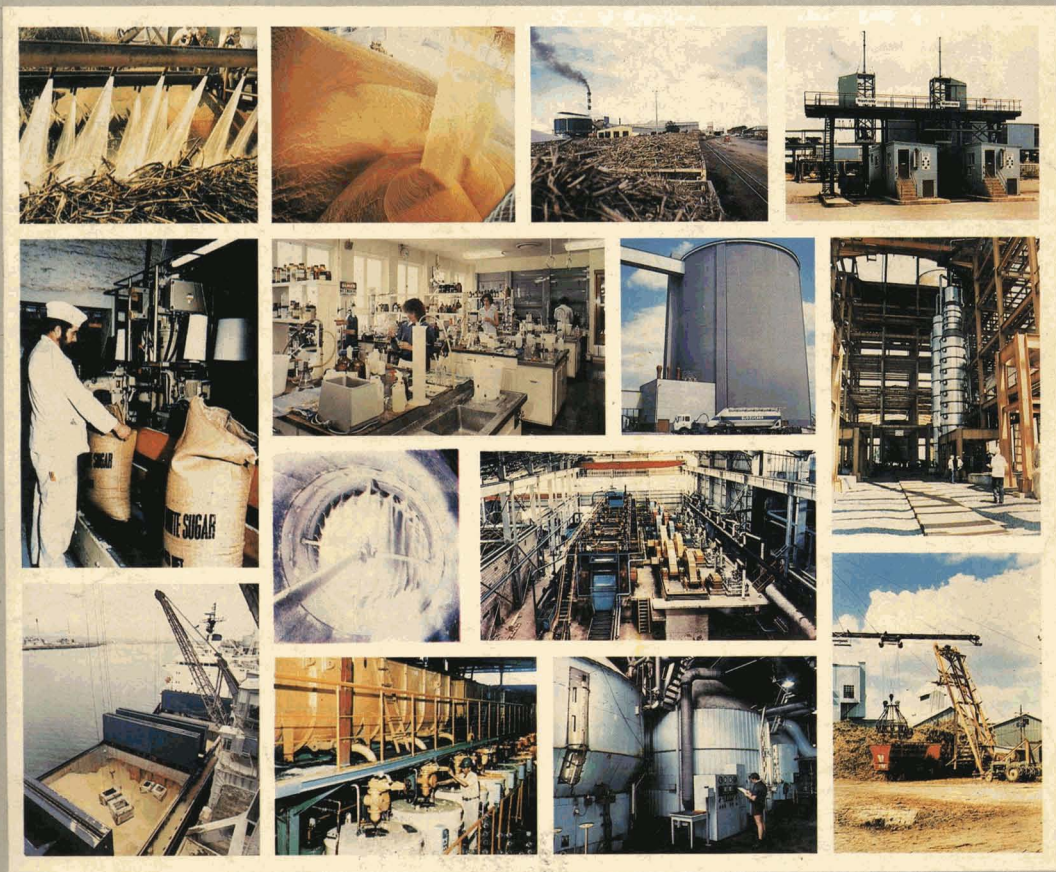
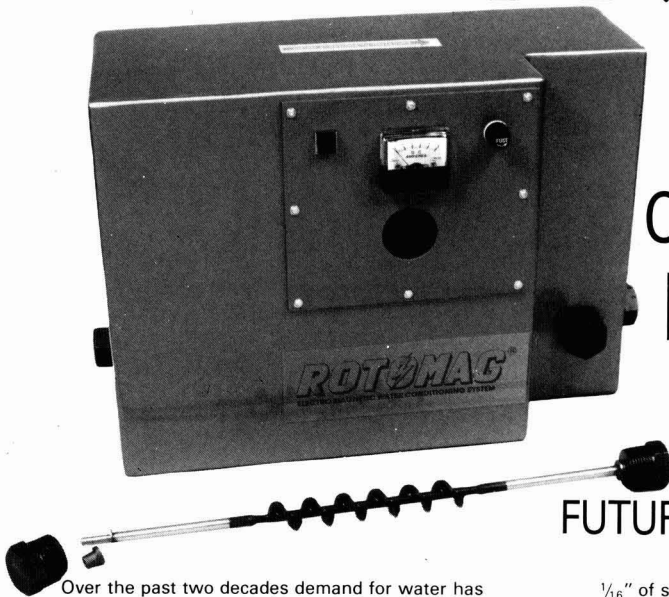


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# INTERNATIONAL SUGAR JOURNAL



Volume 87  
Issue No. 1034

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UK ISSN 0020-8841

**Annual Subscription:**  
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Published by  
The International Sugar Journal Ltd.,  
23A Easton Street, High Wycombe,  
Bucks., England HP11 1NX  
Tel: 0494-29408 Telex: 21792 REF 869

Printed by Adams & Sons (Printers) Ltd.,  
Blueschool Street, Hereford.  
Telephone: 0432 54123.

ห้องสมุดกรมวิทยาศาสตร์บริการ  
10 มี.ค. 2528

Published by  
**The International Sugar Journal Ltd.**

23A Easton Street, High Wycombe, Bucks., England HP11 1NX.

Telephone: 0494-29408

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US Office: P.O. Box 143773, Coral Gables Station, FL 33114-3773.

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# Notes and comments

## World sugar prices

Very quiet conditions prevailed on the world market during the beginning of December and the LDP was the same on December 10 as it had been on the first trading day of the month (December 3) at \$113.50 per tonne. The market suddenly collapsed and the LDP fell by £7.50 and reached a low of \$92 on December 27 before recovering slightly to \$94 on December 31. There was little that could be pointed to as a reason for the fall in prices; problems had arisen with sales to Egypt and deferment of shipment of Thailand sugar had been agreed, but these had been known about for some time. There were further reports of failure to reach agreement on renewal of previous supply contracts and new estimates indicating that the likely drawdown of world stocks in the next twelve months would not reduce them substantially. Licht's new estimate of European sugar production was raised slightly. All these influences combined to reduce market confidence and the price fell to its lowest level for 14 years, the I.S.O. price reaching 3.10 cents/lb before recovering to 3.18 cents.

The fact that so much of the surplus is available as white sugar presumably explains why the LDP(W) led the fall in values; the differential between this and the LDP started the month at \$41.50 and remained at about \$40 until December 18 when it narrowed to \$36. It stayed at this level until December 27 when the two sugar prices bottomed and the differential returned to \$40, rising to \$41 on December 31.

## New Spanish sugar quota system

Negotiations are under way for the accession of Spain and Portugal to the European Economic Community and as a measure to ease these, Spain is to introduce a new system governing production of sugar. A- and B-quotas are to be introduced, the former being the normal amount contracted between growers and the factories, and the

latter a further 10%. The total of the two quotas must not exceed 1.1 million tonnes, and anything above this figure need not be accepted by the factories. The government will set the beet prices for each quota, that for B-beet being lower.

High fructose syrup has been making inroads into the Spanish sweetener market; production capacity is more than twice consumption level and HFS costs less than sugar. Unlike the EEC, however, there is no effective control on HFS production and it has been suggested that the government should provide some sort of subsidy to promote the use of sugar by the food industry to recover part of the market loss, as well as legislation to limit HFS use.

## World sugar balance, 1984/85

F. O. Licht GmbH recently published<sup>1</sup> their first estimate of the world sugar balance for the crop year September 1984-August 1985 and this appears below, together with corresponding figures for the two previous years.

	1984/85	1983/84	1982/83
	tonnes, raw value		
Initial stocks	39,459,000	38,945,000	32,970,000
Production	96,425,000	97,573,000	100,630,000
Imports	28,141,000	28,628,000	29,003,000
	164,025,000	165,146,000	162,603,000
Consumption	97,145,000	96,500,000	94,166,000
Exports	28,552,000	29,187,000	29,492,000
Final stocks	38,328,000	38,459,000	38,945,000
Production change	-1,148,000	-3,057,000	- 80,000
„ „ (%)	-1.18	-3.04	-0.08
Consumption change	+ 645,000	+2,334,000	+2,167,000
„ „ (%)	+0.67	+2.48	+2.36
Stocks % consumption	39.45	40.89	41.36

For the first time in several years, consumption is expected to exceed production by a small margin and, while this is a development to be welcomed, it will take a considerable time for surplus stocks, i.e. that proportion above about 25% of consumption, to be eliminated in the

absence of natural disasters. Thus the new figures have not given rise to any great optimism in sugar markets.

Licht point out that there has been a steady decline in the proportion of sugar production entering world trade; at the turn of the century it was more than a half but has now fallen to about a quarter. The requirements of a number of former major importers are falling so that the decline is likely to continue.

## Philippines sugar prospects

According to an assessment by *World Sugar Journal*<sup>2</sup>, the outlook for the Philippines sugar industry is that it is on the decline. A sizeable fall — about 17% — in sugar production is expected in 1984/85, to 1.9 million tonnes from 2.28 million tonnes in 1983/84. The Philippines government is in fact encouraging lower production of sugar by implementing a stricter crop financing policy. Average cost of production is 13 US cents/lb so that it is unprofitable to make sugar for sale to the world market where prices are currently 3-4 cents/lb.

Until recently, planters could borrow their total farm budget for a sugar crop; under the new policy, the Central Bank prohibits lending banks from financing the full amount and the 2100 million pesos in crop loans released by

<sup>1</sup> *International Sugar Rpt.*, 1984, 116, 601-607.  
<sup>2</sup> 1984, 7, (4/5), 24.

the government for 1985/86 in effect only amounts to about half the amount available for the previous crop year. Small and medium-scale planters will be forced out of production if they cannot provide enough funds of their own to stay in business. It is estimated that about 85% of sugar cane planters are now in deficit and it is probable that many will shift to other crops for which finance is easier to obtain.

### **US sugar refineries proposal to produce HFS<sup>3</sup>**

A proposal which, if successful, would have broad implications for the US and world sugar markets has been advanced by Savannah Foods & Industries Inc. Savannah, with the support of the Cane Sugar Refiners Association, has proposed to the Administration that US refiners be allowed to import non-quota sugar in order to produce a high fructose syrup to compete with that obtained from corn. Savannah contends that, if this were to be permitted, sucrose could recapture about 25% of the market lost to the corn-based sweetener. Expressed in other terms, about 1.0-1.5 million tonnes of sugar could be involved, mostly to be used in the beverage industry. It is maintained that sufficient safeguards could be devised to minimize the risk of the product being substituted for quota sugar. Furthermore, the loss to the wet milling industry might be made up by converting existing plants to the manufacture of ethanol. While it is too soon to measure Administration reaction to the proposal, it is worth noting that all that would be needed to implement the program appears to be a Presidential Proclamation.

### **India sugar imports in 1985**

At end of 1983 India was said to be contemplating putting the brakes on sugar production after a dramatic recovery in the early part of this decade swung the market right back into surplus<sup>4</sup>. By the start of the

1984/85 campaign the situation had been completely reversed. Production in 1983/84 had slumped by more than 2 million tonnes and, in trying to keep supplies to consumers running smoothly while at the same time holding exports down to the bare minimum, the government was forced to fall back on the buffer stock it had accumulated during times of surplus.

The fact that the shortfall required the drawdown of a 1 million tonnes buffer stock as well as imports of more than 500,000 tonnes provides a good indication of the extent of the shortfall. The stock was the first of its kind and, now that it has been wiped out altogether, there could be a need for even larger imports as the 1984/85 season advances. This could be particularly relevant if consumption continues to expand at its current rate. In the first eleven months of the 1983/84 season, the domestic market accounted for more than 6.7 million tonnes against 5.8 million the previous season, while almost twice as much was designated for export.

The developments of 1984 clearly show that the optimism expressed a year ago when production exceeded needs was misplaced. Unless the government urges millers to produce more, it seems likely that it will need to turn to the world market to top up supplies and it could be some time before the country is in a position to build up stocks again.

### **Possible changes in US agricultural policy<sup>5</sup>**

There are many reasons for the current enormous surplus of sugar in the world. The faulty escalation clause in the ISA fall-back formula and the substantial expansion of output in the EEC have been partly responsible but the policy of the US government in underpinning domestic production has certainly also been a factor. Not only has this safeguarded the interests of both domestic cane and beet sugar producers but it has also placed an

effective floor to the market for all caloric sweeteners, to the advantage of producers of HFS.

Now, however, there are suggestions that the US government may be contemplating a change in its agricultural program. The US Secretary of Agriculture has stated that the US Farm Bill, which will be introduced into Congress in February, will contain radical reforms with the aim of bringing US prices for farm products more in line with those ruling in world markets. The aim of this measure will be to encourage US farmers to attune themselves more closely to world market costings.

As part of the new agricultural package it has been suggested that the Administration will endeavour to exert pressure on the European Community to adjust its own agricultural support program so as to make EEC farmers also more responsive to world market pressure. It is difficult to imagine any immediate response from the Community, especially in view of the fact that the various pressure groups in the US might well nullify or at least seriously adjust the proposal well before the new Farm Bill would come into effect in October 1985. Nevertheless, it must be of interest that the administration of a major developed country is considering the phasing-out of the price supports which currently sustain the domestic producers.

It might well be that overall the agricultural interests of the United States would eventually stand to gain from such a policy change but a unilateral move would surely lead in the near term to greater opportunities for foreign sugar producers in the United States and consequently to an improvement in the world statistical position.

3 C. Czarnikow Ltd., *Sugar Review*, 1984, (1731), 232.

4 *Public Ledger's Commodity Week*, December 1, 1984.

5 C. Czarnikow Ltd., *Sugar Review*, 1984, (1732), 238.

# Sucrose inversion with cation exchange resins

By G. Siegers and F. Martinola

(Bayer AG, Leverkusen, Germany)

## Introduction

Hydrolysis of polysaccharides and oligosaccharides is catalysed by H<sup>+</sup> ions. The splitting of sucrose leads to a mixture of glucose and fructose which, in contrast to the dextrorotatory sucrose, rotates polarized light to the left. Consequently, this process is also referred to as inversion, the resultant mixture being invert sugar. This is processed to form artificial honey and liquid sugar. Liquid sugar, in particular, has gained considerable significance, since it is widely used for sweetening soft drinks<sup>1</sup>.

