons were made of various precision drills in laboratory and field trials. (Pneumatic types of drills were excluded, since at the author's institute it has been found that these are economically unjustifiable for use with beet seed alone; other types of drill have a sowing precision of 96-99% with pelleted seed, so that any improvement brought about by the 40% more expensive pneumatic models can only be marginal.) It was found that the distance between seed became more irregular as the inter-seed distance increased; this adversely affected beet topping. Reasons for the fall in precision and ways of avoiding it are examined. One major source of variation in seed spacing was coulter wear, and need for attention to coulter condition before sowing is emphasized. Average results are given of harvester tests in West Germany and other countries. These include topping performance, root breakage, lifting losses, beet damage and total losses. The total losses were remarkably high, after which came the high proportion of beets topped too high; wheel sensor machines gave better results than did those machines which hack off the leaves and then top. With beet sown to stand, the topper performances were within the limits of 20% under- and 15% over-topped beets.

Technological aspects of high nitrogen fertilization. J. Trzebiński. *Gaz. Cukr.*, 1977, **85,** 141-143 (*Polish*).—The adverse effect of increased N dosage rates on beet processing quality is discussed. Trials have shown that a 50 $kg.ha^{-1}$ increase in N application causes a 1-3% fall in sucrose content, a 2-5% increase in K, a 5-10% increase in Na, a 6-12% increase in N, and a 10-20% rise in amino-N. The significance of the K:Na ratio relative to beet quality and composition is discussed. It is pointed out that, with an imbalance between the N, P and K rates, increase in N application will cause a reduction in the alkalinity coefficient and increase in the reducing sugars. It is also stressed that, under Polish conditions, 80-100 $kg.ha^{-1}$ N may be present in the soil as a result of farmyard manure application, so that 80-100 $kg.ha^{-1}$ should be regarded as the optimum N dosage rate (giving a total of 160-200 $kg.ha^{-1}$).

Sugar factory waste water irrigation effect on the size and quality of the sugar beet crop. Z. Izsáki. *Cukoripar,* 1977, **30,** 88-93 (*Hungarian*).—Two-factorial replicate tests were conducted on 20-m^2 plots in 1973-74 and three-factorial tests on 100-m^2 plots in 1975, the aim being to establish the effect of factory effluent spraying on beet yield and quality. In terms of root, leaf and sugar yields, conductimetric ash, noxious N, invert sugar and resistance to slicing, the best results were achieved by effluent application as opposed to fresh water application (which was nevertheless more beneficial than lack of irrigation). However, because of phosphate deficiency in the soil, it was found better to add 100 $kg.ha^{-1}$ P_2O_5 as well as effluent, while application of carbonatation mud was also of advantage. Generally, optimum results were achieved with effluent spraying (the amounts varied according to year, viz. 190, 75 and 80 mm, respectively, in the growth periods of 1973, 1974 and 1975) plus 100 $kg.ha^{-1}$ P_2O_5, 150 $kg.ha^{-1}$ K_2O and 10 $tonnes.ha^{-1}$ carbonatation mud. While irrigation reduced the sugar content, the increase in root yield was sufficient to give an increased sugar yield per ha.

Beet agricultural technology and its relationship to beet quality. J. Kollár. *Cukoripar,* 1977, **30,** 106-111 (*Hungarian*).—It is shown that over the period 1971-75 there was a decided reduction in beet sugar content in Hungary, so that at the same average beet yield over the 5-year period as in 1966-70, the sugar yield was lower. Moreover, molasses sugar rose. Of factors which affect beet quality and sugar yield, eight are examined and the role they played under actual Hungarian conditions is discussed. They are: fertilizer application, varietal selection, sowing density and plant population, weed infestation and chemical control, irrigation, disease, mechanical harvesters and beet storage. In each case the author indicates where beet quality and sugar content were adversely affected, either by comparing results in 1975 with those in earlier years, or by distinguishing between different practices.

Factors governing sugar beet yield and sugar content. M. Göbelez. *Seker,* 1977, **27,** (104), 32-40 (*Turkish*). The effects on beet yield and sugar content of such factors as soil and weather conditions, particularly rainfall, are examined and comparison made between beet yields and sugar contents in Turkey and France during the period 1970-75. Where beets are grown in areas comparable to the temperate climate regions of Western Europe, there may be wide monthly fluctuations in sugar content during the growth period, while yields may fluctuate less markedly from year to year. On the other hand, although heavy rainfall can reduce the sugar content appreciably, where beets are grown in drier zones such as Central Anatolia (as exemplified by results for Konya, Kayseri, Kütahya and Usak factory areas) and irrigation is needed to make up for the rainfall deficiency, the root yields will be highly dependent on April-May rainfall and on the number of irrigations. The data indicate a progressive fall in yields per ha over the 6-year period in all the areas investigated.

Destruction of (weed) beet, weeds, bolters and chenopodia. A. Vigoureux. *Le Betteravier,* 1977, **11,** (111), 9 (*French*).—Illustrations are given of these undesirable plants, with a note on the times and means of ridding the beet fields of each, including topping of bolter heads, rotary cultivation and the application of chemicals to destroy the weeds and bolters.

CANE SUGAR MANUFACTURE

Conveyor for bulk sugar. J. Gonzalez Rosique and G. Ugas Bustamante. *Rev. Tecnol.* (Cuba), 1974, **12**, (6), 55–64; through *S.I.A.*, 1977, **39**, Abs. 77-678.—Pneumatic conveying systems based on suction and/or pressure are outlined with diagrams, sources of losses are listed, and formulae are given for operating parameters and losses of pressure and power.

Influence of extraneous matter in cane on recovery. V. González E. and J. J. García N. *ATAC*, 1977, **36**, (1), 11–21 (*Spanish*).—Samples weighing 6 arrobas (about 150 lb) were taken from mechanically-harvested cane on the feed side of a field cleaning station and two corresponding samples taken from cane which had passed through the centre, all cane being comparable, from the same field, etc. The first sample was analysed within 1-2 hours of cutting as was one of the cleaned cane samples, while the last was analysed after a delay of 12–24 hours to determine the effect of delay between cutting and milling. The analyses carried out included measurement of Brix, pol, reducing sugars, dextran, fibre, fibre in trash, and pol in bagasse. During the season 100×3 samples were studied. The extraneous matter in the feed cane averaged 10·42% and, after cleaning, 6·84% and 6·46%, respectively, for the other samples, the difference being due to loss of moisture from the green leaves. Cleaning reduced the fibre in cane from 13·58% to 12·97%, the bagasse produced from 33·58% to 31·50% and the pol in bagasse from 0·494% to 0·436% on cane. The juice purity obtained was 90·67 against 89·50 but was reduced to 90·02 by a 24-hour delay between cutting and milling. Dextran in uncleaned cane was 0·273% on cane, reduced to 0·189% by cleaning, but it increased again to 0·220% as a result of the delay. Corresponding glucose coefficient figures were 1·53, 1·35 and 1·66. Sugar recovery increased from 12·427% to 13·200% after cleaning and reduced to 13·180% with a 24-hour delay; these figures are on cane milled, however, and do not allow for the trash separated or loss of weight by drying during the delay. Nevertheless, the gains through elimination of trash are real, and effort is urged on the improvement of efficiency of the cleaning stations, to reduce the extraneous matter to a maximum of 5%.

Massecuite system 300. J. L. González. *ATAC*, 1977, **36**, (1), 30–39 (*Spanish*).—The system is a 3-massecuite system in which *C*-sugar is produced by seeding a mixture of syrup and *A*-molasses of 80 purity. After seeding, the pan is built up on *B*-molasses and then half the contents discharged to a tank G_1. The remaining half is again built up on *B*-molasses and then half discharged to another tank G_2. The remainder in the pan is boiled as the *C*-strike and discharged to the crystallizer, after which the contents of tank G_2 are returned to the pan and boiled as a *C*-strike in the same way. Once this is discharged, the contents of tank G_1 are returned to the pan, built up with *B*-molasses and half discharged to tank G_2 while the remainder is boiled as *C*-massecuite and finally the contents of tank G_2 returned to the pan and boiled as a *C*-strike. The system requires a high proportion of *B*-molasses feed, of 54 ± 1 purity, and the *B*-strike must therefore be boiled partly on syrup as well as *A*-molasses, while the *A*-strike is of high purity and boiled on syrup, *C*-sugar being used to grain both *A*- and *B*-strikes. The system was used by a group of nine Cuban factories in 1976; by comparison with 1975, when syrup purity was 84·53 against 84·71 in 1976, the massecuites totalled 131·35 m^3 per tonne of solids entering the factory against 141·07 m^3, *C*-molasses purity was reduced from 34·79 to 33·51 and steam consumption reduced by 3–6%.

Pan seeding. J. G. Ziegler. *Sugar J.*, 1977, **39**, (12), 9–10.—The application of fine-ground sugar crystals to act as seed for final massecuite is described and a brief history of the technique in the USA is given (with a note on its earlier application in Java). Experience with the method is discussed, with reference to the harmful effects of fine crystal dissolution by the small water content when ethanol was used as the carrier. Various mills have been used, and the Ditmar mill and Sweco mills are discussed in more detail.

The Okeelanta sugar factory. A report on the expansion of Florida's second oldest mill. J. Prieto. *Sugar y Azúcar*, 1977, **72**, (6), 58–60.—The Okeelanta factory started in the mid-1940's as a mill brought in part from Puerto Rico. By 1961, when it was taken over by Gulf & Western Food Products, it was crushing 3000 t.c.d., since when capacity has been expanded continuously to 13,500 t.c.d. in 1976/77 and a planned 16,000 t.c.d. for 1977/78. Cane is delivered to the factory throughout the 24 hours, so requiring no storage and giving a supply in fresh condition. The original 21-roller 41×84 inch tandem has been augmented by a 16-roller 44×84 inch Fulton tandem and a fifth mill will be added to this for 1977/78 and a sixth for 1978/79. New 150,000 $lb.hr^{-1}$ boilers are being installed and will operate at 375 psig and 650°F TT. The older turbo-generators have been replaced with two new 6000-kW units with switchgear and distribution at 4160 V. New juice heaters have been added and a 32-ft Dorr-Oliver 444 clarifier, together with two new 10×20 ft "Rapifloc" filters. An 1800 ft^3 pan from Moore Haven is being installed, and a new Werkspoor continuous crystallizer.

Cane quality and how it affects sugar recoveries. J. C. Fandialan. *Crystallizer*, 1977, **2**, (1), 7, 20; (2), 10, 9. The factors in low quality cane which affect sugar recovery are discussed: red rot fungus attack causes inversion and so reduces extraction and purity, while excessive trash reduces milling extraction, and soil in the cane enters the juice and this reduces boiling house recovery. Drying of cane during drought increases the Brix but reduces purity of cane juice. It would be of advantage for growers to produce cane which is high in sucrose and medium-to-low in fibre content, giving high juice purity; the cane should be delivered fresh and without trash. An example is calculated of the losses in cash terms which result from the presence of 10% trash in gross cane by comparison with trash-free cane.

Diffusion: how much we know about it. M. A. Oliveros. *Crystallizer*, 1977, **2**, (1), 11, 18–19, 22; (2), 7, 16–17.—The history of diffusion is briefly considered as is the theory of this means of extraction. It is then pointed out that diffusion does not take place with cane because of the nature of the material, and that extraction is achieved by washing juice from opened cells. The principle of counter-current extraction is briefly discussed, and the difference between the percolation and maceration type of diffuser explained. Factors affecting extraction efficiency are listed and discussed; these include cane preparation, temperature, residence time, pH, microbiological status, bed thickness and dewatering of the wet bagasse. Finally, reference is made to lower installation and maintenance cost of a diffuser and lower power consumption compared with a milling tandem.

Determining cost of steam and electricity in a sugar factory. J. P. Sto. Domingo. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 18-64.—Detailed calculations are given as to the cost of steam and electricity appropriate to the sugar factory/refinery complex at Victorias Milling Co. The share of steam consumption appropriate to power generation and to process heating relates to the proportion of loss in B.Th.U. from high-pressure to exhaust steam in the turbines to that from exhaust steam to condensate. Process steam requirement is explained to be a limiting factor on power generation steam conditions because of the need to avoid a surplus of exhaust steam which would have to be vented to the air. Another factor in calculating costs is the value of the bagasse; for accounts purposes, in appropriation of electricity cost between the sugar company departments, it can be taken as the money value equivalent to its bunker fuel heat value, whereas the true cost is where bagasse is given no money value except what is paid to planters as payment for their share of the bagasse.

Good clarification—basis of efficient boiling house operations. C. M. Madrazo. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 86-93.—The clarification process is discussed and the effects of a number of factors on it are described. Juice screening with a vibrating wire screen or DSM screen removes bagacillo, but whether this is of advantage or not is a matter of opinion. Variants of liming—cold, hot, compound and fractional—are described as applied at San Carlos mill; since 1948 hot liming has been adopted. The optimum pH cannot be defined, as it depends greatly on the nature of the non-sugars present. The role of phosphate is important and addition of soluble PO_4^{---} may be needed for good clarification. Apparent purity increase is not a valid indication of clarification efficiency since it may result from inversion; 15-20 minutes is needed for the milk-of-lime to react, and the retention tank should be of sufficient capacity to allow this. Flocs formed should not be disturbed so that settling is efficient, and the size of the clarifier should be such as to allow for the reduction from the initial rate of settling, with juice flow rates low enough to exclude turbulence and eddying. Clarification aids may be economical where clarification is poor and causes milling rate reductions or boiling house problems.

Measuring the efficiencies of sugar boiling systems. D. I. Balagso. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 70-85.—Two formulae are presented for Philippines conditions: the first, $P = 35{\cdot}90 - 0{\cdot}34R + 1{\cdot}32A$, gives the theoretical purity of a well-exhausted molasses where R is the reducing sugars content % molasses solids and A is the ash %. The second formula gives the Boiling System Efficiency BSE $= \frac{P(S-M)}{M(S-P)} \times 100\%$, where P is the theoretical purity of the first formula, M is the purity of the molasses produced and S is the purity of the sugar produced. Derivation of the formulae is described and application to the results of Philippine sugar factories indicated. Efficiencies range from 76·39% to 120·39%.

Transloading sugar cane by barge. E. Gamboa. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 259-260.—A list is presented of factors concerned in the receipt of cane from a new 15,000 ha area in the northern part of Panay whereby it will be cut and brought to Victorias mill by a system involving trucks, transloading to barges, and transloading to cane cars for delivery to the mill. The system and larger cane area will permit the factory to operate throughout the year without taking cane normally supplied to other mills.

Drawing up a pollution abatement programme. A. Damian and M. Gloria. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 285-289.—Basic steps in drawing up a pollution abatement programme are described under headings: background information, education, analysis of effluents, methods of handling effluents, practical methods of treatment, design of treatment system, implementation and monitoring.

Dextran as an indicator of cane deterioration. M. A. Garcia. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 323-330.—Four experiments showed that there was a significant increase in dextrans and gums % mixed juice Brix with delay between harvesting and processing of whole-stalk cane which had been cut and burnt in the windrow. On the other hand, there was no significant change over a 4-day delay (at mean temperature of 70°F and 66 R.H.) in moisture and pol % bagasse and pol extraction, in mud volume % treated juice or sugar yield % syrup solids in boiling, while no objectionable grain quality or growth characteristics were observed.

Economics of sugar manufacturing operations. A. M. Hain. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 367-370.—Areas where savings may be effected are: manning, preventive maintenance, and purchase of materials and equipment. These are discussed with examples of savings at the author's factory.

Rural electrification in the sugar belt. N. G. Aesquivel. *Proc 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 371-373.—The development of rural communities is aided greatly by provision of electricity, and the part which could be played by sugar factories in the supply of power from their generators to a proposed electricity grid in Negros is discussed. The factories would also benefit by being able to draw on the grid for power in the event of a breakdown in their own generators.

Sugar and molasses distribution. J. M. Binueza. *Proc. 23rd Ann. Conv. Philippines Sugar Tech.*, 1975, 413-430.—The amount of available sugar in cane is subject to many factors and these are incorporated in a series of calculations to derive distribution tables.

BEET SUGAR MANUFACTURE

Plant for separation of beet fragments and tails from light impurities. N. G. Lila, B. I. Eibozhenko and P. A. Sobol'. *Sakhar. Prom.*, 1977, (6), 39-40 (*Russian*). Details are given of a patented unit which consists of two parallel inclined rotating drums about 12 mm apart at their closest proximity to each other. Waste from flume-wash water is delivered into the space between the higher ends of the drums and is thoroughly mixed by pins protruding through the drum walls which move upwards into the waste as the drums rotate in opposite directions. The pins are attached on the inner surface of each drum to pivoting rods which, through levers, are held by springs; thus, as the drums rotate, the pins (considerably longer than the 12 mm separating the drums) are "retracted" at the minimum distance between the drums, but spring back through the drum wall as the gap widens. The light impurities are loosened by the pins and fall through the narrow space between the drums to a hopper and thence to a conveyor. The beet fragments and tails gradually move down over the gap between the drums to their lower ends and are transferred to further processing. The unit has operated successfully at a number of factories.

The screw pump. I. N. Pinchuk and O. P. Marchenko. *Sakhar. Prom.*, 1977, (6), 40-41 (*Russian*).—Because of problems encountered with two rotary pumps used at the authors' sugar factory to transfer *A*-massecuite from the crystallizers to the distribution troughs feeding the centrifugals, it was decided to replace them with two screw pumps rotating at 975 rpm. The screw pump is briefly described with the aid of a diagram.