It was found very soon after the invention of synthetic ion exchange resins that highly acidic resins in the form of the free acid are just as capable of splitting the cane sugar as hydrochloric acid, for example. However, unlike the case with hydrochloric acid solution—homogeneous catalysis—this is a form of heterogeneous catalysis. Nevertheless, the course of the reaction can be described as a first order reaction, just as in the case of homogeneous catalysis with soluble acids<sup>1-3</sup>.

The lower reaction rate is one disadvantage of heterogeneous catalysis, since the actual splitting reaction is accompanied by the necessary diffusion of the reactants to the catalytic centres. However, this limitation is more than compensated for by the possibility of separating the catalyst from the reaction at any time by simple mechanical means, thus obtaining the desired degree of inversion. A fully continuous inversion process can be obtained by filtering the sugar solution through a column filled with granular catalyst. The catalyst is not consumed and does not contaminate the invert sugar solution obtained.

Ion exchange resins have been in use for several years for demineralizing and decolorizing sucrose solutions<sup>6</sup>. It was consequently an obvious step to integrate inversion with ion exchange resins having suitable properties into



G. Siegers

F. Martinola

these demineralization systems, always assuming that inversion was desired. As already mentioned, this is the case when producing liquid sugar or for complete conversion of sucrose into fructose<sup>7</sup>.

All the works of reference published to date have studied gel-type resins with a degree of cross-linking corresponding to about 8% divinyl benzene. One paper referred to the use of a macroporous cation exchange resin with a high degree of cross-linking, but without specifying precise details<sup>8</sup>. This resin proved inferior to the gel-type resins cross-linked with 8% DVB. Furthermore, most measurements were performed using the stirring test and quite highly diluted solutions. However, use of concentrated solutions and splitting of the sugar on passage through a column of catalytic resin are of greater practical interest.

Consequently, the conditions selected for this paper are similar to the practical conditions encountered in sugar refineries. Gel-type resins with varying degrees of cross-linking were also compared with macroporous exchange resins.

## Experimental

The cane sugar solutions were prepared with demineralized water, heated, and maintained at the specified temperature with the aid of a thermostat. The ion exchangers were styrene sulphonic resin beads with the specified cross-linking and macroporosity. Their properties were determined by the standard methods. All figures refer to the H<sup>+</sup> form. The relevant properties are compiled in

Table I. The resins were filled into columns of 18.4 mm diameter, using a quantity of 100 ml each time.

Resin No.	Matrix	Cross-linkage, % DVB	Shipping weight, g/litre	Total capacity, equiv./litre
1	Gel	4	720	1.25
2	Gel	6	755	1.6
3	Gel	8	780	2.0
4	MP	5	750	1.1
5	MP	8	760	1.4
6	MP	12	750	1.7
7	MP	18	750	1.4

The exposure time was calculated as the space time<sup>9</sup> of the solution in the filter column; this is the reciprocal of the flow rate and is expressed in minutes.

The rate constants were calculated on the basis of the following formula:

$$\ln(1 - X_s) = -K \cdot t$$

where  $1 - X_s$  = unsplit sucrose  
 $t$  = space time (minutes)  
 $K$  = rate constant.

## Results

The finding that the splitting of sucrose can be represented as a first order reaction was fully confirmed as may be seen in Fig. 1.

### Dependence on grain size

Table II shows that the rate constant decreases with increasing resin bead diameter, as was to be expected.

### Dependence on temperature

The rate constant triples between 40°C and 70°C, as shown in Table III.

- "Technologie des Zuckers", Ed. Schneider. (Schaper, Hanover) 1968, pp. 385 *et seq.*
- Mariani: *Anal. Chim. Appl.*, 1949, 39, 283; 1950, 40, 500.
- Bodamer & Kunin: *Ind. Eng. Chem.*, 1951, 43, 1082.
- Devillers & Loilier: *Ind. Alim. Agric.*, 1958, 75, 465-470.
- Täufel & Grunert: *Archiv der Pharmazie*, 1961, 66, (7), 439-447.
- "Technologie des Zuckers", Ed. Schneider. (Schaper, Hanover) 1968, pp. 620 *et seq.*
- German Patent, 1,567,325 (Boehringer GmbH), 1965.
- Gilliand *et al.*: *Ind. Eng. Chem. Fundamentals*, 1971, 10, (2), 185-191.
- Reed & Dranoff: *ibid.*, 1964, 3, (4), 304-307.

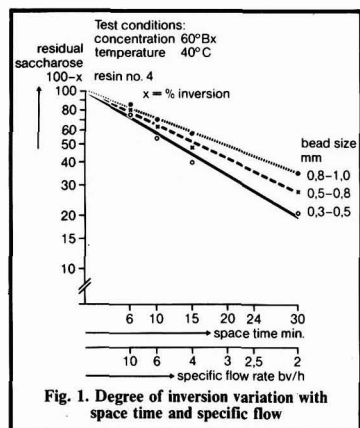


Fig. 1. Degree of inversion variation with space time and specific flow

Behaviour of different ion exchangers used

If the rate constant is plotted as a function of the degree of cross-linking, it is seen that a higher level of cross-linking considerably impedes the reaction.

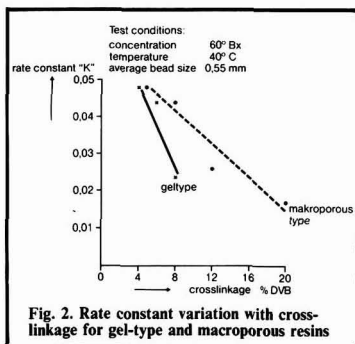


Fig. 2. Rate constant variation with cross-linkage for gel-type and macroporous resins

The macroporous resin is slightly superior, however, especially at higher degrees of cross-linking (Fig. 2). The inner surface or pore diameter, determined according to BET, have only minor effects compared with the influence of cross-linkage (see Table V). The results of Gilliland *et al.*<sup>8</sup> therefore lead to the conclusion that the macroporous resin used by them consisted of highly cross-linked beads in view of the faster reaction of the gel-type resins.

Table V. Rate constant of macroporous resins at 40°C and 60°Bx

Resin No.	Diameter of pores, A	Inner surface, m <sup>2</sup> /g	Rate constant, K, min <sup>-1</sup>
4	<100	6	0.048
5	350	42	0.044
6	303	41	0.026
7	715	39	0.018

Secondary reactions during inversion

One undesirable phenomenon accompanying acid hydrolysis of sucrose is the formation of hydroxymethylfurfural (HMF). This slightly yellowish compound, with an extinction maximum at 283 nm, is difficult to remove and gives the evaporated liquid sugar an unpleasant colour. Figure 3 shows that HMF formation is promoted at higher

temperatures; this acts as a constraint on increasing the inversion rate by raising the temperature.

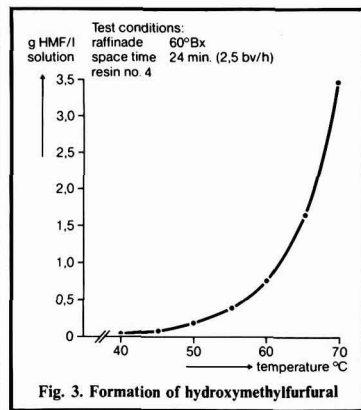


Fig. 3. Formation of hydroxymethylfurfural

Conclusions

The functions of the rate of constants in relation to grain size, degree of cross-linking and temperature, as described above, can be taken as a basis for estimating the flow rate in accordance with the volume of solution per volume of ion exchange resin used which can be filtered via an inversion column per hour in order to obtain, for example, 99% inversion. Figure 4 summarizes these data for two gel-type resins with different degrees of cross-linking. It shows that, even if a fine-grained resin with 4% DVB is selected, a flow rate of 1.2 BV/hr cannot be exceeded, since the reaction temperature must be limited to 40°C in order to minimize HMF formation.

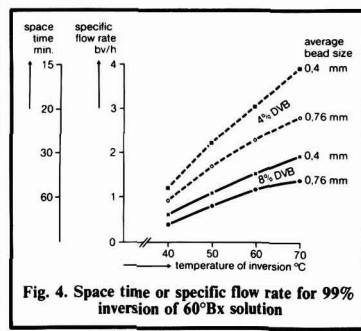


Fig. 4. Space time or specific flow rate for 99% inversion of 60°Bx solution

Table II. Rate constant variation with bead size

Resin No. 4, 60°Brix, 40°C	
Average diameter of beads, mm	K, min <sup>-1</sup>
0.85	0.036
0.76	0.039
0.63	0.046
0.55	0.048
0.40	0.054

Table III. Rate constant variation with temperature

Resin No. 4, 0.76 mm average bead size, 60°Bx	
Temperature, °C	K, min <sup>-1</sup>
40	0.039
45	0.059
50	0.076
55	0.088
60	0.105
65	0.110
70	0.125

Dependence on sucrose concentration

An increase in the rate constant is noted between 30° and 50° Brix, although it ceases to rise between 50° and 60° Brix (see Table IV).

Table IV. Rate constant variation with sucrose concentration

Resin No. 4, specific flow rate 2.5 BV/hr, 40°C, 0.65 mm average bead size	
°Bx	K, min <sup>-1</sup>
30	0.034
40	0.041
50	0.045
60	0.044



**Practical notes**

The following considerations can be made if the inversion column is to be integrated into a demineralization plant:

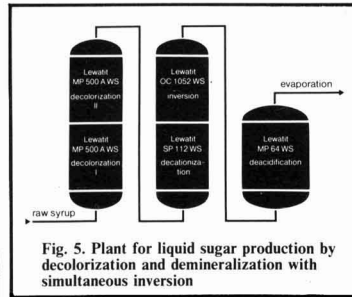
**Mechanical strength**

High osmotic loads occur during the change from sugar solution to water during sweetening-on and sweetening-off, as well as during regeneration. Resins with a low degree of cross-linking are mechanically less stable than products with higher degrees of cross-linking. Consequently, it is recommended to use suitable macroporous ion exchange resins, since these have greater mechanical strength than their gel-type counterparts.

**Position of the inversion resin in a demineralization plant**

The inversion rates measured can only be achieved with a cation exchange resin which is completely in the H<sup>+</sup> form. Even partial loading with other cations will reduce the inversion efficiency. Therefore, the inversion column is always connected downstream of a cation column which removes the metal cations present in the solution. It must also be possible to treat the inversion column with acid from time to time, in order to remove the cations absorbed.

This can be achieved in a space-saving manner by using the Lewatit compound fluidized bed system (VWS System<sup>10</sup>). The column required for this purpose contains the cation exchange resin in the lower chamber and the inversion resin in the upper chamber (Fig. 5). The upflow principle is used to make the sugar solution flow from the bottom to the top through the two resin beds, thus being freed of cations and inverted in a single process. Regeneration is performed in the opposite direction, i.e. from top to bottom, using an acid solution, thus ensuring that the inversion resin always remains fully active. In Fig. 5, the cation resin column is preceded by a



decolorizing column of the Lewatit lift-bed system type, this being regenerated with alkaline salt solution. The anions are removed by means of a weakly basic anion exchanger, which is also capable of absorbing any residual colour bodies.

The main advantages of the Lewatit upflow principle for the treatment of sugar solutions are as follows: it is a true countercurrent method combining optimum purification with a high ion exchanger capacity and particularly economical utilization of the regenerating chemicals. Sweetening-on is with the high-density sugar solution from below, thus giving a low sweetening-on solution volume. Sweetening-off is with water from above, thus giving low sweetening-off solution volume. The apparatus design is simple, with no moving parts.

**Dimensioning of the inversion column**

The space times and flow rates shown in Fig. 4 were determined with pure solutions not containing free mineral acid created by ion exchange. In practice, some free acid will always be formed from the salts present in the untreated product in a demineralization plant. These acids are helpful in inversion. Consequently, the values in Fig. 4 are maximum space times, and the values used in practice can be lower.

The use of optimized catalytic resins based on ion exchangers, and their inclusion in demineralization systems or chromatographic columns results in improved cost-efficiency and simplified process control. Practical experience

has already been obtained in a number of plants in Europe.

**Summary**

Heterogeneous catalysis of the inversion reaction of sucrose possesses a number of advantages which more than compensate for the benefits of catalysis with dissolved mineral acids. The rate constants for the first order reaction were measured using three gel-type and four macroporous ion exchange resins of various degrees of cross-linking and bead size, at several temperatures and various sugar solution concentrations. It was found that the degree of cross-linking is of particular significance when selecting an inversion catalyst. For 99% inversion, a space time (reciprocal of flow rate) of about 50 minutes in the catalyst column must be provided, even with highly suitable resins, if the temperature is to be limited to 40°C. Information on the integration of an inversion column in a demineralization plant shows that application of the upflow method offers particular advantages of both a technical and economic nature.

**Inversion de saccharose à l'aide d'échangeurs cationiques**

La catalyse hétérogène de la réaction d'inversion de saccharose présente un nombre d'avantages qui font plus que compenser le bénéfice de la catalyse à l'aide d'acides minéraux dissous. On a mesuré les constantes de vitesse de la réaction du premier ordre en utilisant trois résines échangeuses de type gel et quatre macroporeuses. Elles correspondaient à différents degrés de réticulation et de granulométrie. On a opéré à plusieurs températures et différentes concentrations en saccharose. On a trouvé que le degré de réticulation a une importance particulière lorsqu'on choisit un catalyseur d'inversion. Pour 99% d'inversion un temps de rétention (l'inverse du débit) d'environ 50

10 Martinola: *Proc. Int. Water Conf.*, 1978, 39, 29-42; *ibid.*, 1981, 42, 325-332.

minutes dans la colonne doit être prévu, même avec des résines convenant parfaitement et lorsque la température doit être limitée à 40°C. L'information au sujet de l'intégration de la colonne d'inversion dans une usine de déminéralisation montre que l'application de la méthode du parcours de bas en haut offre des avantages spéciales tant au point de vue technique que sur le plan économique.