Experience in the use of storage tanks for chemically treated water. V. N. Klochkov. *Sakhar. Prom.*, 1977, (6), 45-46 (*Russian*).—Cation exchange-treated water containing 130 ppm ammonium ion was stored in a 20-litre glass vessel for up to 28 days; the vessel was open to the atmosphere (only the water surface being protected to prevent dust settling), so that nitrite formation from the ammonium ions was possible through bacterial action. At a temperature varying only slightly in the range 18-21°C, the nitrite content rose from 24 $\mu g.kg^{-1}$ after 3 days to 115 $\mu g.kg^{-1}$ after 10 days, and subsequently rose very sharply. Since nitrites can cause considerable corrosion in boilers, it is recommended to maintain a close check on storage tanks and replace the water as soon as the nitrite content exceeds established levels.

Prevention of beet freezing during short spells of frost by spraying of piles. V. A. Knyazev and M. Z. Khelemskii. *Sakhar. Prom.*, 1977, (6), 47-51 (*Russian*). Since the freezing point of beet tissue falls with moisture content, it is suggested that an effective means of preventing freezing of stored beet during short-lived autumn frosts (which occur in all beet zones of the USSR) is to spray the pile with water, e.g. with a unit applying 0·45-1·25 litres.sec^{-1}. The authors explain how to forecast frosts and how to determine the amount of water to apply as a function of weather conditions.

Measurement of massecuite density by means of an isotope densitometer. R. Štengl and M. Friml. *Listy Cukr.*, 1977, **93**, 56-59 (*Czech*).—Details are given of an isotope densitometer using Cs-137 or Co-60 to measure massecuite density and hence concentration in °Bx. Results are given of laboratory and factory tests. Over a range of 0·5-3 g.cm^{-3}, measuring precision was to within a maximum of $\pm$0·005 g.cm^{-3}. At a probe working temperature in the range —10° to +60°C, alteration in the voltage output by 1 V in the range 0-10 V corresponded to a 3·7°Bx change in concentration with a response time of 200 sec at up to 240.10^{-3} g.cm^{-3}. A higher response was found possible, but the radioactive radiation caused greater output voltage fluctuation. Measurement was not affected by crystal size, although siting of the instrument was a critical factor.

Statistical processing of operational data for a cossette band weigher. A. Havlíček, J. Čermák, A. Havlín and V. Valter. *Listy Cukr.*, 1977, **93**, 84-88 (*Czech*). Details are given of the statistical processing of cossette and water feed data at Modrany factory with the aim of establishing a control signal for the cossette band weigher and so regulate the loading of the continuous trough-type diffuser installed there.

The rheological properties of carbonatation mud. K. Číž and M. Štetinová. *Listy Cukr.*, 1977, **93**, 88-92 (*Czech*).—The rheological properties of carbonatation mud were determined as a function of type of filtration (by filter press, vacuum filter or filter-thickener), means of conveying (truck, screw conveyor, pump or pneumatic conveying) and during storage. At a solids content greater than 50%, carbonatation mud has pseudo-plastic properties, whereas at below 40% solids content it acts as a Bingham (plastic) substance. At a solids content between 40 and 50% it is in a transient stage between plastic and pseudo-plastic. Mechanical treatment (mixing and pumping) will cause its properties to change from pseudo-plastic to plastic, the change being permanent unless there is a change in the solids content. Temperature also affects the rheological properties: at 10-40°C and constant dry solids, the mud is pseudo-plastic, while above 50°C it is plastic at constant solids content, again passing through a transient stage at 40-50°C.

Tests on forced ventilation of beet piles with the aid of drums. J. Zahradníček, J. Ludvik and J. Mahovsky. *Listy Cukr.*, 1977, **93**, 93-95 (*Czech*).—Tests at two sugar factories are reported in which forced ventilation of beet piles was carried out by means of a line of bottomless metal drums (75 cm long and 45 cm in diameter) placed at the base of each pile midway between the two longer sides. Vertical air ducts were made up of wooden box sections 350 cm long and 40 cm wide linked together and surrounded by stakes as protection. Results for 1974-76 showed that during storage periods ranging from 39 to 63 days, daily sugar losses were cut by about one-third by comparison with unventilated controls.

Considerations on the possibility of reducing energy consumption in the sugar factory. F. Zama. *Ind. Sacc. Ital.*, 1977, **70**, 27-32 (*Italian*).—With fuel costs 6-7 times what they were 5-6 years ago, and an energy requirement for a 9·7 million tonnes EEC sugar crop equivalent to 2·8 million tonnes of fuel oil, it is evident that savings in energy for beet sugar manufacture could reduce fuel consumption by a significant amount. The progress made in West Germany, France, Belgium and Denmark towards reduction of fuel requirements since 1973/74 is recorded, and the importance of doing so in Italy is emphasized. This may be achieved by a regular supply of beets in good condition and by attention to thermal efficiency in various process stages including steam and electrical energy production, diffusion, juice purification, evaporation, sugar crystallization, pulp drying and waste water treatment, as well as to other factors such as balance of equipment capacities, steady uninterrupted operation, automation, etc.

Prevention of scaling in evaporation. P. Devillers, R. Detavernier, and M. Groult. *Sucr. Franç.*, 1977, **118**, 217-226 (*French*).—The formation of scale in sugar factories is reviewed. Calcium is mostly removed by carbonatation, but if the pH is too low it can remain in solution as bicarbonate and is also present as soluble salts such as lactate, chloride, etc. On hydrolysis of its amide, oxalic acid is liberated and forms insoluble Ca oxalate which is deposited as scale, while $Ca(HCO_3)_2$ also decomposes on heating to deposit $CaCO_3$. Scale also includes silica formed from soluble or colloidal silicates which pass through filters. Two classes of scale preventative have been developed—the polyelectrolytes (e.g. polyacrylates) which form complexes with Ca and Si and prevent them forming insoluble materials, and organo-polyphosphates which can act similarly or at higher Ca concentrations affect the physical form of the precipitate and can also re-disperse scale which has been deposited. During the 1976/77 campaign, 22 factories employed scale prevention agents from the start of the campaign. In spite of a higher than usual Ca salts level in the juices, 17 did not encounter scaling, and maintenance of a high pH in 1st carbonatation reduced the juice Si content, so preventing its deposition as silicate scale. No soda addition or decalcification with resins was necessary. Where scale did form it was easily and cheaply removed.

Action of a bacteriostat against contaminants in a (RT2 and RT4) diffusion juice. P. Lamant and Y. Compagne. *Sucr. Franç.*, 1977, **118**, 227-230 (*French*). "Anios DIF" is a bacteriostat derived from the action of a quaternary ammonium salt on formaldehyde[1] and has been tested by addition to pulp press water returned to the diffuser and also by injection of a 10% solution in the drum at Roye sugar factory. Better bacteriological quality in the diffuser was obtained without inhibition of SO_2 or $Al_2(SO_4)_3$, without corrosion or toxicity. No danger arises of colour formation in thick juice because of the absence of free reducing power. Use and handling are easy and safe, and little storage space is required.

Chemical engineering representation of diffusion. T. Baloh. *Zeitsch. Zuckerind.*, 1977, **102**, 363-372 (*German*). The processes taking place during beet diffusion are described in terms of chemical engineering theory, whereby the author limits himself to a unit comprising a scalding trough and tower to which press water is recycled. The importance of counter-current operation is discussed, and calculation of the minimum raw juice temperature (which is not affected by the length of the scalding trough but is only governed by the maximum temperature in the diffuser proper) explained. In an examination of the sucrose transfer from cossette to extraction liquor, it is shown on the basis of measurements and materials balances that a third of the sucrose is extracted by squeezing or shrinkage while the remainder is transferred as a result of diffusion. It is suggested that increase in the amount removed by squeezing would allow more sugar to be extracted, so that maximum cossette exhaustion could be attained in a shorter period of time or in a shorter length of diffuser. Calculation of non-sugars extraction is briefly demonstrated, followed by discussion of the applicability of Fick's law and the Silin diffusion formula. Calculation of the free cross-sectional area $A [= A_o (1 - \frac{f_r}{\rho_r})$, where A_o is the diffuser cross-sectional area, f_r is the charge and ρ_r cossette density] is explained; while this is the space theoretically available for juice flow, it is stressed that the amount of extraction liquor, the volume of cossettes and hence free cross-sectional area will alter during diffusion, so that juice volumetric flow and velocity will also vary. The question of press water addition point is discussed, and finally equations are presented for calculation of important diffusion variables. A sample calculation is also given.

Unit for investigating "in advance" sugar crystallization conditions in a vacuum pan. V. A. Miroshnik, V. D. Popov and V. G. Tregub. *Izv. Vuzov, Pishch. Tekh.*, 1977, (2), 97-99 (*Russian*).—Details are given of a method, protected by USSR Patent 179,690, of automatic control of syrup addition which is based on cooling of a massecuite sample in a water-cooled by-pass tube to obtain crystals in advance of the pan crystals. The sample is withdrawn from the pan into the vertical tube and cooled through a given temperature difference (which depends on the massecuite crystal content). At the formation of primary crystals at the exit from the cooling zone, a signal is sent to the pan syrup intake control (this signal being the difference between signals from sensors at the entrance and exit of the tube). If false grain forms, a second signal is sent to the syrup feed control, which will either increase the syrup feed or adjust the pan vacuum. The system has been successfully tested.

Boiling point elevation in industrial sucrose solutions. V. I. Tuzhilkin, L. G. Fedorov and V. V. Yaroshevich. *Izv. Vuzov, Pishch. Tekh.*, 1977, (2), 163-164 (*Russian*).—Change in the BPE value with alteration in massecuite purity within the range 65-93, supersaturation within the range 0·8-1·3 and vacuum corresponding to water temperature in the range 60-80°C, was studied in a laboratory vacuum pan. While the changes in BPE were practically linear with changes in vacuum and supersaturation, massecuite purity had a non-linear effect which would be difficult to smooth out.

Application of "Gunite" to furnace walls in the sugar industry. Z. Kowalski and Z. Domagalski. *Gaz. Cukr.*, 1977, **85**, 107-110 (*Polish*).—Spray cementing of furnace walls as a protective coating is described and properties of various cements indicated.

[1] Cornet *et al.*: *Suc. Franc.*, 1974, **115**, 211-217.

LABORATORY STUDIES

Colorimetric determination of the mean size of sugar crystals in massecuite. L. I. Trebin, V. A. Mikhailik and N. I. Shtangeeva. *Sakhar. Prom.*, 1977, (6), 32-33 (*Russian*).—A method is described which was successfully applied to *B*-massecuite in the 1975/76 campaign at a Soviet sugar factory. It is based on colorimetric determination of the amount of molasses remaining on the sugar crystals after centrifuging a massecuite sample. Since the thickness of the molasses layer is the same for a test sample as for a control sample of known fractional composition, it is possible to calculate the surface and find the mean crystal size. Both samples are centrifuged for 10 minutes at 3000 rpm, diluted 1:1 with distilled water, filtered with kieselguhr and the optical density determined with a green filter. The mean crystal size d is then given by

$$d = d_1\sqrt{\frac{D}{D_1}}$$

where d_1 is the mean crystal diameter in the control massecuite and D and D_1 are the optical densities of the test and control low-grade sugars, respectively. The method takes 30-35 minutes. A sample calculation is given.

The water sorption behaviour of icing sugar. D. Roth. *Zucker*, 1977, **30**, 274-284 (*German*).—Freshly milled icing sugar has an amorphous surface layer representing about 2% of the total sugar and less than 100 nm thick. The amorphous sugar resumes its crystalline form only when it has been in prolonged contact with moist air, as is the case with normal packeted sugar. Investigations were conducted on samples taken from the same 50-kg bag and stored for about 6 months in an air-conditioned room. It was found that even at low atmospheric moisture levels, the amorphous sugar adsorbs much more water vapour than does the crystal sugar and at a high rate. Fluctuations in temperature cause moisture "migrations" which could lead to marked local increases in moisture adsorption. Increase in vapour pressure is also accompanied by considerable increase in moisture adsorption. At any given temperature and vapour pressure, adsorption continues until saturation. However, at a constant ratio of vapour pressure p to saturation vapour pressure p_o, the amount of water adsorbed is the same, irrespective of temperature, although the process is not completely independent of temperature, as otherwise the heat of adsorption would be the same as the heat of condensation of the water vapour, which is not the case. A greater heat of adsorption is liberated by the amorphous surface layers than by the crystals, and differences occur in the adsorption hysteresis pattern of the two forms of sugar. While the desorption isotherm for the crystalline sugar is situated above the adsorption isotherm, exactly the opposite is true of freshly milled amorphous sugar. Lumping and caking of icing sugar is a result of release of moisture during the re-crystallization process and of fluctuations in temperature. Differences in the adsorption behaviour also occur between sugar stored in bulk and stored in a sealed container and as a result of cooling rate differences; hence, sugar stored in a sealed container and subjected to slow, uniform cooling will adsorb only a small amount of moisture, unlike the same sugar cooled quickly. The pattern of moisture adsorption and desorption is in fact a series of three cycles, the first of which is a discontinuous process in which the initial part is represented by considerable moisture adsorption as a result of the surface layer structure. The process is demonstrated by means of a large number of diagrams, and details are also given of the gravimetric equipment used to measure moisture adsorption and liberation.

New ideas on beet reception. I. A. Goethals. *Le Betteravier*, 1977, **11**, (110), 3-4. **II.** L. Rigo. *ibid.*, 4-6 (*French*).—The first part of this paper discusses the drawbacks of the directions of the Belgian Sugar Commission in regard to beet reception and analysis of losses which can vary with the method of screening the roots from a gross sample; a 5 mm screen can remove small pieces of root which with dirt at one factory will give a tare of 1·8% whereas if they are returned to the roots for processing will give a dirt tare of only 0·9%, and this affects the price paid for the beets. A more detailed procedure, to be agreed between farmers and factory representatives, is recommended. The second part discusses the development of the control service which, from a large number of analytical stations, has been reduced to 22 and, the author believes, will be further reduced with continuing rationalization of the Belgian sugar industry. With development of new techniques and especially automation, the number of analyses per man per hour can be raised; in Belgium it is about 100 while in some US laboratories automation permits 300 analyses. The principles of the system to be borne in mind include production of exact and representative figures for sugar and beet balances of the factory, avoidance of errors in dirt tare and sugar content, and rapid, exact transfer of data to the growers. New ideas mentioned include: the use of digital displays with luminous figures which can be read by the driver of the delivery vehicle, and a control station where the load zero can be checked several times a day; modification of the "Rüpro" and Silver samplers to give more representative samples; improvement of sample weighing and washing to determine dirt tare (as mentioned in Part I); adoption of a new grille for use at the rasp stage; control of time of digestion, mixing, etc. and use of an electronic polarimeter (checked with quartz plates or by an optical polarimeter at intervals); determination of the quality and dry matter content of wet and dry pulp (in the future a sugar content determination will be necessary so as to check the quantity of molasses added); and improvement of the method of informing the grower of the analytical results by use of documents where the same figure is provided for both factory and grower. Other ideas concern the organization of the control service and include control officers supervising on a visiting basis rather than continuously present at the factories, improved diffusion of new ideas within the service, studies by duplicate sampling, etc., employment of specialist control teams, use of closed-circuit television, etc.

PATENTS

UNITED STATES

Cane harvester. R. Reyes M., of Wilmington, DE, USA. **3,851,449.** 6th June 1973; 3rd December 1974.

Resinous reaction product of a sucrose partial ester, a cyclic dicarboxylic acid anhydride and a diepoxide. R. N. Faulkner, of Esher, England, *assr.* Research Corp. **3,870,664.** 10th January 1974; 11th March 1975.—Oil-modified sucrose resins useful in manufacture of paints and other coating compositions are made by reaction, at below charring temperature [20-120°C (100-110°C); at least 140°C], of (*a*) a sucrose partial ester [1-5 (4-5) ester groups per molecule of sucrose] of a fatty acid, aromatic acid, a vegetable or marine oil unsaturated fatty acid or a mixture of these [an unsaturated vegetable oil of the drying, semi-drying or non-drying type (dehydrated castor oil)], (*b*) at least two molecules of a cyclic dicarboxylic acid anhydride (dodecenylsuccinic, nonenylsuccinic, tetrahydrophthalic, maleic, phthalic or succinic anhydride or a soya acid/maleic anhydride adduct) per molecule of partial ester, and (*c*) about 0·7-3·0 molecules of a diepoxide (bisphenol A diglycidal ether). The reaction may be carried out in the presence of an alkaline catalyst (a soap present as an impurity in the partial ester) and also may be in a solvent. The resin may be made water-dispersible by conversion of the carboxyl groups to salt groups, or may be reacted with ammonia or an amine.

Cane harvester. I. L. Schexnayder and J. W. Angers, *assrs.* J & L Engineering Co. Inc., of Jeanerette, LA, USA. **3,871,162.** 18th June 1973; 18th March 1975.

Production of itaconic acid. T. Kobayashi, of Sagamihara, Japan, and I. Nakamura and M. Nakagawa, of Tokyo, Japan. **3,873,425.** 14th November 1972; 25th March 1975.—An itaconic acid-producing mould is cultured (continuously to maintain a concentration of 3% itaconic acid, or batchwise until an end-point where >1% of sugar remains) in a broth containing a sugar source (molasses), a N source and inorganic salts, under aerobic conditions (with agitation and aeration). High molecular weight substances which can prevent electrodialysis of itaconic acid salts from the broth are removed (by ultrafiltration or reverse-osmosis) and the filtered broth placed in contact with a cation exchange resin in alkali metal form, which is thereby regenerated to the free acid form. The liquor so produced is neutralized and fed into the diluting compartment of an electrodialyser composed of ion exchange membranes, while a solution of an alkali metal salt of itaconic acid or a mineral salt (or a mixture of these) is fed into the concentrating compartment, and then the itaconic acid salts in the neutralized liquor are electrodialysed. The concentrate is incorporated with the retentate from the high M. W. substance removal stage, which is refined (by anion exchange or a lead carbonate process) before incorporation, and itaconic acid or its alkali metal salt crystallized. The dialysate recovered in the electrodialysis is treated with an equivalent quantity of cation exchange resin in acid form (produced earlier in the treatment of filtrate) and recycled to form the raw material of the next fermentation.