#### Saccharose-Inversion mit Kationenaustauscherharzen

Die heterogene Katalyse der Inversion von Saccharose besitzt eine Reihe von Vorteilen, die die Vorzüge der Katalyse mit Mineralsäuren mehr als aufwiegen. Die Geschwindigkeitskonstanten der Reaction 1. Ordnung wurden unter Verwendung von drei gelartigen und vier großporigen Ionenaustauscherharzen variierender Kreuzverknüpfungsgrade und

Partikelgrößen bei verschiedenen Temperaturen und Konzentrationen der Zuckerlösung untersucht. Es wurde gefunden, daß der Grad der Kreuzverknüpfung von besonderer Bedeutung bei der Auswahl eines Inversionskatalysators ist. Für 99% Inversion muß eine spezifische Aufenthaltszeit (das Reziproke der Durchflußgeschwindigkeit von ungefähr 50 min in der Katalysator-Säule auch bei sehr geeigneten Harzen vorhanden sein, falls die Temperatur 40°C nicht überschreiten soll. Informationen über den Einbau einer Demineralisierungsanlage zeigen, daß die Katalyse mit aufsteigendem Produktstrom besondere wirtschaftliche und technische Vorteile bietet.

#### Inversión de sacarosa por resinas para cambio de cationes

Catálisis heterogeneo de la reacción de inversión de sacarosa presenta algunas ventajas que hacen más que

compensar los beneficios de catálisis por ácidos minerales disueltos. Los constantes de velocidad para la reacción del primer orden se han medido empleando tres resinas del tipo gel para cambio de iones y cuatro resinas macroporosas, de diferentes grados de reticulación y granulometría, a diferentes temperaturas y varias concentraciones de la sacarosa. Se ha notado que el grado de reticulación tiene importancia mayor en la selección de un catalizador de inversión. Para obtener 99% de inversión, se requiere una retención (inverso del flujo) de unos 50 minutos en la columna de catálisis, aunque si las resinas están muy convenientes, si la temperatura tiene que limitarse a 40°C. Información sobre la integración de una columna para inversión en una planta de desmineralización demuestra que la aplicación del método de flujo de abajo en arriba ofrece de las ventajas especiales tanto técnicas como económicas.

# Heat economy and supervisory computer control

By Christian Møller and Henrik Jansdorf  
(A/S De Danske Sukkerfabrikker, Gørlev, Denmark)

#### Introduction

At DDS (A/S De Danske Sukkerfabrikker) we have focused on the problems of heat economy for years; about 30 years before the oil crisis of 1973 we had already installed the first steam jet compressors at the evaporator station in our Nakskov factory.

In Denmark we have to import all our fuel, and the fuel costs were even at that time an important part of our production costs, so it was attractive to examine closely the question of heat economy.

In the late forties we started systematic calculations on the minimum attainable steam consumption of a white sugar factory along with intensive practical trials on reducing the steam consumption of



Christian Møller



Henrik Jansdorf

different stations in the factory.

Because of the progress of electronics we have now in addition realized an on-line data-logging and computing system giving us the key thermodynamic figures for supervisory control and optimizing of the energy conservation of our Gørlev sugar factory.

#### Minimum obtainable steam consumption

The minimum obtainable steam

consumption of a sugar factory is heavily dependent on the local production facilities such as the quality of the beets to be processed, the design and size of the production machinery, e.g. type and capacity of diffusers, juice purification facilities, type, design, size and coupling of the heaters and evaporator station, pan design and capacity and the general production technique. In addition, power consumption and boiler-house design are of great importance in the total heat consumption.

#### Beet quality

The beet quality has a marked influence on the total steam consumption of the factory. The lower the sugar content of the beets the lower the dry substance of the thin juice

going to the evaporator station and, in turn, the higher the condenser and condensate losses.

Reduction in juice purity increases the amount of low-grade massecuite and in turn the amount of sugar going to recrystallization, thus requiring an increased steam consumption. A drop of thick juice purity from 92 to 91 at a fixed beet pol content of say 16% means an increase in steam consumption of 1.5 to 2.0% on beets. In addition, lower thick juice purity is normally accompanied by higher colour level and consequently increased water purge at the centrifugals to ensure a given quality of sugar.

#### *Diffusion*

In the days of the diffusion batteries it was favourable in respect of steam economy to have as many cells in operation as possible promoting efficient heat exchange between fresh cossettes and final juice so as to obtain as low a juice temperature as possible.

In the DDS diffuser the heat exchange is even better, allowing a minimum steam consumption for the diffuser of only about 0.5% on beets. The more inefficient the heat exchange the higher the juice temperature and the higher the steam consumption of the diffusion process.

This presupposes sufficient diffuser capacity to obtain a low draft which is fundamental to effective steam economy. Increasing draft means increasing vapour loss to the condenser, increasing heat loss to the condensate and increased steam consumption in the heaters.

#### *Juice purification*

The juice purification technique has a marked influence on the total steam consumption. As the optimum temperature for first carbonatation is about 82°C, any further heating of the limed juice before carbonatation means additional exhaust loss from the gassing tank.

The necessary recirculation to the

prelimer of mud to promote filtration should be done in as concentrated a form as possible to minimize the recycling of hot juice to the prelimer. In our factory we use filter cake directly from selected drum filters. Addition of hot juices to the prelimer means reduced utilization of the pan vapour heaters which in turn will increase condenser losses.

Inadequate juice purification has a negative influence on steam economy because a higher degree of recrystallization is required to obtain a standard quality sugar. Poor juice purification might also mean increased lime salts level with resultant fouling of the heat transfer areas of heaters and evaporators which is damaging to heat economy.

#### *Heaters and evaporator station*

The size and coupling of the different heaters and evaporator bodies has an important influence on steam economy. The heating of the limed raw juice should start using vapour from the pan boiling station, followed by heating with hot condensate after it has been systematically flashed to the fourth effect of the evaporator station. This regenerative heating should be followed by heating on fifth vapour and finished by a temperature-controlled final heating with fourth vapour.

We prefer a quintuple-effect evaporator station with a final juice temperature in the fifth effect of 85-88°C, so as to be able to make the most of the fifth effect vapour. The upper limit of juice temperature in the first effect should be 125-128°C to avoid any harmful thermal influence on the quality of the juice.

Vapour is taken systematically from each effect from number four to number one to heat the thin juice in a battery of heaters ahead of the evaporator station; the juice heating is finished using ventings from the first effect calandria. The efficiency of the evaporator station increases the more low-pressure vapour it is possible to utilize. This underlines the importance

of having efficient heaters with ample heating surfaces.

The heating surface of the evaporator station should be 1.6-1.8 m<sup>2</sup> per tonne slicing capacity. Vapour for boiling is the largest consumption in a single station, and it should be taken from the third and fourth effect. To be able to do so the heating surface and temperature adjustment in the evaporator station should aim at a juice temperature in the third effect of about 112-114°C and 100-102°C in the fourth effect.

#### *Vapour compression*

An appropriate vapour compressor installation allows additional water evaporation from the thin juice, and a corresponding reduction of the vapour losses from the evaporator station to the consenser — under favourable circumstances a reduction to about zero.

In order to reduce the power consumption of the compressor only first effect vapour should be compressed and this to exhaust steam pressure. The higher the temperature level and the smaller the difference between exhaust steam and first effect vapour temperatures the lower the minimum work of compression per tonne of vapour. In addition, in our Gørlev factory we are using a high efficiency turbine-driven compressor in order to reduce the live steam consumption by the turbine. Formerly, we used low efficiency steam jet compressors; such installations are relatively cheap but they require about three times as much live steam to compress a given amount of first vapour than does the turbocompressor — thus having a markedly adverse effect on the heat balance of the factory by comparison with a turbocompressor installation.

The importance of steam compression increases gradually as the vapour consumption of the different stations in the factory is reduced — which otherwise should be followed by an increased amount of vapour from

the fifth effect to the condenser to preserve a high thick juice Brix.

#### *Pan boiling station*

As previously mentioned, the pan boiling station has the greatest vapour consumption of any station in the whole factory. This is why the running of this station has a decisive influence on the heat economy of the factory.

All our pans at Gørlev are high-efficiency stirrer pans and we aim at a thick juice of about 74% Brix. We prefer Brix values up to 80° for the feed to the B- and C- strikes to restrict to a minimum the amount of water to be evaporated. In addition we are employing an advanced pan boiling technique to avoid the use of "movement water"<sup>1</sup> and to combat the formation of conglomerates<sup>2</sup>, so as to limit effectively the need for recrystallization, which in turn means decreasing steam consumption.

Towards the end of the strikes we lower systematically the steam pressure in the calandrias to make the best use of the latent heat of the massecuite, thus increasing the output of crystals and reducing the need for diluting the mother syrup with water after spinning of the massecuite.

The necessary venting vapour from the calandrias should be utilized for heating purposes, e.g. at the melters, before going to the condenser.

#### *Power consumption and boiler house*

Power consumption is an integral part of heat economy in a sugar factory. The lower the power consumption of the factory the better the possibilities of obtaining an overall low heat consumption. That is why we are aiming at high efficiency pumps, low throttling losses and elaborate mass transfer through the factory to avoid unnecessary energy consumption. As the factory should be self-supporting in electricity the most favourable boiler pressure is dependent on power consumption. With a power consumption of 18-19 kWh per tonne of beets, a boiler pressure of 40 bar is

sufficient for a well-designed sugar factory with waste water treating facilities, but without pulp drying. The higher the boiler pressure the higher the power consumption of the feed pumps and the more critical the feed-water quality. A well-designed evaporator station allows an exhaust pressure below 2 bar, giving an extra amount of electricity per tonne of live steam.

The efficiency of the boilers is also an integral part of heat economy. In spite of oil burning giving a higher efficiency than coal firing, we have rebuilt our boilers to 100% coal firing as coal is far cheaper than oil. The final heat economy of the factory must naturally be measured in terms of energy costs.

#### *Evaluation of heat economy*

The daily fuel consumption figures of the factory are insufficient for a detailed evaluation of the heat economy. That is why we started, 6 years ago, to construct a computer follow-up program to collect and analyse the key operating data of the factory. On this basis we can control and optimize, in respect of heat economy, operating conditions at the most decisive stations of the factory.

#### *Equipment for measurement, data collecting and computation*

Our first steps in making an automatic data-logging and computing system for heat economy started in 1977. At that time the microprocessor was only 5-6 years old and computer systems for data-logging and computing were still relatively expensive and complicated. That is why we decided to develop our own system in a simple way.

Most of the measurements of interest consist of temperatures and flows, and all the temperatures in question are measured by platinum resistance thermometers (Pt 100), and most of the flows are measured by computer flowmeters. The measurements are transmitted as 4-20 mA signals to a computer room.

In 1978 we developed an electronic system for data-logging and converting the analogue current signals to digital signals. This system was built in standard TTL (Transistor-Transistor-Logic) integrated circuits. These digital figures are transmitted to the heart of the system—a pocket calculator from Texas Instruments (TI programmable 59) whose program- and memory capacity is very good. It is possible to collect a reasonable number of input signals, do the necessary calculations and finally present the results in a clear way on a small Texas Instruments PC 100 printer connected to the calculator.

Our electronic data-logging system is able to handle 64 input signals. Depending on the complexity of the calculations the TI 59 calculator is able to handle about 30 input signals. We therefore connected two calculators to one data-logging system to achieve full capacity.

Programming of the calculators is simple and does not require knowledge of any program language. It is therefore easy to make changes in both the measuring and the calculation programs. Nevertheless it is possible to use advanced programming such as indirect addressing, conditional loops and subroutine calculations. In the DDS-Gørlev factory two of these systems have been working since 1978 and 1979. Figures 1 and 2 are photographs of these automatic data-logging and computing systems. Fig. 1 shows the cabinets containing the data-logging electronics (left) and the two TI-59 calculator cabinets (right), while Fig. 2 shows a view inside the two TI-59 calculator cabinets.

#### *Diffusion draft calculation*

The draft is one of the most important parameters dealing with diffusion control. Continuous information on the draft immediately shows if something is wrong in the diffusion process, e.g. a sudden reduction in the cossette supply to the

1 Jansdorf: *Proc. 17th Gen. Ass. CITS*, 1983, 396-398.

2 Møller: *I.S.J.*, 1983, 85, 163-165.

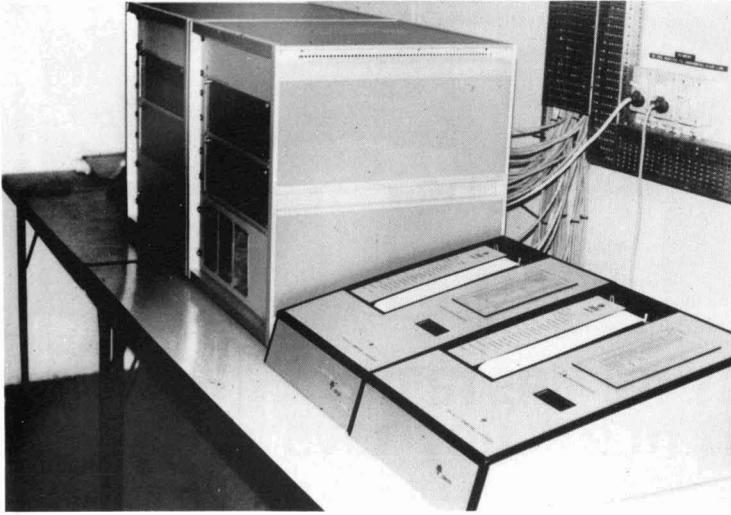


Fig. 1

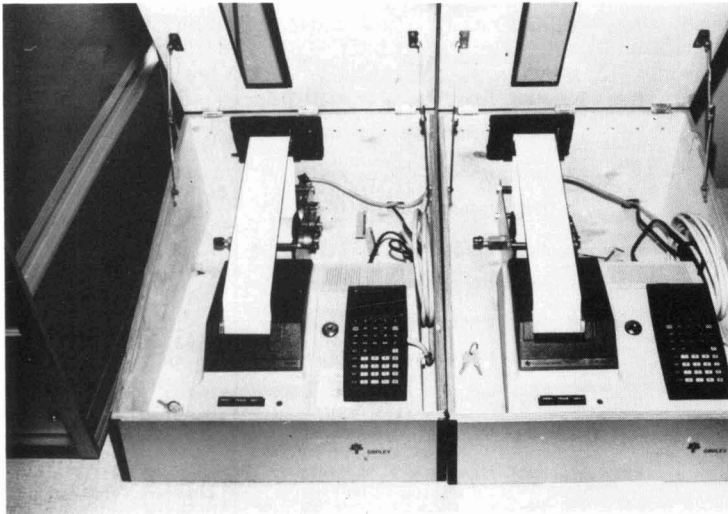


Fig. 2

diffuser will give an immediately increasing draft, and bad knives or absence of press water will also influence the draft.