Animal fodder. W. P. Moore, of Chester, VA, USA, *assr.* Allied Chemical Corp. (*A*) **3,873,728.** 28th September 1973; 25th March 1975. (*B*) **3,873,733.** 2nd August 1973; 25th March 1975.

(*A*) A feed (containing 63% total digestible nutrients) is prepared by grinding together a high-energy component—grains, grain mill by-products, cottonseed meal, fishmeal—and a slow-release N product obtained by mixing a liquid feed supplement [4-8% $(NH_4)_2SO_4$, up to 20% molasses, 20-30% urea and 15-25% by dry weight of aqueous ammoniated superphosphoric acid having 9-12% N and 28-39% P_2O_5 by weight and 30-70% of polymeric phosphates on total phosphate) with a solid natural ruminant feedstuff (hay, silage, straw or fodder) to give 3-10% total N, drying in a gas-fired dryer at 180-240°F for 5-60 minutes, and cooling.

(*B*) The liquid feed supplement of the above patent is mixed with a solid carbohydrate material (bagasse, alfalfa, orange pulp, peanut hulls, straw) to give a mixture containing 25-60% protein equivalent, which is dried at 180-240°F for 5-60 min to give a solid containing 6-12% of water. This is coated with a concentrated aqueous [60-90% (80-85%) solids] urea/formaldehyde [1:0·5-6·5 (1:4·2-5·2) molar ratio] solution. The coated material is pelleted and agglomerated at 140-300°F (200-300°F) and cooled within 1-60 min to give a hard pelleted product.

Increasing sugar yield in sugar cane. R. H. Kupelian, of Yardley, PA, USA, *assr.* American Cyanamid Co. **3,874,872.** 2nd March 1973; 1st April 1975.—The sugar content of cane is increased by application, 2-10 weeks prior to harvest, at a rate of 1-10 $lb.acre^{-1}$, of a polyalkylene glycol ester or α-hydroxy-β,β,β-trichloroethane phosphinic acid, where the polyalkylene ester is the 2-(2-hydroxypropoxy)-1-methyl-ethyl ester, the 2-(2-hydroxyethoxy)-ethyl ester, the 2-(2-hydroxypropoxy)-1-methyl ethyl diester with 1,1′-oxy-di-2-propanol or the 2-(2-hydroxyethoxy)-ethyl diester with diethylene glycol.

Extraction of sugar from beet and cane. M. Loncin, of Sint-Pieters-Leeuw, Belgium, *assr.* Granimar AG. **3,874,925.** 8th December 1972; 1st April 1975.—See UK Patent 1,370,389[1].

Preparation of levulose by isomerization of dextrose and mannose. S. A. Barker, P. J. Somers and B. W. Hatt, *assrs.* Boehringer Mannheim GmbH, of Mannheim, Germany. **3,875,140.** 30th May 1973; 1st April 1975.—Levulose is produced by isomerization of dextrose or mannose or mixtures of these in alkaline solution of pH 10-14 (11-12·5) and 20-80°C (45-60°C) in

[1] *I.S.J.*, 1978, **80**, 28.

Copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price 95p each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).

the presence of an aryl boric acid [which is a component of an insoluble organic (vinylphenyl) boric acid polymer or copolymer; an ion exchanger resin loaded with a phenyl boric acid derivative].

Massecuite viscosity reduction. N. L. C. Suzor, of Nchalo, Malawi. **3,876,466.** 30th October 1972; 8th April 1975.—See UK Patent 1,381,315[1]; the additive may be further specified as sodium dodecyl benzene sulphonate.

Reaction product of chloral with molasses. R. C. Parish and E. Trei, *assrs.* Smith Kline Corp., of Philadelphia, PA, USA. **3,878,298.** 24th September 1973; 15th April 1975.—A mixture containing molasses and 10–15% (20–40%) of chloral is reacted, e.g. by heating at steam bath temperature, and gives a product which improves animal fodder utilization efficiency.

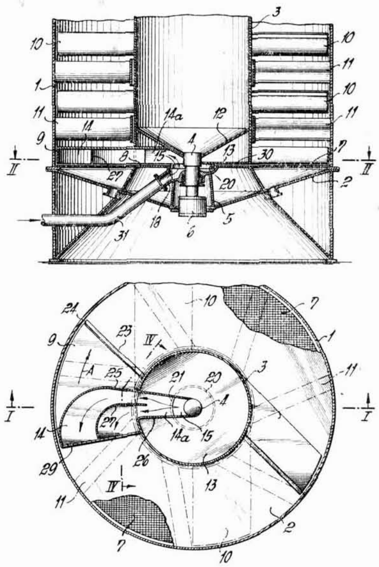
Animal fodder. W. P. Moore, of Hopewell, VA, USA, *assr.* Allied Chemical Corp. **3,878,304.** 21st October 1974; 15th April 1975.—A mixture of 4–8 parts by weight of water-soluble sulphate, up to 20 parts of molasses, 20–35 parts of urea and 10–25 parts of superphosphoric acid or an aqueous ammoniated superphosphoric acid containing 9–12% N, 28–39% total P_2O_5 and 30–70% polymeric phosphate on total phosphate, giving a pH of $\leqslant$4·8 (2·4), is mixed with a solid waste or by-product carbohydrate (polysaccharide) material containing <1% N and 25–75% of water, to give a product containing 2–10% N on dry weight and of pH $\leqslant$6·7 ($\leqslant$6·3). This is dried at 160–290°F (180–240°F) for 5–60 min to 5–12% water, ground so that it passes through a 12-mesh Tyler screen, (0·5–7% of a water-soluble polysaccharide or a minor proportion of sewage sludge incorporated,) pelleted and agglomerated at 500–20,000 psig and 140–300°F (200–300°F), (held at 140–300°F for 1–60 min,) and cooled to ambient temperature to give hard feed pellets in which 50–90% of the total N is water-insoluble.

Continuous vacuum pan. O. D'Hotman de Villiers and A. Hussain, *assrs.* Hyesons Sugar Mills Ltd., of Karachi, Pakistan. **3,879,215.** 23rd August 1973; 22nd April 1975.—See UK Patent 1,381,766[2].

Molasses food product. R. E. Miller, of Lakewood, CA, USA, *assr.* Western Consumers Industries Inc. **3,880,668.** 13th March 1974; 29th April 1975.—Molasses is dehydrated by continuous deposition of a film on the heated (vertical) walls of a (cylindrical) container and agitation of the film by means of a number of blades (rotating about a central vertical axis) close to but spaced apart from the walls. A chamber maintained under partial vacuum (in the form of a column) is inter-connected with the container and the heated molasses is metered and continuously transferred from the container to the vacuum chamber at a controlled rate. It is then transferred (by an outlet nozzle) to a cooling device (a belt conveyor on which the nozzle discharges) which shapes the dehydrated molasses as a continuous ribbon-like strand.

Beet diffuser. E. Straube, of Bedburg, Germany. **3,880,667.** 28th August 1973; 29th April 1975.

In a tower diffuser the lower end 4 of central shaft 3 is supported by bearing 6 mounted in the lower support 5 of base 2 of the outer cylinder 1. It carries stirrer arms



10 which rotate between arrestor bars 11. The bottom plate 8 has a central hole 15 beneath which is a casing 2 with seals round the shaft 4 and connected to pipe 31. Above the hole 15 is a plate 13 with a cutaway section 14a bounded by vertical plates 26 and 25, the latter extending beyond plate 13 to near the inside surface of cylinder 1. This provides a channel 14, having a flap 29 and a baffle 27, which is covered by a plate sloping down to the level of screen bottom 7 and wiping the latter clean by means of slide edge 23. Cossettes are pumped through pipe 31 and are transferred via compartment 14a to the channel 14. Since the latter revolves with shaft 3, the fresh cossettes are distributed over a cleaned screen surface and not mixed with partially extracted cossettes. Juice drains through the screen 7 and is removed in a conventional manner from the chamber below.

Recovery of sugar from beet molasses. H. G. Schneider and J. Mikule, of Euskirchen, Germany, *assrs.* Pfeifer & Langen. **3,884,714.** 9th July 1973; 20th May 1975.—An impure solution containing ionic impurities including alkaline earth ions (beet molasses) is (passed over a cation exchange resin to remove the alkaline earth ions and then) passed over an ion exclusion resin (having more than 90% of grain size >0·315 mm) so that sugar is adsorbed by the resin and ionic impurities excluded. A sugar-containing solution (one or more recycled fractions) is passed over the resin and then water, the effluent being collected in separate fractions of different ionic impurity content, after which the resin is regenerated with either molasses diluted to 30–70% (50–65%) dry solids or a solution obtained by concentrating to 10–70% (25–40%) dry solids the effluent fraction of highest ionic content. Part of the alkaline earth ions in the effluent fraction of highest ionic content is precipitated by double reaction with alkali metal salts (ash from the waste products of the sugar extraction) before the fraction is used for resin regeneration.

[1] *I.S.J.*, 1978, **80**, 60.
[2] *ibid.*

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Submerged fermentation to produce citric acid. A. J. Kabil, of Vienna, Austria, *assr.* AG Jungbunzlauer Spiritus- und Chemische Fabrik. **3,886,041.** 17th August 1972; 27th May 1975.—See UK Patent 1,392,942[1].

Decalcification of beet juice. K. W. R. Schoenrock, P. Richey and H. G. Rounds, of Ogden, UT, USA, *assrs.* Amalgamated Sugar Co. **3,887,391.** 19th February 1974; 3rd June 1975.—Beet juice after second carbonatation is passed through a column of carboxylic-type cation exchange resin in H^+ form to as to remove the Ca^{++} ions, at a flow rate of 20–200 resin bed volumes per hour, at 70–95°C and for a contact time of 20 sec–3 min. The juice is then brought to pH 7·5–9·5 by treatment with MgO, and filtered to remove excess MgO and insoluble impurities, part of the last being recycled for adjustment of the pH of the resin-treated juice. The MgO treatment may be the passage of the juice through a column of granular MgO to a steady-state point of alkalinity.

Cane planter. V. A. Boots, of Belle Glade, FL, USA, *assr.* A. Duda & Sons Inc. **3,890,909.** 8th March 1973; 24th June 1975.

UNITED KINGDOM

Enzymatically isomerizing dextrose to levulose. Standard Brands Inc., of New York, NY, USA. **1,400,829.** 28th September 1972; 23rd July 1975.—In a dextrose-containing solution is provided a dextrose isomerase derived from the micro-organisms *Nocardia* spp., *Micromonospora* spp., *Microbispora* spp. or *Microellobospora* spp. (*Microellobospora flavea* IMRU No. 3857R) (cultivated in a medium containing xylose, dextrose, sorbitol and corn steep liquor and a source of Co^+ ions) which have the ability to assimilate xylose and produce dextrose isomerase. The solution is maintained under suitable conditions until part of the dextrose is isomerized to levulose.

Increasing the sugar content of beet and cane. Nipak Inc., of Dallas, TX, USA. **1,401,888.** 3rd January 1973; 6th August 1975.—See US Patent 3,860,411[2].

Enzymatic isomerization of dextrose to levulose. Baxter Laboratories Inc., of Morton Grove, IL, USA. **1,401,946.** 13th February 1974; 6th August 1975.—D-dextrose is converted to D-levulose by an immobilized dextrose isomerase prepared by reacting whole microbial cells (from fermentation of *Streptomyces phaeochromogenes*) containing dextrose isomerase enzymes with a diazotized aromatic primary diamino compound (2,6-diaminopyridine or acriflavine) (at 0–25°C for 1–100 hr) so that the enzyme becomes covalently linked to the diazo compound.

Mixed partial esters of carbohydrates. Krems Chemie GmbH, of Krems, Austria. **1,402,069.** 5th November 1973; 6th August 1975.—Biologically degradable surface active agents in the form of the title esters are prepared by reacting a carbohydrate (sucrose, dextrose) (in aqueous solution or suspension or dissolved in the acylation agent) with an aliphatic acylation agent having up to two C atoms in the chain (acetic acid, acetic anhydride) (at ≥90°C) until the product has one acyl group per monose unit and then this is reacted with a fatty acid or anhydride having at least 6 C atoms in the chain (lauric acid, palmitic, stearic, myristic, sacacic, coco-fatty acid or anhydride) in the presence of an acid catalyst [a proton acid, a Lewis acid, or a cation exchanger in the H form (toluene sulphonic acid)] and any remaining aliphatic acylation agent not used in the first stage. The second stage is continued until the content of chemically combined fatty acid is 4–5%, the water of reaction being removed by distillation with the aid of an azeotrope (a lower alkyl acetate).

Centrifugal. Shin Nippon Machinery Co. Ltd., Tokyo, Japan. **1,403,934.** 29th March 1973; 28th August 1975. See US Patent 3,857,783[3].

Increasing the sucrose content of beet and cane. Monsanto Company, of St. Louis, MO, USA. **1,404,743.** 11th February 1974; 3rd September 1975.—The sucrose content of growing sugar beets and cane is increased by applying, 10 days to 10 weeks (10 days to 5 weeks, 3–7 weeks) before harvest, an effective amount [0·1–5 $lb.acre^{-1}$ (0·25–4 $lb.acre^{-1}$)] of 1-hydroxy-1,1-ethane diphosphonic acid or a (n alkali metal) salt.

Rigid foamed polymers (of enhanced fire-retardant properties). Imperial Chemical Industries Ltd., of London, England. **1,404,822.** 9th May 1972; 3rd September 1975.—Rigid polyisocyanurate foams are made by mixing a polyesterification product having [acid value <10 (<8) mg KOH per g and] a hydroxyl value in the range 200–700 mg KOH per g and $\not>1·5$ branch points per 1000 units of M.W., a blowing agent (a halogenated hydrocarbon of b.p. $\not>100$°C at atmospheric pressure), a catalyst for the trimerization of isocyanates, (2–40% of) an intumescing agent (sucrose) and a crude diisocyanatodiarylalkane composition containing 5–70% (20–60%) by weight of polyaryl polyalkylene polyisocyanates of functionality >2, in an amount sufficient to provide 3–10 (4–6·7) isocyanate group equivalents per equivalent of active hydrogen (there being $\not>0·1$% water in the mixture). The presence of the intumescing agent improves the fire-retarding properties of the foamed polymer.

Beet harvester. Deere & Co., of Moline, IL, USA. **1,405,371.** 27th February 1973; 10th September 1975.

Dry granular mixture of dextrose and levulose. Suomen Sokeri Oy., of Helsinki, Finland. **1,405, 897.** 19th June 1973; 10th September 1975.—A dry granular mixture of (75–25%) dextrose and (25–75%) levulose (invert sugar) is obtained by combining, at 40–50°C, an aqueous solution containing at least 94% by weight of the two sugars with (0·3–10 parts per part of solution by weight of) a dry crystalline mass also containing them and agitating the solution and crystal mass (at 20–50°C) in an atmosphere of 30% R.H.

Beet thinner. Agostroj Jicin Narodni Podnik, of Jicin, Czechoslovakia. **1,408,915.** 22nd September 1972; 8th October 1975.

Beet harvester. Ransomes Sims & Jefferies Ltd., of Ipswich, Suffolk, England. **1,410,167.** 26th May 1971; 15th October 1975.

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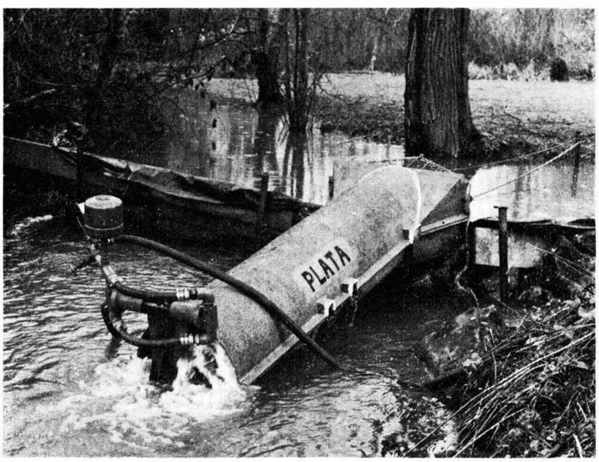
[1] *I.S.J.*, 1978, **80**, 62.
[2] *ibid.*, 124.
[3] *ibid.*

TRADE NOTICES

"Plata" fuel-less pump. Natural Energy Ltd., P.O. Box 66, Hamilton 5, Bermuda; Sir Patrick Crofton, Foxleys Farm, Holyport, Maidenhead, Berks., England.

The "Plata" water pump is designed to transfer water for e.g. irrigation purposes by making use of the power of the flowing water itself to drive a turbine which in turn transmits power to a pump. The only requirement is an adequate gradient (a fall of 23 cm is enough, so that the natural fall of the water course may be sufficient), which can be created by building a simple bank across the stream and/or digging a 80-cm wide channel for the downstream end of the turbine section to rest in. As the water flows through the turbine housing, it causes the six impellers (mounted on a shaft which is parallel to the stream flow) to rotate at as little a flow as 1 cusec (28 litres.sec^{-1}). The illustration shows the system in



operation in a typical stream in low-lying country where the maximum height for dam construction was only 12 inches; despite this and a slow-moving current, the water was still being pumped to a point well above the stream level and left the pipeline at a considerable flow rate. Tests conducted by the British Hydromechanics Research Association have indicated that the system is capable of delivering 909 litres.hr^{-1} to a delivery head of 24 metres or 2500 litres.hr^{-1} to a delivery head of 3 m at an input of 85 litres.sec^{-1} and a fall of 23 cm.