The draft is usually calculated only once, or a few times, a day from the weight of cossettes and polarimeter analyses. However, with the DDS diffuser it is possible to determine the

draft in % on beets continuously from a heat balance. This balance is based on the temperature of the cossettes and raw juice and the working temperature in the diffuser. The heat capacity of the cossettes and the raw juice are determined in the laboratory, and they are dealt with as constants in the calculations. The computer system

collects the temperatures over a time interval of about five minutes and makes the calculations. The draft in % on beets is displayed to the operator. In addition the average is printed every hour. These draft calculations are very valuable to both the operator and the technical staff.

#### Heat transmission

From 1978 we have systematically calculated the heat transfer and the heat transmission coefficients for most of our heaters and all of the bodies in our evaporator station. The reference for all these calculations is the actual thin juice flow in terms of cossettes.

The transmission coefficients of the heaters are calculated from measured juice and vapour temperatures, measured limed raw or thin juice flow and, of course, the heating surface. The results from the computer system are printed as heat transfer in % on beets and transmission coefficient in  $\text{kcal. min}^{-1}.\text{°C}^{-1}.\text{m}^{-2}$ . These continuous calculations are very helpful in controlling and optimizing the venting from the juice heaters. Insufficient venting results in a low transmission coefficient; on the other hand, too much venting only increases the condenser losses. As to the heaters for limed raw juice it is possible to follow the fouling rates and optimize the cleaning frequency.

The heat transmission coefficients of the individual bodies of the evaporator station are calculated similarly to those of the heaters. The calculations are based on measurements of the condensate flow, the vapour temperature in the calandria and the juice temperature in the body.

These calculations are very useful because it is possible on a daily basis to follow the condition of every body throughout the campaign. In addition they are a very helpful tool in connexion with the reconstruction and adjustment of our evaporator station.

#### Calculation of main heat losses

One of the most important uses of

our computer system is provision of regular information on some of the main heat losses in the sugar factory. The following are the three main losses to be calculated by our computer: (a) heat loss to the condensers, (b) heat loss to the condensate, and (c) supply of vapour necessary for juice preheating.

The condenser loss is listed both as the total loss to the condensers and as the separate loss from the evaporator station. The total loss which includes both the pan boiling station and the evaporator station is calculated from the cooling water flow to the condensers and the temperature rise of this water. The condenser loss from the evaporator station is calculated by measuring the separate vapour flow from the fifth effect to the condenser.

The heat loss to the hot condensate is calculated as the heat remaining in the condensate after the regenerative heating in the heaters for limed raw juice.

We get an estimate of the net necessary supply for finishing the preheating of the juice by measurement of the thin juice flow, the juice temperature after the final regenerative heating of the limed raw juice with condensate and the temperature of all condensates flashed to fourth effect vapour. These three losses, i.e. condenser loss, condensate loss and net vapour supply to heaters, provide a very good estimate of the heat consumption in the sugar factory. Although they do not cover all heat losses these calculations have helped us in optimizing the evaporator station and reducing losses.

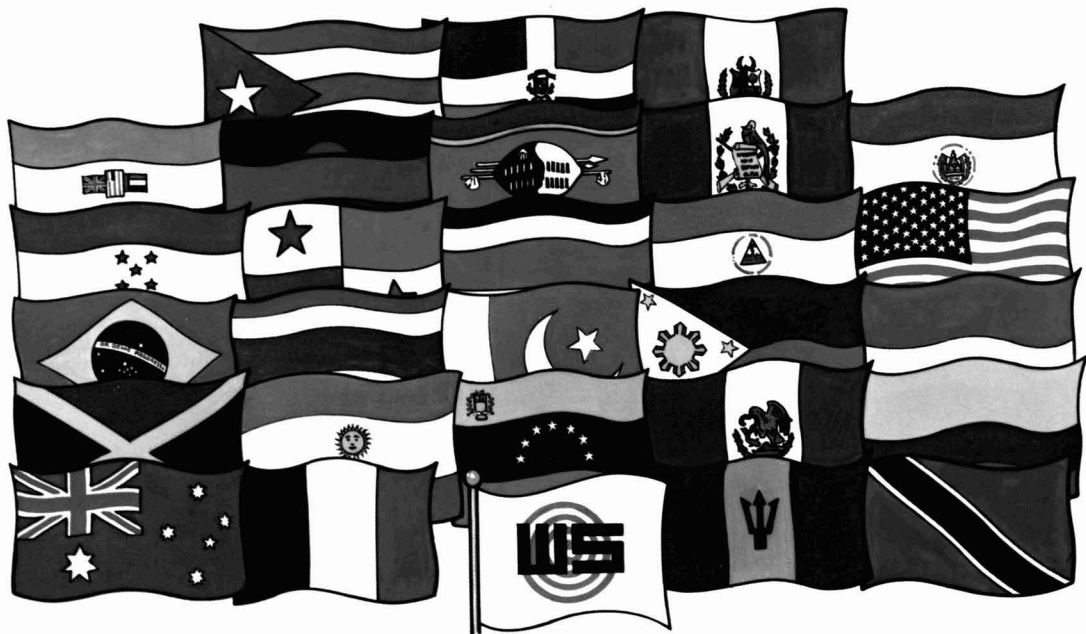
*Presentation of the computer results*

Since the development of our first computer system in 1978 our strategy has been to use modern techniques just to the extent that fits our goals.

The systems work in the following way. All input channels or points of measurement are read by the computer in turn and each value adds to the content of the memory location in

		5.	KAN.
		74.7	%
		4.	KAN.
		81.4	%
		3.	KAN.
		81.5	%
		2.	KAN.
		87.2	%
		1.	KAN.
		87.1	%
		- 2 NOV. 1983	
Clock.....		20.56	
Cosset supply t/h.....		281.4	
Turbocompr. vapor t/h.....		44.9	
Body 1A Heat transfer < % on beets.....		16.8	% PR
{kcal/min.....	387028.5		KCAL
Heat transmission coefficient...	92.0		
Body 1B Heat transfer < % on beets.....		17.1	% PR
{kcal/min.....	393357.3		KCAL
Heat transmission coefficient...	99.9		
Body 2A Heat transfer < % on beets.....		24.6	% PR
{kcal/min.....	571182.4		KCAL
Heat transmission coefficient...	86.1		
Body 2B Heat transfer < % on beets.....		11.4	% PR
{kcal/min.....	264890.2		KCAL
Heat transmission coefficient...	71.2		
Body 3A Heat transfer < % on beets.....		18.1	% PR
{kcal/min.....	424828.2		KCAL
Heat transmission coefficient...	53.9		
Body 3B Heat transfer < % on beets.....		10.2	% PR
{kcal/min.....	239027.8		KCAL
Heat transmission coefficient...	40.9		
Body 4 Heat transfer < % on beets.....		4.4	% PR
{kcal/min.....	104891.5		KCAL
Heat transmission coefficient...	24.7		
Body 5 Heat transfer < % on beets.....		1.1	% PR
{kcal/min.....	27406.8		KCAL
Heat transmission coefficient...	4.2		
Condenser losses total < kcal/min.....	257665.5		KCAL
% on beets.....	10.4		% PR
Condenser loss evaporation < kcal/min.....	21028.5		KCAL
% on beets.....	0.8		% PR
Thick juice Brix.....		73.7	BX

Figure 3. Print-out from the computer system shown in Figures 1 and 2 from Nov. 2, 1983. [% PR = kg vapour (530 kcal/kg) per 100 kg beets]



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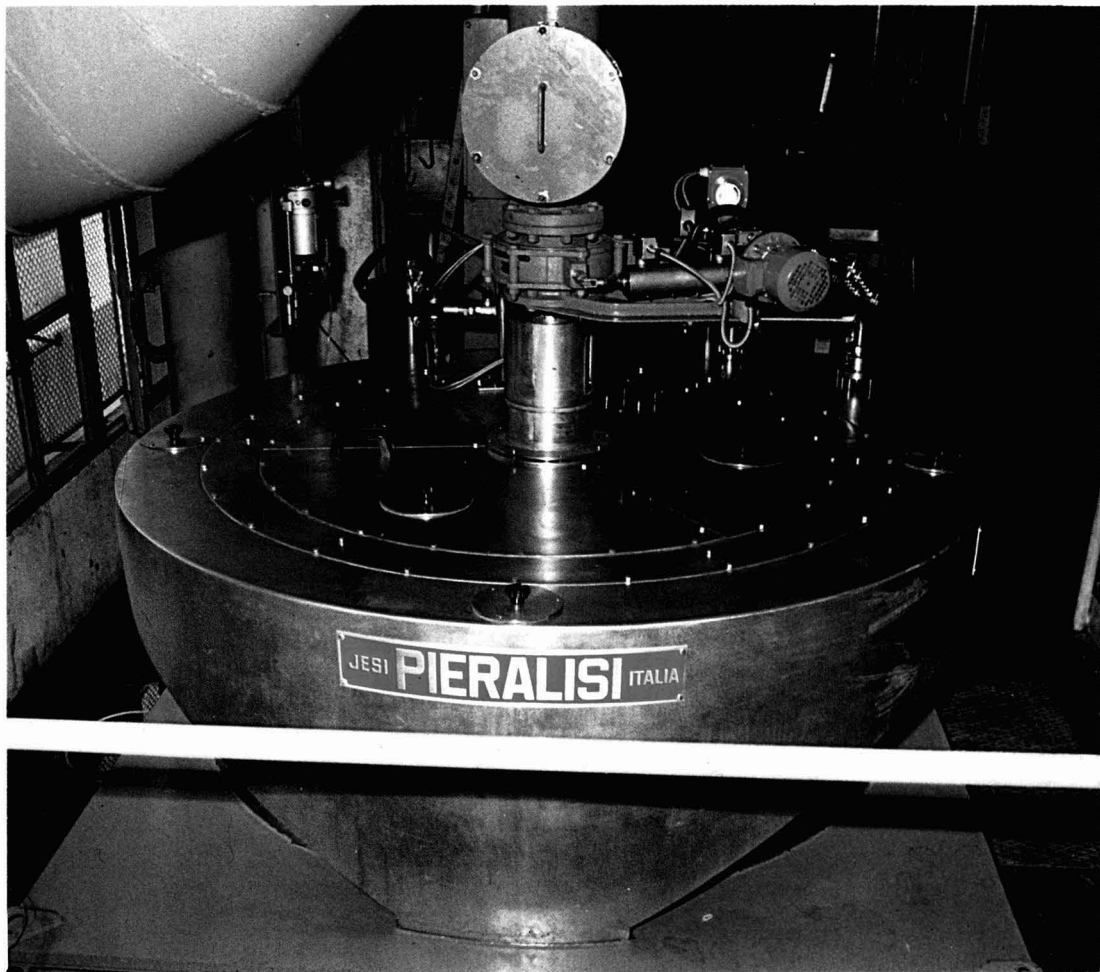
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# Cane sugar manufacture

## Characteristics of the generation, purchase and utilization of electrical energy at sugar and alcohol factories

A. P. Neto and I. de C. Macedo. *Boletim Tecnico Copersucar*, 1982, (19-82), 13-18, 28; through *S.I.A.*, 1984, 46, Abs. 84-583.

Data on processing rate (and variation), power consumption and generation, and economic aspects, are presented for 42 factories classified in five groups (up to 100, 100-200, 200-300, 300-500, 500 + tonnes of cane/hr). Charge factor (= average power demand/peak demand over a 15-minute period) was 0-10, 10-25, 25-50, 50-75 and 75-100%, respectively, for the groups; the lower the charge factor the higher the unit price of power consumed. The factories on average purchased 41% of their power; the degree of self-sufficiency could be greatly improved by better selection of boilers and turbogenerators, and introduction of variable-speed equipment.

## Separator for treatment of waters from wet scrubbers

C. E. V. Rossel. *Boletim Tecnico Copersucar*, 1983, (23-83), 28-31, 32; through *S.I.A.*, 1984, 46, Abs. 84-742.

A simple, cheap, compact system, developed by Copersucar to avoid air pollution, is described with diagrams and process parameters; its advantages are listed. Waste waters from treatment of boiler flue gases by wet scrubbers are sent to a separator where sand and ash settle, while incompletely burnt bagasse floats; both materials (totalling 2.2-3.6 kg/tonne of cane) are removed by conveyor belts to one hopper and periodically emptied into dump trucks, the liquid being recycled to the scrubber.

## Use of ultrafiltration and reverse osmosis for the purification and concentration of sugar solutions

P. Friedman, A. Fariñas and I. Alegret.

*CubaAzúcar*, 1983, (April-June), 18-28 (Spanish).

The two processes are explained and a summary given of some of the applications in the sugar industry which have been reported in the literature. An account is given of experiments with application of the methods to treatment of water and pure sugar solutions and to the purification of raw sugar solutions and industrial cane juices. The results, using two different membranes, are tabulated, and it is concluded that juices could be purified at 20-47 litres/m<sup>2</sup>/hr with pol losses between 5 and 15%, best results being given with juice at 70°C and higher than pH 7.0. Although initial capacity of a synthetic membrane, GR61P, was higher than that of cellulose acetate membrane 600, its capacity loss was greater. The capacity of the GR61P membrane at 30°C was half that at 70°C. Using cellulose acetate membrane 990, productivity was 11 litres/m<sup>2</sup>/hr at 15°Bx to 6 litres/m<sup>2</sup>/hr at 20°Bx using 40 bar pressure and 17 litres/m<sup>2</sup>/hr at 16°Bx to 9 litres/m<sup>2</sup>/hr at 23°Bx using 70 bar pressure.

## Studies of some variables which affect steam consumption in the evaporators and comparison of different evaporation schemes

L. Hernández C. *CubaAzúcar*, 1983, (April-June), 37-43 (Spanish).

A computer simulation program has been developed for calculations in respect of various evaporation systems and, with its aid, the author has studied the influence of a number of parameters including clarified juice temperature and Brix, syrup Brix, heating steam pressure, pressure distribution, number of effects and condensate auto-evaporation. The consequent steam consumption figures and losses to the condenser are compared. Juice temperature is the most important factor, a 1°C rise lowering steam consumption by 0.835%. Minimum steam consumption

was given by a quadruple pressure evaporator with bleeding from the first three vessels.

## Linear dynamic model for the boiling process in sugar pans

F. Herrera F., M. Rodríguez B. and M. E. Torres R. *Centro Azúcar*, 1983, 10, (1), 3-12 (Spanish).

A linear dynamic model of the boiling process in sugar industry vacuum pans is presented, based on a state model with four state variables defined by the characteristics of the boiling process. The original state model is non-linear but, by using the classical methods of linearization, the equations for the calculation of the matrices in the linear dynamic model are derived. The calculated matrices are presented for a particular vacuum pan, and it is shown that these depend on the variables of state of the process in one case and on time for the other. It is shown to be possible to derive time-variant analytical equations for all matrices. A brief analysis is presented of the effect of supersaturation on the model.

## Application of thermodynamic methods to the analysis of efficiency of industrial thermal plants

J. Castellanos A. and J. C. Campos A. *Centro Azúcar*, 1983, 10, (1), 45-56 (Spanish).

The practical application of thermodynamic methods used in the analysis of irreversible cycles in an industry permit great convenience and speed of detection of technical, operational or constructional deficiencies in each equipment and of the installation as a whole, with the object of increasing its efficiency and the consequent saving of fuel or raw material used in the production process. The paper presents the application of the methodology developed for the exergetic analysis of industrial thermal plants and the results obtained in a modern sugar factory and a fertilizer plant.

# Beet sugar manufacture

## Examination of heat transfer in a combined system of sugar solution evaporation in a falling film

V. N. Gorokh and A. I. Sagan'. *Sakhar. Prom.*, 1984, (4), 36-39 (*Russian*).

Investigation of the process taking place in an experimental falling-film evaporator, where counter-current conditions occurred in the upper part of the tube and co-current in the lower section, is reported. Results for 40° and 60° Bx sugar solutions indicated the advantage of the system in providing increased heat transfer by comparison with conventional natural-circulation evaporators as well as evenly distributing the liquid to the tubes.

## The packaging plant at Hajdusag sugar factory

F. Gal. *Cukoripar*, 1984, 37, 35-39 (*Hungarian*).

Details and illustrations are given of the Chambon tableting press and wrapping plant at Hajdusag. Experience over three years has shown that the moulding press and sugar preparation equipment have operated satisfactorily, with the press still in excellent condition, but problems have arisen with the wrapping line, with frequent stoppages and the need for numerous adjustments.

## Changes in the content of some organic non-sugars in sugar juices during the campaign

K. Szwajcowska. *Gaz. Cukr.*, 1983, 91, 265-269 (*Polish*).

Raw juice, thick juice and molasses samples obtained at Dobrzelin sugar factory were analysed for organic colloids (precipitated with alcohol), galacturonic acid, laevan and dextran. The data, as well as Brix, sugar content, purity and invert content, are tabulated for each 10-day period in October, November and December 1979 (with the exception of the second 10-day period in November). The results are discussed and the pattern of change in total non-sugars

indicated by time curves, showing a general increase up to the second period in December, after which there was a fall in colloids in all three products and a fall in laevan and dextran in thick juice but a rise in these non-sugars in raw juice and molasses.

## The juice purification scheme in Wielkopole sugar factories

G. Kowalska. *Gaz. Cukr.*, 1983, 91, 269-270 (*Polish*).

Among modifications made to process stations at sugar factories in the western province of Wielkopole are the installation of buffer tanks after the diffuser to ensure constant juice feed to preliming, and raising of the preliming tank to allow gravity flow of juice to cold liming. The juice purification scheme is identical in all the factories. Although cold liming is based on the DDS system, the Polish factories have not favoured the idea of restricted lime usage but subscribe to the view that it is better to use as much lime as is technologically practical. After cold liming, the juice is heated and subjected to hot liming. Various aspects of juice purification are discussed, including the effects of fluctuation in juice parameters and flow rates, optimum 1st carbonatation and the benefits of the various changes in processing and equipment.

## New system for preventing DC diffuser failures

A. Gronkiewicz. *Gaz. Cukr.*, 1983, 91, 280-282 (*Polish*).

The balanced protective system which is standard on all DC continuous twin-scroll diffusers made in Poland (under licence from DDS) does not always work or suffers from a time lag, resulting in buckling of components in the event of non-synchronization of the scrolls, with consequent long downtime periods and substantial monetary losses. Details are given of a mechanical device coupled to each end of the scroll shafts which permits non-synchronization only within certain

limits; should these limits be exceeded, a circuit breaker is actuated and the drive motors stop. The system, which has been tested over a number of years, is the subject of a patent application.

## Open day (March 27, 1984) on bioconversion of methane from effluent at Thumeries sugar factory

Anon. *Sucr. Franç.*, 1984, 125, 177-179 (*French*).

Further details are given of the waste water fermentation plant at Thumeries<sup>1</sup>. The 12-m diameter cylindrical steel digester has a total volume of 1400 m<sup>3</sup> and contains 1100 m<sup>3</sup> of Flocor R supported on a grid; a 10-cm layer of glass wool protected by a metal facing provides heat insulation. Waste water passes down the digester via distribution pipes, while a centrifugal pump is used for recirculation. The methane feeds a boiler producing 3 tonnes of steam per hour at 15 bar. Power input is rated at 60.5 kW, although the actual value has been measured at 44 kW, representing 65,000 kWh consumed during the 63 days of the 1983/84 campaign, when 73,000 m<sup>3</sup> of methane was produced. Link-up with the steam circuit was possible for only the last 18 days of the campaign, during which time 340 tonnes of steam were generated, plus 1000 tonnes produced during the 35 days of the thick juice processing period in February/March. However, it is expected to achieve the nominal 2.5-3.0 tonnes/hr steam generating capacity in the next campaign. COD of the effluent was reduced by 90%.

## Raw juice treatment by warm pre-carbonatation

P. V. Moroz *et al.* *Sakhar. Prom.*, 1984, (5), 15-18 (*Russian*).

In trials at Ivanichevskii sugar factory, raw juice heated to 55-60°C was subjected to "instant" preliming at pH<sub>20</sub> 8.5-9.0 with a mixture of

<sup>1</sup> See also Lescure & Delannoy: *I.S.J.*, 1984, 86, 50A.

unfiltered 1st carbonatation juice and sweet-water from the disc filters in the juice line leading to a circulation tank in which the juice was mixed with recycle juice from the pre-carbonatation vessel (300-500% on raw juice). After addition of 40-60% of the total milk-of-lime, the juice was pre-carbonated at 55-60°C to pH<sub>20</sub> 11.2-11.8; 20-30% milk-of-lime was then added together with 5-10% (on beet) of mud from the 1st carbonatation juice settlers. Warm liming for 10-12 minutes was followed by heating of the juice to 87-90°C and liming for a further 10-14 minutes, followed by settling, check filtration and heating to 95°C for 4 minutes' treatment with the rest of the lime before 2nd carbonatation. Comparison with the system currently in use (hot pre- and main liming, 1st carbonatation and liming before 2nd carbonatation) showed that the trial scheme substantially reduced the colour content of 2nd carbonatation and thick juice and of subsequent products, increased the settling rate by up to 200% and reduced the mud volume by up to 26%.

#### Activation of 2nd carbonatation mud

K. P. Zakharov *et al.* *Sakhar. Prom.*, 1984, (5), 22-25 (*Russian*).

Tests are reported in which 2nd carbonatation mud was treated with the same amount of lime as used in preliming to which it was then recycled. By comparison with the results given by recycling untreated 2nd carbonatation mud, this form of activation gave lower colour and lime salts in 2nd carbonatation and thick juice while the filtration coefficients of 1st carbonatation were about the same. Adding the activated mud to raw juice before preliming adversely affected the 1st carbonatation juice filtration coefficient by comparison with addition to preliming, although 2nd carbonatation and thick juices had similar properties. Further tests showed

that activation of recycled 2nd carbonatation mud was inadvisable in the case of raw juice containing greater quantities of reducing matter and colloids than normal, since under these circumstances 1st carbonatation filtration coefficients and the colour of 2nd carbonatation and thick juices were higher.

#### Water utilization at Slutsk sugar combine

N. I. Yakimenko, S. A. Brenman, S. S. Guseva, V. Z. Nakhodkina and O. I. Dapiro. *Sakhar. Prom.*, 1984, (5), 25-27 (*Russian*).

Details are given of process water utilization and treatment at Slutsk sugar factory which also refines beet sugar during the campaign and cane raws in the post-campaign period. Fresh water pumped direct from artesian wells is used as well as artesian water that is fed to a holding tank at the start of the campaign—this tank also receives condenser water and cooling water from the sublimators of the sulphur burners. None of the input water is chemically treated, but the key item in initial heat treatment is a pre-condenser receiving pan vapour. The physico-chemical and microbial properties of the artesian and tank water are tabulated. The tank water has been a source of problems in the form of scale formation and bacterial slime, which has created difficulties in refinery syrup filtration; the problems are aggravated by the mixing of the two forms of water in the pre-condenser. Some advice is offered.

#### Optimum raw juice draft

V. V. Maiorov and A. R. Sapronov. *Sakhar. Prom.*, 1984, (5), 27-30 (*Russian*).

A computer program is described which has been written for calculation of the heat scheme of a sugar factory and from which it is possible, for a given processing system and economic situation, to determine the optimum raw juice draft where press-water is

recycled. It is shown how the optimum falls with reduction in pulp sugar or with rise in fuel costs, and rises with increase in the sugar production costs.

#### Modernization of the heat economy of a sugar factory

W. Lekawski and K. Urbaniec. *Gaz. Cukr.*, 1984, 92, 1-5 (*Polish*).

After a brief survey of fuel consumption in the sugar industries of various countries and a discussion of how to achieve optimum results, the authors examine possible ways of reducing energy consumption in Polish sugar factories. Specific sources of heat input and output throughout the factory are analysed, and heat balances are given for a factory operating conventionally and after a number of improvements are made, whereby steam consumption in the evaporator is reduced from 40% to 27.5% on beet. This is made possible by: increasing the CO<sub>2</sub> content of carbonatation gas from 32% to 36% and raising its utilization factor as well as lowering the juice temperature in 1st and 2nd carbonatation; using a quintuple-effect evaporator with 1st effect vapour compression to raise thick juice Brix to 70° instead of 65°; double washing the sugar in the centrifugals; using indirect heating of run-offs; making use of pan vapour to heat raw juice (by indirect means) and predefecation juice (by direct contact); and using condenser water to heat and moisten carbonatation gas, to heat the air used for sugar drying, to heat centrifugal wash water and pre-heat raw juice.

#### Tests on the use of Polish synthetic flocculants in rapid settlers

F. Nowak and S. Zarzycki. *Gaz. Cukr.*, 1984, 92, 7 (*Polish*).

While TF-1, an acrylic polymer of Polish manufacture, failed to have any positive effect by comparison with Magnafloc LT-25 even when used at much greater concentrations than the other flocculant, W-100 gave a clear overflow and a reduction in mud

density from 24 to 19°Bé, although at a greater quantity than Magnafloc LT-25, and should be tested further. The trials were conducted at three sugar factories.

### Computers in sugar factories—the current situation and prospects

T. Kalitynski. *Gaz. Cukr.*, 1984, 92, 8-11 (Polish).

The three major task areas in which computers are applied within a sugar factory are described: process parameter control and preparation of material balances, provision of measured data for e.g. the central control room and factory laboratory, and on-line process control. Experience over the 8-year period 1976/84 at Lublin and Krasnystaw sugar factories is used to illustrate how the systems operate, problems encountered, results achieved and possible means of improving performances.

### The process automation project at Zeil sugar factory

H. E. Uecker and H. Kemter. *Zuckerind.*, 1984, 109, 433-440 (German).

Details are given of the Fischer & Porter DCI-4000 digital distributed control system, the first stage of which was installed in Zeil sugar factory in 1983, while the second stage (to complete the project) was planned for 1984. The system has a 3-level hierarchy, with DCU's (Direct Control Units) as the key units located at the lowest level; each DCU is linked to a local operator's panel and to a back-up station for manual or automatic control. The data highway from this level leads to central operator's panels (COP's) on the second level, which carry out centralized control and data processing, recording, etc. as well as triggering alarms. The COP's are also linked via the data highway to the store and forward terminal (SFT) at the top level; this acts as a transcriber,

passing requests from the supervisory computer at the very top of the tree to the data highway system and transferring the required data to the computer. A SFT is also able to act as link between a highway system produced by one company and a supervisory computer or DCI (Distributed Control Instruments) system of different manufacture. The task of the supervisory computer is process optimization, calculation of target values for the DCU's, establishment of product and energy balances and overall process control. Experience in the first campaign has shown that the system operates smoothly, with need only for monitoring of processes via the viewing screens and alarm panels.