The turbine generates maximum power when its body is just over half full; it feeds the power to a Godwin variable-flow, positive-displacement pump via a crank, lever and fulcrum assembly which has six possible settings, presenting a wide choice of volumes and delivery heads. The turbine casing is of moulded, rigid glass-reinforced cement which is alkali-resistant, impervious to ultra-violet radiation and resistant to low temperatures down to —15°C. The bearings are self-lubricating and require no attention for at least 12 months. The impeller blades are of stainless steel. The intake to the turbine section is protected by a delta-shaped grid which traps floating debris. Approximate cost of the complete unit is $950 f.o.b. The net weight is about 190 kg. Since no fuel is required to operate the system, running costs are low, as are installation and maintenance costs. Moreover, the unit is easily transportable to any suitable site as required by the farmer. It is possible to use the unit in multiples, e.g. six placed at regular intervals across a stream.

PUBLICATIONS RECEIVED

Solenoid valves. Vento Solenoids Ltd., 25 Mitre St., Buckingham, Bucks., England MK18 1DW.

The main catalogue of Vento Solenoids gives detailed information on their range of solenoid valves for use with corrosive fluids and non-corrosive gases and fluids.

Cane mill transmissions for Pakistan.—Four complete cane mill transmission sets have just been completed by David Brown Gear Industries Ltd. for a new sugar factory/refinery being erected by Tate & Lyle Engineering Ltd. for the Punjab Industrial Development Board at Kamalia, 180 miles south-west of Lahore, in Pakistan. The primary reduction double-helical, double-reduction gear unit of 24×36 in centre distance will transmit 500 hp at a reduction from 1200 rpm input to 36 rpm at intermediate pinions. These will mesh with final reduction open-spur gear wheels of 12½ ft diameter to provide a mill drive speed of 5·75 rpm. Similar cane mill gearing contracts have been obtained from the Philippines, Guyana, Jamaica, Kenya and Colombia.

Philippine sugar refinery order.—Fletcher and Stewart Ltd. have been awarded a £15 million contract for the design, supply, installation and commissioning of a refinery to produce refined sugar from 550 tons of raw sugar daily. The new refinery, to be erected at Batangas on the island of Luzon in the Philippines, will produce bottlers' sugar and thereby obviate the need for imports of this particular grade of sugar for local fruit canning and soft drinks manufacture. Dashwood Finance Co Ltd., international financiers and project consortia experts, have collaborated with Fletcher and Stewart Ltd. in this and three other Fletcher and Stewart projects in the Philippines. The factory built by Fletcher and Stewart at Davao on the island of Mindanao in 1969 has withstood severe typhoons and earthquakes which have devastated adjoining areas, and now has one of the best operating efficiencies in the industry. The FS diffuser installed in another new factory built by the company at Bicolandia on the island of Luzon (the order was placed in 1972) has been performing with great success. A FS diffuser is also being installed in another new factory nearing completion at North Cotabato on Mindanao.

Sugar factory pipework contract.—Fosters Power Piping Ltd. have recently completed an order for 230 tonnes of fabricated pipework for installation in Las Majaguas sugar factory in Venezuela. The pipework is designed to carry low-pressure steam and injection water (the high-pressure steam section of the contract having already been supplied by Fosters). Over the last 4 years Fosters Power Piping have made pipework for sugar factories in Tanzania, Mozambique and Indonesia and are currently erecting 4000 tonnes of steelwork, plant and pipework at a sugar factory under construction by Fives-Cail Babcock in Kenya. The company has also undertaken a considerable amount of work for the British Sugar Corporation, particularly where major factory reconstruction has been carried out.

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

UK sugar imports and exports[1]

IMPORTS	1977	1976	1975
		tonnes, tel quel	
Argentina	—	—	16,466
Australia	49,485	135,720	51,709
Barbados	21,814	—	51,143
Belgium	1,520	16,258	121,259
Belize	47,090	44,092	37,871
Brazil	67,724	89,938	94,057
Colombia	—	—	18,213
Costa Rica	56	—	20,025
Cuba	—	133,228	15,232
Cyprus	4,625	640	—
Czechoslovakia	10	558	1,016
Denmark	91,466	87,643	99,522
Dominican Republic	—	12,192	13,239
Salvador	—	—	17,275
Fiji	194,419	132,666	208,424
France	109,231	103,512	288,919
Germany, East	—	—	—
Germany, West	52,830	45,731	93,774
Guatemala	—	—	75,993
Guyana	161,825	192,281	138,342
Holland	19,801	10,171	13,182
India	27,469	40,193	21,997
Ireland	47,241	27,860	46,512
Jamaica	131,420	148,175	123,678
Kenya	64	3,159	—
Leeward Is.	15,172	15,703	16,327
Madagascar	—	—	10,451
Malawi	20,456	11,099	15,031
Mauritius	495,965	497,467	421,012
Mozambique	—	61,959	2
Nicaragua	—	—	23,231
Philippines	—	32,354	58,530
Poland	—	51	—
Réunion	84,725	19,333	—
Salvador	—	—	17,275
South Africa	2	12,751	20
Surinam	427	—	—
Swaziland	99,199	99,554	101,274
Sweden	—	—	1
Switzerland	16	4,515	104
Tanzania	10,603	10,292	—
Thailand	—	13,584	—
Trinidad	90,427	75,325	73,737
Uganda	3,162	—	—
USA	229	18	7,832
Other Countries	330	14	110
	1,848,803	2,078,036	2,295,510

EXPORTS	1977	1976	1975
		tonnes, tel quel	
Algeria	—	3,992	—
Bahamas/Turks and Caicos Is.	161	32	1
Bahrein	234	113	101
Barbados	66	102	126
Belgium/Luxembourg	84	19	467
Belize	8	34	98
Bermuda	417	695	214
Cyprus	3,494	6,364	3,735
Egypt	22	21	11
Germany, West	890	269	1,423
Ghana	131	2,894	4,407
Gibraltar	540	827	569
Greece	2	5	5,107
Holland	10	540	35
Hong Kong	1	1,762	51
Hungary	—	—	10,062
Iceland	448	676	1,527
Indonesia	—	—	11,667
Iran	887	154	12,528
Iraq	—	12,000	—
Ireland	3,160	14,552	4,542
Israel	7,951	16,969	4,580
Ivory Coast	31	1,987	7,315
Jamaica	7	5,141	1
Jordan	63	4,229	4
Kenya	83	22,988	183
Kuwait	53	2,472	127
Lebanon	14,864	6	15,280
Leeward Is.	458	—	2,516
Liberia	128	337	685
Malta	634	1,865	2,565
Morocco	1,046	—	—
Niger Republic	—	—	—
Nigeria	21,390	21,512	32,541
Norway	32,889	49,840	43,651
Oman	447	195	501
Saudi Arabia	972	18,033	20,586
Sierra Leone	611	3,150	3,433
Spain	81	252	10
Surinam	500	120	—
Sweden	229	275	289
Switzerland	34,746	17,418	80,244
Trinidad & Tobago	3	4	4
Trucial States	1,716	—	—
Tunisia	23,914	32,255	37,706
Turkey	6	—	27,970
Venezuela	—	5,700	—
Windward Is.	1,437	2,315	—
Yemen, North	6,600	1	14
Yemen, South	1	5,688	4
Yugoslavia	—	—	11,549
Other Countries	2,489	4,336	5,507
	163,904	262,139	353,936

Israel sugar situation.—The sugar industry in Israel is suffering from the general world situation and the owners of the two sugar factories are asking the Government to impose a customs duty on imported sugar; otherwise, they threaten to liquidate the factories and sell their equipment. If the threat were carried out and the land sold it would not be possible to renew sugar production even if it should become commercially worthwhile. The owners have also suggested turning their factories into refineries for processing of raw sugar as well as producing sugar from beet. They will take this step once the Government has imposed the duty on imported sugar.

Liberia sugar factory inaugurated[2].—A new mill at Barrake in Maryland County has been inaugurated by the Liberia Sugar Corporation. The factory was built and put into operation with Chinese assistance in accordance with the agreement on economic and technical cooperation between the two countries. The factory will initially have a capacity of 8000 tonnes per annum which will gradually be increased to 12,000 tonnes. The cane supply to the mill will be secured by its own plantation of 2400 hectares. This is the first sugar factory in Liberia where imports in 1976 amounted to 8849 tonnes.

New Indian sugar factories[3].—Three sugar factories, each costing Rs. 82·5 million, are to be set up shortly in Assam, according to the state's Deputy Minister for Cooperatives. The factories are to be located at Kampur in Nowgong District, Gopia in Dibrugadh District and Nalbari in Kamroop District.