### Influence of stirrers on heat transfer during the boiling process

K. E. Austmeyer. *Paper presented to 27th Tech. Conf. British Sugar plc*, 1984, 31 pp.

Analysis of heat transfer during pan boiling shows that three resistances arise, whereby the temperature of the steam is first reduced within the condensate film, then within the wall of the tube and finally on the inside of the tube over which the massecuite and vapour bubbles flow. The last resistance becomes increasingly dominant during the boiling process, so that finally the heat transfer coefficient inside the tube ( $\alpha_i$ ) approximates to the overall heat transfer coefficient ( $k$ ). However, because of considerable changes to the flow behaviour of the massecuite and differences associated with mechanical circulation, it is apparently impossible to provide a definition of  $\alpha_i$  that is constant. Mathematical analysis of the Brixing-up stage, in which there is distinct ebullition, showed that heat transfer in fluids undergoing considerable superheating at the heating surface can only be defined by an equation such as that of Forster & Zuber<sup>1</sup> applicable to temporary change in bubble size as

a function of superheating or undercooling. Comparison of results obtained by the author with experimental values obtained by Forster & Zuber show that both sets are definable by straight lines, for which the Forster & Zuber equation takes the form:  $Nu = 0.0015 Re^{0.62} Pr^{0.3}$ , while the author's values are defined by  $Nu = 0.0011 Re^{0.62} Pr^{0.3}$ , where  $Nu$  = Nusselt number,  $Re$  = Reynold's number and  $Pr$  = Prandtl number. The lower position of the author's line is ascribed to the fact that heat flux density considered in the Nusselt number refers to the total tube height, including the reheating stage. During the first stage of boiling, when the temperature gradient is normally high, a massecuite stirrer cannot increase the heat transfer but has a primary role of transmitting shearing forces to the massecuite. Types of stirrer used in pans in West Germany are described, and the power consumption of stirrers discussed. Equations are presented for calculation of a heat balance for the boiling process and investigations of the effect on the apparent overall heat transfer coefficient  $k^*$  of Brix, stirrer speed and massecuite level are reported. Continuous low-grade boiling at Lage is described, and white sugar boiling in stirred pans discussed. Brief mention is made of the vertical multi-stage pan built by BMA and installed at Wabern.

### The KD2-A30 tower diffuser

D. S. Nosov, V. I. Tatarinov, V. I. Potekhin and V. A. Boldyrev. *Sakhar. Prom.*, 1984, (6), 49-51 (Russian).

The construction and operation of the KD2-A30 tower diffuser, a modification of the KDA-30-66, are described and tests on a 3000 tonnes/day model reported in which losses in pulp pressed to 14-16% dry solids totalled 0.34% on beet at a juice draft of 118%.

<sup>1</sup> *J. Appl. Phys.*, 1954, 25, 474.

# Sugar refining

## Decolorization of sugar liquors by use of fixed-bed columns of granular carbon

O. Jimenez C. and M. Navarro. *ATAC*, 1982, 41, (6), 22-27 (Spanish).

An account is given of the installation of fixed-bed columns of granular carbon for liquor decolorization at the Manuel Martinez Prieto sugar factory refinery section. The plant has shown a fundamental flaw in that the liquor applied contains insoluble material which forms a deposit on the top of the bed, reducing its efficiency and also requiring considerable amount of wash water. Attention is required to the possibility of pH fall owing to removal of MgO from the carbon (and the consequent possibility of inversion on a column if it has been in use for a long time).

## Management philosophy at Savannah sugar refinery

G. Fawcett. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 10 pp.

A general account is presented of operations at Savannah and Everglades refineries, with emphasis on the tasks of individual employees and mention of specific equipment changes.

## Some incentives for improving raw sugar quality

J. B. Alexander and A. B. Ravnö. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 10 pp.

Details are given of the new method of payment for raw sugar supplied at the Durban refinery of Tongaat-Hulett Sugar Ltd. which is based on a standard pol of 99.3° with a premium or penalty of 1.875% per degree above or below the standard, respectively. This compares with a previous pol premium of 1.375%. Justification for the new value is explained by comparing the refined sugar yields from raw sugar of 98.4° and 99.4°; comparison is also made between the South African system and the modified

system introduced at Savannah refinery in the USA. Details are given of the standards and penalties for raw sugar supplied to the terminal in Durban. Bonuses are paid where the starch content is below 100 ppm and the colour content below 1000 ICUMSA units, while a starch content of >150 ppm and a colour of >1300 units incur penalties. Moisture has been excluded as a criterion for payment since no cases have occurred of deterioration of VHP sugar in storage, while grain size has also been omitted since the refinery does not need to affine VHP sugar; the major effect of ash is to increase molasses losses, which are already covered by the pol premium system, while dextran has not proved a problem in South Africa; the most important polysaccharide is starch. Factories supplying raw sugar to the refinery have welcomed the new scheme.

## Adsorbent decolorizing systems -- resins

D. S. Martin. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 4 pp.

The decolorizing system involving treatment with acrylic resin followed by bone char and then styrene-based resin used at Westburn refinery was described earlier<sup>1</sup>. In the meantime, the resin plant has been expanded to permit treatment at all times and multiple treatment with either type of resin. Typical performance of the system during 1983 is indicated. The colour of the melt liquor from 97.7 pol raw sugar was reduced from 1000/1200 units to 600/800 by defecation and filtration, after which double treatment with acrylic resin reduced it by 70% (falling to 50% after 185 cycles). The liquor off-char had a colour content of 90/120 units which was reduced by 40-55% to 65 units by double treatment with styrene resin. Comparison of the costs of treating 150,000 tonnes of melt per year with bone char alone (at 12% on melt) with the system using only 3% char plus resin shows that, in terms of materials, energy and losses, the new system is some 40% cheaper (labour and maintenance costs not being considered). The major

saving is in energy, the costs of which are less than one-third those of the conventional char system.

## Energy conservation—use the second law first

C. C. Chou. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 16 pp.

Thermal efficiency based on the first law of thermodynamics is the ratio of useful work output to the total energy input; applied to any individual process in a cycle, the law simply states that energy flowing into a fluid minus that discharged must equal the increase in the total energy of the fluid. However, while all of a quantity of work energy can be converted into heat energy, the converse is not true; according to the second law of thermodynamics (which concerns potential energy, the quality and availability of energy and its flowability), the usefulness of any given energy is variable and depletion of the energy starts as soon as it is released in a combustion process. Thus, efficiency as measured by the first law is considered misleading and erroneous, whereas analysis based on the second law shows that, for the sake of energy saving, it is desirable to make full use of potential energy and maintain available energy. In the case of a multiple-effect evaporator, the second-law efficiency will increase with the evaporation rate in the 1st effect, provided the Brix of the liquor leaving the last effect is not restricted by the saturation limitation at a given operating temperature. While increasing the steam temperature will increase evaporation, there are limiting factors, and it is more practical to improve the heat transfer coefficient ( $U$ ). However, tube fouling by scale or oil film can greatly reduce the coefficient. Calculations of  $U$  based on three different assumptions show values that are well below the expected value; in a refinery, a low value may be due to the limit imposed on evaporation

1 Martin et al.: *I.S.J.*, 1982, 84, 331-333.



when the Brix of the liquor leaving the 4th effect exceeds the saturation point at a given temperature. However, a number of modifications to the evaporation process are examined whereby the thermal efficiency could be raised. Schemes are also described in which potential energy is re-utilized.

#### Energy savings at the Tirlmont refinery

M. Braeckman. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 19 pp.

The energy-saving aspects of the new sugar house scheme at Tirlmont in Belgium are described<sup>1</sup>. A maximum use is made of pan vapour (1) to heat all incoming product to approx. 60°C in plate-and-frame heat exchangers, and (2) to concentrate syrup of inadequate Brix (e.g. after decolorization with resin) to 73°Bx in falling-film evaporators recovered from old installations. Heat recovered from vertical crystallizers is available at a daily total of approx. 29 million kcal for boiler feedwater heating. The quantity of syrup in circulation is minimized by maintaining low levels in tanks, the size of which is reduced as a result of a high degree of automation, so that heat losses and sugar inversion are decreased. Tight control of the saturation of syrup passing to the mingler for magma preparation prevents dissolving of crystals; use of 1st run-off or green syrup from the previous crop for mingling ensures a saturated liquor and further crystallization rather than dissolution. The important role played by computers in process control, monitoring, reporting and data acquisition and processing is discussed.

#### Adsorbent decolorizing systems — bone char

L. G. Sansaricq. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 10 pp.

The author discusses the advantages and

disadvantages of bone char on the basis of experience at refineries of Amstar Corporation where it is the main decolorizing agent. The technical advantages include its ability to provide adequate decolorization to meet normal market requirements provided the raw sugar is of suitable quality (but its decolorizing capacity is too low for treatment of sub-standard raws); its excellent ash removal properties (most other adsorbents require a supplementary de-ashing system); its good buffering capacity (so that little or no pH control is necessary in order to minimize sucrose losses in treated material) and lack of major environmental problems in regard to dust and effluent. Economic advantages include relatively low make-up costs of new char (because of the hard structure and hence low attrition rate of char); lower unit costs of new char by comparison with most available alternatives; and reduced costs and amounts of steam required to evaporate the smaller quantities of sweet-water than with comparable adsorbents. Apart from problems involving low-quality raws, major disadvantages of bone char include the high energy consumption in regeneration, high maintenance costs of the equipment; the considerable space occupied by the filtration cisterns, regeneration equipment and conveyors; and its unsuitability for use where customer requirements are strict with regard to trace elements in special products.

#### Some questions regarding evaluation of raw sugar processing efficiency

Yu. D. Golovnyak, L. G. Belostotskii, S. A. Brenman and T. Ts. Mishchuk. *Sakhar. Prom.*, 1984, (5), 20-22 (*Russian*).

The question of cane raw sugar quality and its effect on the performance of Soviet factory-refineries is briefly discussed, and the mathematics of evaluating performance in terms of sugar yield, process losses and molasses sugar examined. It is suggested that a fairer assessment of factory performance is given by relating yield

to raw sugar pol rather than by subtracting total losses from pol input, and comparison of the efficiencies of two factories processing sugar of different pol is demonstrated on this basis. Other formulae given concern calculation of molasses quantity (allowing for purity rise of liquor by carbonation), and of the sugar:non-sugars ratio.

#### Affination using two continuous centrifugals in series

Anon. *Ann. Rpt. Sugar Milling Research Inst.* (Natal), 1983-1984, 11.

A two-stage curing system was tested in an attempt to reduce the purity rise across a continuous machine resulting from heavy washing of *A*-massecuite to yield a very high pol sugar; it consisted of two identical continuous centrifugals operating at 900 rpm, the first machine processing the massecuite without washing to give a sugar of about 98 purity which was then made into a magma with refinery returns; this was then fed to the second machine for washing to produce a sugar of about 99.4 pol which was then remelted for refining. Because of the use of an outside sugar stream in the form of refinery returns for affination, the normal exhaustion calculation to assess process efficiency was not suitable, and the results of the experiments had to be compared on the basis of an efficiency factor defined as:

$$\text{efficiency} = \frac{\text{weight of pol in affined sugar to refinery}}{\text{weight of pol in feed to system}} \times 100.$$

For the same final (affined) sugar purity, the double-curing system had a lower efficiency than the one-stage system, partly because of the large proportion (50-60%) of fines in the feed to the after-curer, partly as a result of crystal breakage in the fore-curer and perhaps partly because of non-optimum operating conditions in the factory during the tests. A further set of tests was planned for the next season.

<sup>1</sup> See also Braeckman: *I.S.J.*, 1984, 86, 54.

# Laboratory studies

## Determination of the residual quantity of polymers in sugar solutions

I. A. Oleinik, E. N. Shirokikh, I. G. Bazhal, G. V. Lantukh and N. V. Golovko. *Sakhar. Prom.*, 1984, (4), 48-52 (Russian).

Determinations were made of the residual amounts of K-4 and K-9 polymers (produced by hydrolysis of polyacrylonitrile) and of a non-ionic polyoxyethylene (POE) polymer in unfiltered 1st carbonatation juice and a model juice made up with 15% sucrose after treatment with the flocculants. Results showed that 2.5% CaCO<sub>3</sub> suspension added to the juices after treatment adsorbed 94-98.6% of the K-4, 90-93.7% of the K-9 but only 64.50-70.25% of the POE flocculant. The interferometric method used for the K-4 and K-9 flocculants was accurate to within  $\pm 0.005 \text{ g/dm}^3$ , while a spectrophotometric method for the POE was accurate to within  $\pm 0.0005 \text{ g/dm}^3$ ; the methods, recommended for normal use, are described in detail.

## Butyl esterification for determination of organic acids in sugars

S. Saito, T. Miki, H. Ito and M. Kamoda. *Nippon Nogei Kagaku Kaishi*, 1983, 57, (2), 147-149; through *Anal. Abs.*, 1984, 46, Abs. 4F18.

A simplification is described of the butyl esterification procedure<sup>1</sup>. A 2-ml portion of aqueous solution containing 1 ml/litre or 1 g/litre of each of 14 acids (propionic, butyric, isovaleric, valeric, lactic, glycollic, laevulinic, oxalic, malonic, fumaric, succinic, malic, aconitic and citric) was neutralized with IM NaOH and the solution was evaporated to dryness at 40°C under reduced pressure. The residue was treated with 0.7 g of Amberlite CG-120 resin (H<sup>+</sup> form, 200-300 mesh), 5 ml of butanol containing 10  $\mu\text{l/ml}$  of tetradecane (internal standard) and 2 g of Na<sub>2</sub>SO<sub>4</sub>, and the mixture was heated

under reflux at 135-140°C for 2 hr and then cooled; hexane (3-5 ml) was added, and the mixture was filtered. For GLC, a column (2 m  $\times$  3 mm) packed with 2% of OV-17-1% of Reoplex 400 on Gas-Chrom Q (80-100 mesh) with temperature programming at 5°C/min from 55° to 215°C, or packed with 2% of OV-227 on Gas-Chrom Q with temperature programming at 3°C/min from 55° to 210°C, was used, with N (30 ml/min) as carrier gas and a flame ionization detector. Best separation was attained on the second column.

## Non-sucrose components of cane sugar and efficiency of press filtration

J. A. Devereux and M. A. Clarke. *Paper presented at 43rd Ann. Meeting Sugar Ind. Technologists*, 1984, 21 pp. As a contribution to investigations of reasons for poor press-filter performances in refineries, an attempt was made to determine the chemical nature of filtration-impeding substances in raw sugars as well as relevant physical properties. Correlation coefficients were obtained for soluble and insoluble non-sugar components of six washed raw sugars. Of the soluble solids, dextrans were the main contributor to filtration impedance ( $r=0.72$ ); low M.W. dextrans played a lesser role than high M.W. dextrans, but still had a significant effect. The correlation between dextrans and filtrability was higher than that for total soluble polysaccharides, as represented by starch ( $r=0.42$ ); although known to be a major filtration inhibitor, starch was not gelatinized at the temperature used in the study. Amino-N compounds (proteins) also had a negative effect on filtration ( $r=0.61$ ). In the insoluble solids fraction, 75-90% was hydrolysed by acid; analysis of the hydrolysate revealed primarily polysaccharides: dextrans, starch, indigenous sugar cane polysaccharide and bagasse polysaccharide. Non-hydrolysable

material was thought to be field soil. The mean particle diameter was found to be 3.2-3.6  $\mu\text{m}$ , with the major particulate fraction (including some starch granules) being  $<10 \mu\text{m}$ . Viscosity was not a major filtration-impeding parameter under the room temperature conditions of the study.

## New measurements of melasigenic coefficients

P. Devillers, R. Detavernier and J. Roger. *Sucr. Franç.*, 1984, 125, 181-192 (French). See *I.S.J.*, 1984, 86, 23.

## Particle size analyser benefits factory and farm

R. A. Johnson. *BSES Bull.*, 1984, (6), 22-23.

After explaining the basic layout of a HIAC PA-720 particle size analyser and how the instrument is used, the author indicates specific applications, including soil classification, seed sugar preparation for pan boiling, assessment of the effectiveness of modifications to a centrifugal to reduce crystal breakage, and analysis of particulate matter in boiler flue gases.

## Use of infra-red spectroscopy to check the processes in sugar solution treatment by adsorbents

G. A. Chikin, V. F. Selemenev, V. A. Uglyanskaya and A. R. Saponov. *Sakhar. Prom.*, 1984, (5), 31-34 (Russian).

The value of infra-red spectroscopy as a method for determining optimum use and condition of decolorizing resins is discussed, and details are given of a procedure for preparation of resin samples and of samples of colorants extracted from resin. The resin sample was dried at 40-50°C to constant weight, ground to a powder in a mortar and pressed together with optically pure potassium bromide (1:100) to form a tablet. For

1 Yamashita et al.: *Anal. Abs.*, 1975, 28, Abs. 2F6.

preparation of colorant samples, the colorants were desorbed by water or alcohol after 8 hours' contact with the resin at 20, 60 or 80°C, after which 1 litre of the extract was evaporated to constant weight and then pressed into a tablet or prepared as a suspension in petroleum jelly. The IR spectra were determined over the range 4000-600/cm. Details are given of the nature of the colorants found and of their interaction with resins, and of the changes effected in resin by the decolorizing process.

#### Evaluation of beet damage by grabs and the consequent chemical and enzymatic implications for storage in clamps

G. Baraldi, M. Bentini, P. Spettoli, G. Vaccari, M. G. Marzola and G. Sgualdino. *Ind. Sacc. Ital.*, 1984, 77, 47-54 (Italian).

Investigations were conducted on the effect of damage to beets during harvesting and piling by grabs on the changes in their chemical composition during storage in clamps for up to 6 days. There was a general trend for pol to fall with increased mechanical damage and with storage time, where comparison was made between undamaged beet, those damaged only during harvesting and those damaged during harvesting and by the grabs. Simultaneously there was a general increase in raffinose and reducing sugars (% on pol). There were marked differences in the specific activities of invertase (both acid and neutral) and of sucrose synthetase with degree of damage and storage, whereas differences in the activities of esterase, acid phosphatase, glutamic dehydrogenase and peroxidase as a function of degree of damage and storage time were only slight.

#### Colorimetric determination of invert in white sugar

H. Gruszecka. *Gaz. Cukr.*, 1984, 92, 5-7 (Polish).

A colorimetric method based on use of

Müller's solution is described. The intensity of the dark blue colour formed by the reaction between the potassium sodium tartrate and  $\text{Cu}(\text{OH})_2$  is decreased by the precipitation of  $\text{Cu}_2\text{O}$  in the presence of reducing sugars; after removal of the precipitate by centrifuging for 3 minutes at 5000 rpm, the colour is measured at 680 nm. A calibration table showing values of light absorbance at this wavelength was prepared for solutions containing between 0 and 35 mg/100  $\text{cm}^3$  glucose or fructose. The effect of a constant 10 g sucrose/100  $\text{cm}^3$  on the values is also indicated. While comparison between values given by the new method and the Berlin Institute method<sup>1</sup> first showed considerable differences over a wide range of values, further tests showed closer agreement. Solutions were prepared containing 0-15 mg added glucose/100  $\text{cm}^3$  and 10 g analytical grade sucrose of 3.5 mg invert content. The colorimetric method proved more accurate than the Berlin Institute method up to 7 mg added glucose, after which the Berlin Institute method was the more accurate; however, it is pointed out that the lower values are the ones more commonly encountered. It is suggested that the effect of sucrose or its degradation products on the iodine used for titration is the cause of error in the Berlin Institute method. The colorimetric method has the advantage of rapidity without the need for the reagents, glassware and titration in the Berlin Institute method.

#### Automatic determination of purity in sugar factories

W. Uhlenbrock. *Paper presented to 27th Tech. Conf. British Sugar plc*, 1984, 20 pp.

After explaining the relationships between conductivity and concentration, purity and conductivity and between conductivity and temperature, the author briefly describes the preliminary work that led to the development of a purity meter

and gives details of the instrument, which is intended for use by unskilled personnel without recourse to the laboratory. The unit contains a reservoir carrying a small amount of tap water into which the juice or syrup sample is poured and mixed using a magnetic stirrer. A computer is switched on, and controlled addition of water started; the conductivity is continuously measured simultaneously with the temperature. Signals from the conductivity cell are fed via the conductimeter to the computer, which indicates the maximum, after which conductivity falls with further dilution. The purity corresponding to maximum conductivity is then calculated by the computer and registered by a printer. The reservoir is emptied and rinsed with water, after which fresh water is injected. The total time per cycle is about 2 minutes.

#### Trace components in sugars. II. Quantitative determination of organic acids by GLC

S. Saito, T. Miki, H. Ito and M. Kamoda. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1984, 33, 31-37 (Japanese).

Details are given of a simple GLC method for determination of organic acids in refinery products. It involves passage of the sample through Dowex 50W resin in  $\text{Na}^+$  form and isolation of the organic acids by adsorption on IRA 401 in  $\text{Cl}^-$  form, followed by elution with 1N NaCl solution. The eluate is concentrated to dryness under reduced pressure at 40°C and esterified with *n*-butyl alcohol at 135-140°C for 2 hours, with Amberlite CG 120 cation exchange resin in  $\text{H}^+$  form as catalyst. Filtration is followed by injection into the chromatograph. Acid recovery is 94-104%. Details are given of the organic acids (up to 12) identified in cane raw sugar samples from various sources and of those found in soft white and soft brown sugars as well as cane juice and molasses.

<sup>1</sup> "Sugar analysis" Ed. Schneider (ICUMSA, Peterborough) 1979, pp. 55-56.

# By-products

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## Study of the storage of bagasse in the Camilo Cienfuegos particle board factory

O. Carvajal, J. Puig, J. A. Leal, C. Coronado, M. Antigua and O. Martínez. *Revista ICIDCA*, 1983, 17, 37-48 (Spanish).

Analysis of samples over a period of 6 months showed that the microbiological and physico-chemical characteristics of the bagasse stored at the title factory did not vary appreciably.

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## Selective separation of the components of filter-cake crude wax by fractionation with solvent mixtures

A. García G., J. Lastra R. and F. González L. *Revista ICIDCA*, 1983, 17, (1), 53-63 (Spanish).

Mixtures of alcohol with various industrial hydrocarbons have been used to extract wax from filter-cake. The most favourable was found to be a 70:30 mixture of 96% alcohol and gasoline HD in which, when hot, the wax was soluble and from which the oils separated on cooling. It is thus possible to separate the wax into two components so that a purified oil-free wax can be obtained using locally-derived materials.

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## Sodium sulphite as a brightener for high-yield bagasse pulps

J. Sabatier, N. Fernández and O. Sardiñas. *ATAC*, 1982, 41, (6), 15-21 (Spanish).

Sodium sulphite is used as a brightener for wood pulps and trials have been carried out on its use with bagasse pulps, using both alkaline and acid solutions alone and after pretreatment with H<sub>2</sub>O<sub>2</sub>. Especially in the latter case, considerable improvements in brightness were achieved and further trials were made using SO<sub>2</sub> and varying the amount of peroxide, and the temperature and consistency of the pulp as well as its original brightness.

The results were subjected to statistical analysis and reported. It is concluded that the treatment produces a rise in Elrepho brightness of 2-5 units, and that this occurs in the first few minutes of the SO<sub>2</sub> treatment so that no long-retention tower is required.

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## Purification of vinasse by the production of *Rhodotorula gracilis* biomass

A. U. O. S. Srur and E. Aquarone. *STAB*, 1983, 2, (1), 34-37 (Portuguese).

Vinasse supplemented with the residue from glutamic acid fermentation was used as a substrate for growing *R. gracilis* in a 30-litre fermenter, using 20 litres of substrate at pH 5 and 29° ± 1°C, agitation at 500 rpm and aeration with 1 volume of air per volume of medium per minute. The maximum yield of dry matter, more than 12 g/litre of suspension, was obtained after 80 hr fermentation and the mass contained an average of 51.43 g of protein per 100 g of product. The BOD<sub>5</sub> was reduced by 42% with respect to vinasse and 93% with respect to glutamic fermentation waste, giving an overall reduction of 74%. Total acidity was also reduced.

---

## The use of fibrous sugar cane by-products by ruminants. VII. Performance of Holstein males consuming complete diets with sugar cane straw during the growing-fattening period

R. Hanke and P. C. Martin. *Cuban J. Agric. Sci.*, 1983, 17, 255-260.

A feeding trial was conducted over 280 days, in which bulls received rations containing 53.5% predigested or undigested cane straw meal. During the trial period, weight gains were greater where the cane straw was chemically predigested.

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## Large intestine digestion of pigs fed molasses. I. Morphological aspects

J. Ly and A. Mollineda. *Cuban J.*

*Agric. Sci.*, 1983, 17, 285-297.

The effects of maize, high-test molasses and final molasses as energy source on the morphological characteristics of the large intestine in pigs were studied. The % distribution of the weight in the gastrointestinal tract indicated that the large intestine was of greater importance with high-test molasses than with final molasses and maize. The morphology of the large intestine suggests functional changes to allow the pigs to digest high-test molasses, whereas earlier studies had shown an inability of the large intestine to absorb sufficient water from diets containing final molasses.

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## Low-temperature pulp drying: fundamentals and economic considerations. III

K. E. Austmeyer and W. Poersch. *Zuckerind.*, 1984, 109, 411-419 (German).

For calculation of the design dimensions of a beet pulp band dryer<sup>1</sup>, the most important parameter is the required drying time for a given amount of pulp solids; on the time will depend the total surface area of the drying band and, for a given band width and average pulp bed height, the band length. However, associated with the time as a function of drying rate is the shrinkage of the pulp particles; since it would be unpractical to operate with a continuously falling bed height, in the case of multi-stage dryers the initial bed heights from band to band must increase; otherwise the rate of air flow through the beds would rise progressively throughout the drying process. The minimum permissible bed height for a required mass transfer must increase and not decrease during the process. Equations are given for calculation of band surface area in the first and second drying sections<sup>1</sup>. The mechanism of particle shrinkage is discussed in relation to investigations conducted by other authors, and it is assumed that pulp particles undergo

<sup>1</sup> Austmeyer & Poersch: *I.S.J.*, 1984, 86, 192.

ideal shrinkage, i.e. the decrease in total volume corresponds to the reduction in moisture volume, so that no void is formed; in this case, the reduction in bed height through shrinkage can be calculated and hence the band surface area. Descriptions are given of the design and process concepts of a Babcock-BSH low-temperature dryer in which heated air passes down through a series of bands arranged in two parallel columns. The pulp also passes from top to bottom in a zigzag path; the speed of each band can be stepwise-controlled to regulate the required bed heights. The air is supplied by two fans, one on each side of the dryer, up the space between the outside vertical wall and the continuous bands, so that it flows across and down through the bands simultaneously, then flows in an upward current in the central space between the two sets of bands. Heating of the air from 7° to 52°C is carried out in V-shaped heat exchanger units located on the suction side of the fans; the heat is provided by pan vapour condenser water. The mathematics of air flow velocity distribution and pressure loss are explained.

#### Re-ensilage and future prospects of ultra-pressed (beet) pulp

J. P. Vandergeten and R. Vanstallen. *Publ. Trimest. Inst. Roy. Belge Amél. Betterave*, 1983, **51**, 157-165 (French, Dutch).