West Germany beet sugar campaign, 1977/78[4].—During the 1977/78 campaign, a total of 20,580,534 tonnes of beet were sliced, compared with 18,817,239 tonnes in 1976/77. White sugar production reached 2,307,933 tonnes with raw sugar production of 501,878 tonnes, white value, the combined total being equivalent to 3,054,142 tonnes, raw value. In 1976/77 white sugar production was 2,097,003 tonnes, raw sugar was 398,463 tonnes, white value, and the total equivalent to 2,712,472 tonnes, raw value. This increase in 1977/78 was in spite of a 4% drop in the beet area from 449,329 ha in 1976 to 433,477 ha in 1977.

1 C. Czarnikow Ltd., *Sugar Review*, 1978, (1375), 32.
2 F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (3), 13.
3 *Maharashtra Sugar*, 1977, **3**, (2), 44.
4 F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (5), 12.

US sugar imports, 1977[1]

	1977	1976
	—short tons, raw value—	
Domestic offshore		
Hawaii	979,473	985,119
Puerto Rico	102,174	203,041
	1,081,647	1,188,160
Foreign		
Argentina	267,177	86,729
Australia	493,620	469,534
Austria	0	16
Belgium	1,690	717
Belize	31,129	14,350
Bolivia	49,473	52,990
Brazil	660,427	0
Canada	138,027	49,457
Colombia	14,249	84,289
Costa Rica	95,365	65,076
Denmark	3,099	0
Dominican Republic	975,056	971,084
Ecuador	55,380	28,441
Fiji	18,407	0
France	27,215	14,275
Germany, West	19,906	904
Guatemala	300,938	330,578
Haiti	0	6,218
Holland	0	1,538
Honduras	25,054	7,483
Hong Kong	1	0
India	32	188,545
Korea, South	288	940
Madagascar	12,052	13,400
Malawi	38,358	17,659
Mauritius	57,363	29,811
Mexico	274	543
Mozambique	97,311	31,847
Nicaragua	119,760	165,710
Panama	131,162	95,031
Paraguay	0	10,187
Peru	312,794	312,726
Philippines	1,443,131	913,781
Salvador	166,028	143,154
South Africa	274,227	98,472
Swaziland	61,643	45,923
Sweden	2	2
Switzerland	0	745
Taiwan	86,055	86,534
Thailand	0	70,059
UK	44	84
Uruguay	0	5,229
West Indies	159,745	243,978
Total foreign	6,136,482	4,658,039
Total domestic offshore	1,081,647	1,188,160
Total offshore	7,218,129	5,846,199

Costa Rica sugar factory[2].—Tenders are being called for by CODESA (Corporación Costarricense de Desarrollo) for construction of their new project, Ingenio Azucarero Tempisque, at Guanacaste[3]. Twenty bids from 13 countries are being examined for construction of Central Azucarera Boruca, in the Pacific zone, which is to have an initial capacity of 4000 t.c.d., with facility for expansion to 6500 t.c.d. Production of raw sugar will reach 50,000 tons per year and the area planted to cane will be 7500 ha. Assistance is being provided by Brazil in the development of alcohol production from cane for use as a motor fuel mixed to the extent of 20% in petrol.

Cameroun sugar factory inaugurated[4].—President Abidjo recently inaugurated the Cameroun Sugar Company's factory in Mbandjock. This company, established in 1975, will grow cane over an area of 10,000 hectares and is expected to produce 18,000 tonnes of raw sugar in 1977/78 with a long-term target of 50–80,000 tonnes of sugar annually from 500,000 tonnes of cane. The Sosucam sugar company already produces 30,000 tonnes of sugar annually, while domestic requirements amount to some 45,000 tonnes.

World Sugar Research Organization

At a meeting of Directors of leading sugar companies held in London on the 9th March 1978, it was agreed to set up a new organization to be known as the World Sugar Research Organization (WSRO) and registered as a company Limited by Guarantee under British law. The objects of the new organization are to promote research into sugar and its by-products and to coordinate research being carried out by regional groupings of sugar companies. Research sponsored by the sugar industries of the member countries will be in the fields of public health, food technology and sucrochemistry.

The sugar industries of the following countries today became the first members of the WSRO: Belgium, Canada, Ireland, South Africa, United Kingdom, United States of America and Venezuela.

The first Chairman of the WSRO is Mr. Kenneth Sinclair, CBE, until recently Chief Executive of the British Sugar Corporation. The first Director-General of the new organization is Mr. Antony Hugill, until recently a Director of Tate & Lyle Ltd., who is also a Consultant to the World Bank and the United Nations Environment Programme. Mr. Daniel L. Dyer, representing the South African Sugar Association, was elected Hon. Treasurer of the organization. The sugar industries of the countries in membership of the WSRO are responsible for manufacturing or refining about 20 million tons of sugar a year.

B. W. Dyer & Company report that the WSRO will succeed and change the International Sugar Research Foundation which, with its predecessors, functioned for 35 years. Instead of funding research itself, as did the ISRF, the new organization will conduct scientific symposia on research topics and disseminate information on the status of such research funded by the regional groups.

Sweden 1977/78 beet sugar campaign[5].—In the 1977/78 campaign the seven Swedish sugar factories sliced 2,182,390 tonnes of beet to produce 248,977 tonnes of white sugar, 64,008 tonnes of raw sugar, 91,155 tonnes of molasses and 129,012 tonnes of dried pulp in various forms.

PERSONAL NOTES

Mr. **J. M. Beckett,** Chief Executive of the British Sugar Corporation Ltd., has been elected Chairman of the British Sugar Bureau in succession to Mr. **F. H. (Tony) Tate.** The new Vice-Chairman is Mr. **J. F. P. Tate,** Chairman of Tate & Lyle Refineries Ltd. The Bureau's new Chairman has become well-known in the UK sugar industry since he was appointed Chief Executive of British Sugar in November 1975. He is the first Chairman of the Bureau to be drawn from the British Sugar Corporation Ltd. The retiring Chairman, Mr. F. H. (Tony) Tate, has been Chairman of the Bureau since 1965 and has presided over its development as one of the sugar industry's major trade associations.

Humphreys & Glasgow Ltd. announce that Mr. **C. D. H. Vernon** has joined the Sugar Division which was formed last year under the leadership of Mr. **N. A. D. Sharvell,** former Chairman and Managing Director of Fletcher and Stewart Ltd. Mr. Vernon was also formerly a director of Fletcher and Stewart Ltd. and has had 26 years in the service of the sugar industry.

[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (9), S7–S8.
[2] *Amerop Noticias*, 1978, (51), 16.
[3] See also *I.S.J.*, 1977, **79**, 349.
[4] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (3), 13.
[5] *Zuckerind.*, 1978, **103**, 159.

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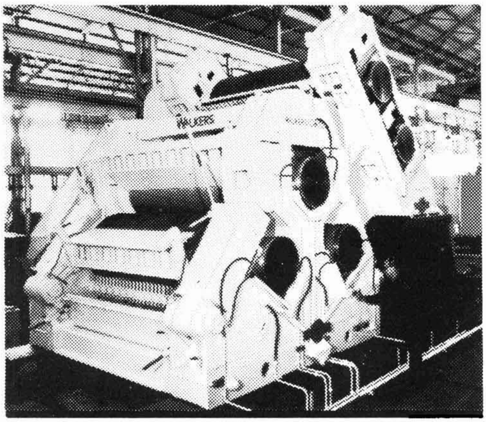

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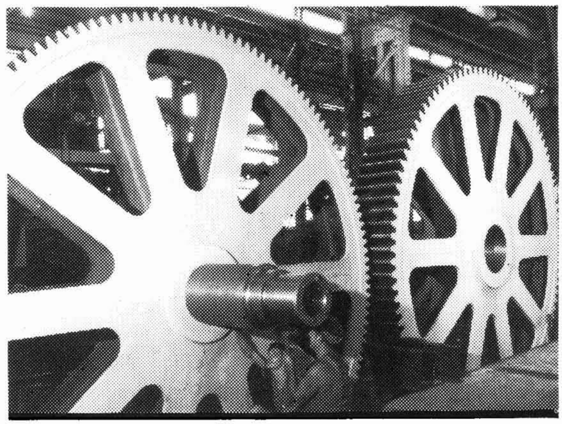

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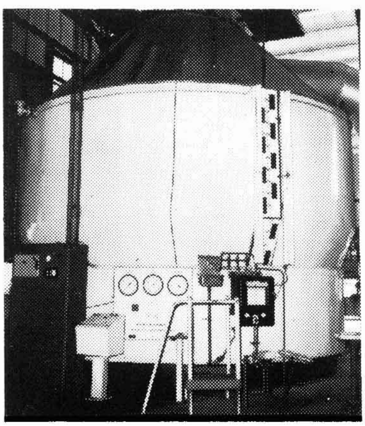

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