Beet pulp deliveries from sugar factories to farms for ensilage may be inconvenient at weekends and during public holidays, yet it is essential that pulp be ensiled as soon as possible after it becomes available at the factory. Investigations were therefore conducted on temporary ensilage at the factory (for 125 days) followed by removal of the silage to farms where it was re-ensiled. Results showed that a further 5 months of ensilage, giving a total period of 9 months, yielded a product which was in good condition and well accepted by cattle. Ensilage of

pulp of up to 50% dry solids was investigated. No problems were encountered in piling by tractor with twin rear wheels. The aim is to reduce energy consumption by combining pressing to 35% solids and then using waste heat to dry the pulp further. Tests were also conducted on compression of pulp to 65% dry solids in the form of small billets 4-8 cm long and 5 cm in diameter. Using a pressure of 40 kg/cm<sup>2</sup>, the pulp volume was reduced by some 85%. Addition of 1% w/w Amasil (a mixture of formic and propionic acids as a water-insoluble powder) as a fungicide was found necessary.

#### Utilization of press mud cake as a phosphate source for green gram (*Vigna radiata*)

B. K. Borde, N. D. Patil and J. R. Kadam. *Maharashtra Sugar*, 1984, **9**, (4), 45-46, 48.

Application of 600 kg/ha filter-cake plus 25 kg/P<sub>2</sub>O<sub>5</sub> increased the yield of *V. radiata*, an important short-duration pulse crop of normally very low yield, by 33% compared with the control. Treatment also reduced the pH and electrical conductivity of the alkaline calcareous black soil used in the experiment.

#### Filter mud application due for review

Anon. *BSES Bull.*, 1984, (6), 16.

The possible value of filter-cake as fertilizer under Australian conditions is assessed. Moist cake contains Ca, N, P, Mg and K in quantities of 43, 28, 26, 9 and 8 kg per 10 tonnes. Studies have shown that of these, N is the least available nutrient; trials and field observations have indicated a requirement of up to 100 kg/ha N as top dressing in ratoon crops. The P in the cake will not increase cane yield because of the amount already present in the soil; if filter-cake is applied, P should be omitted from the fertilizer program unless the soil has high phosphate-fixing properties. At 100

tonnes/ha, filter-cake will supply sufficient K for one crop only, while additional K would be needed in K-deficient soils. Filter-cake is not recommended for Ca- and Mg-deficient soils because of its low Ca and Mg contents; applications of Ca and Mg products would give long-term benefits. Moreover, the Ca in filter-cake will not reduce soil acidity to the same extent as lime. However, filter-cake is considered a good source of plant food and, used in the right situation, will produce increases in crop growth.

#### Economics of disposal of alcohol distillery effluent (vinasse) by incinerator boilers

H. W. Wadhvani and M. M. Mathur. *Maharashtra Sugar*, 1984, **9**, (5), 43, 45, 47-49, 51-54.

Vinasse incineration and the requirements of an incinerator used for this are discussed and the economics of a system to handle the waste from distilleries of up to 80,000 litres/day alcohol output examined by representatives of Kinetics Technology India Ltd., a company specializing in such systems for treatment of effluent in various industries.

#### Beet molasses: its uses

Anon. *Sucr. Franç.*, 1984, **125**, 203-207 (French).

Various aspects of beet and cane molasses are reviewed, including typical composition, detailed non-sucrose composition of beet molasses, chief properties of molasses, and a list of techniques used for analysis as well as standards set for total sugars, As, Pb, F and Hg (in association with molasses use as animal fodder). After some molasses statistics for France (annual average for the period 1977/81), a survey is presented of molasses uses as animal fodder, for yeast and alcohol manufacture as well as other fermentation products, and as an additive to brick clay and foundry moulding sand. Disposal of vinasse is briefly mentioned.

# Patents

## UNITED STATES

### Continuous fermentation process

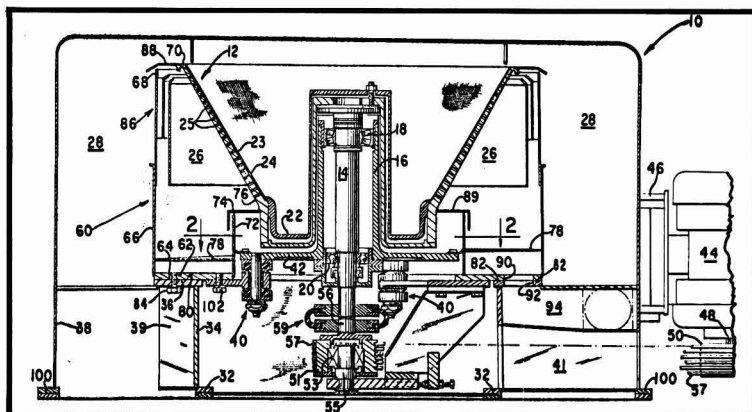
W. C. Muller and F. D. Miller, *assrs.*  
National Distillers & Chemical Corp., of  
New York, NY, USA. **4,315,987**. March  
12, 1980; February 16, 1982.

An aqueous solution of [10-40% (15-25%)] fermentable sugars (e.g. sucrose, glucose, fructose, starch hydrolysate, etc.) is fermented in a series of vessels, using at least two different strains of yeast, one of which (*Saccharomyces cerevisiae*) provides a relatively high rate of conversion of sugar to ethanol and the other (*S. carlsbergiensis* or *S. cerevisiae* var. *ellipsoideus*) provides a relatively high rate of conversion of sugar oligomer to ethanol, each stream being grown, separated from and recycled to its own vessel (which contains 2-8% of yeast, dry basis). The CO<sub>2</sub> gas evolved during fermentation is recovered.

### Continuous centrifugal

D. L. Hurley, of Hamilton, OH, USA, *assr.*  
Western States Machine Co. **4,318,814**.  
January 21, 1980; March 9, 1982.

The continuous centrifugal 10 comprises a conical basket 12 within a curb 38. A base ring 32 carries a vertical annular wall 34 forming an annular chamber 94 between it and the curb. Through one part of this chamber is formed a tunnel 41 to allow the drive belts 57 from the pulley 50 of motor 48 to turn the pulley 51 on stub shaft 55. This is mounted on bearing 53 and is connected to shaft 56 and, through flexible joint 59, to the shaft 14 which carries the basket assembly. The shaft 14 is provided with bearings 18 and 20 and is able to gyrate when the basket is unevenly loaded, since the flange portion 42 of the lower bearing is mounted on three flexible buffer assemblies 40. The buffer assemblies



are mounted on the base structure, the bolts 102 and 84 linking the flange to ring 63 and so to ring 36 carried by wall 34.

An outer annular wall 66 rises from the outer edge of ring 63 while an inner wall 72 rises from the inner edge. A skirt 89 mounted on the basket ensures that molasses separating from massecuite fed into the basket passes into chamber 26 and is directed to the base of the annular space above ring 63. This is provided with a spiral sloping floor 78 which, at its lowest point, delivers the molasses to a point in ring 63 where there is an aperture 92 so that the molasses can pass into chamber 94 and so out of the machine. The discharged sugar leaves the top of the basket 12 and is thrown by centrifugal force into the outer chamber 28 from which it is removed by suitable means.

## UNITED KINGDOM

### Sugar cane wine

H. E. Johnson, of Lusaka, Zambia.  
**2,085,469**. September 2, 1980; April 28,  
1982; March 7, 1984.

Cane juice is acidified to pH 3.3-3.6 (by addition of acidic fruit juice alone or with acetic acid, citric acid, tartaric acid or malic acid) and the juice fermented with

yeast. The juice may be pretreated by addition of diammonium phosphate and one or more amino-acids (glycine). The juice temperature is held below 29.4°C but above 21.1°C, and an antifoam agent may be added. The fermented juice is pasteurized and to it is added one or more of: sorbic acid, copper sulphate, sodium bisulphite, potable alcohol, egg white, agar, isinglass, activated charcoal, calcium sulphate, calcium carbonate, sodium sulphate, a colouring agent, diatomaceous earth and bentonite, after which the fermented juice is filtered and bottled.

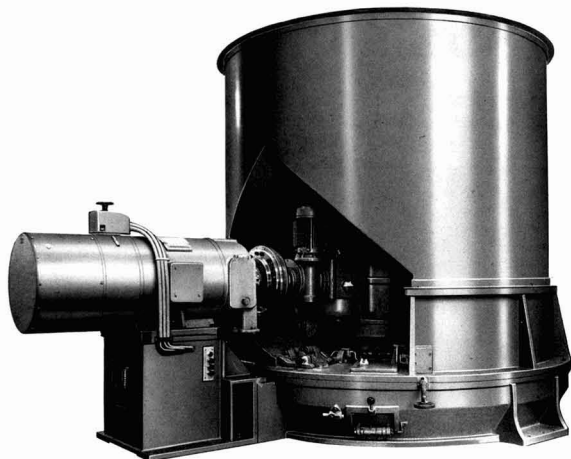
### Animal feed

A/S De Danske Sukkerfabrikker, of  
Copenhagen, Denmark. **2,089,640**.  
December 23, 1981; June 30, 1982;  
March 21, 1984.

Beet pulp is (impregnated with acid at room temperature and atmospheric pressure,) subjected to acid hydrolysis at elevated temperature (100-165°C) and elevated pressure (100-920 kPa) and separated on a band filter into a liquid fraction and a solid fraction, the former being neutralized and evaporated to give an animal feed of low moisture content.

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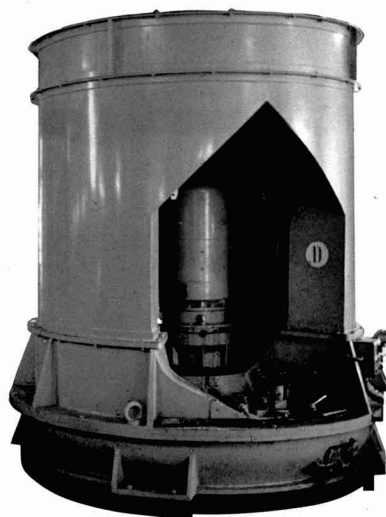
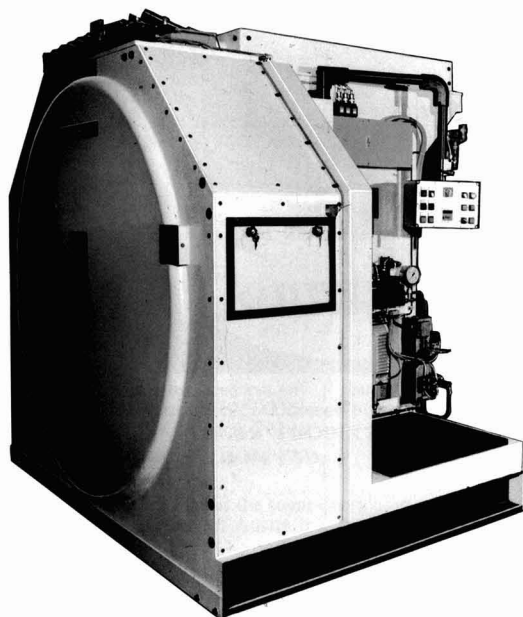
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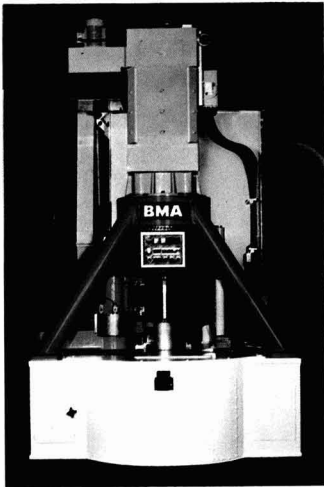
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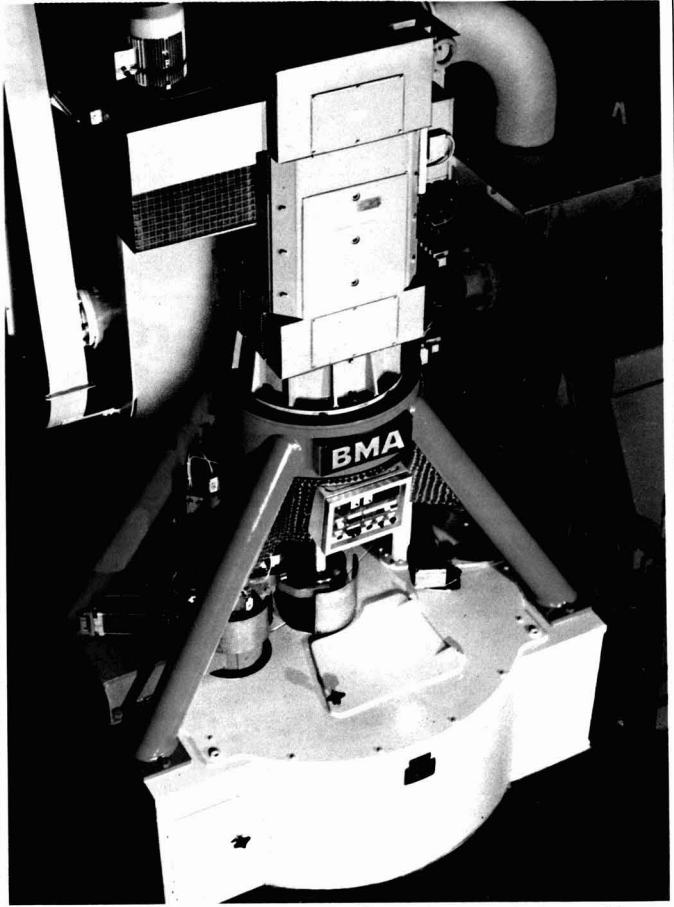
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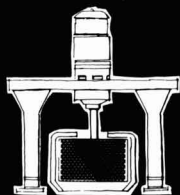
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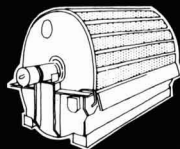


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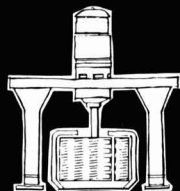




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question. After a given number of such cycles the computer will calculate average inputs and make the previously described calculations. Usually both the average value for each channel and the actual results are to be printed out by the printer.

Usually, heat losses and heat transfer calculations are printed out every

second hour and Figure 3 shows an example of a print-out from one of the TI 59 calculators shown in Figures 1 and 2. In case of special investigations the time interval between two print-outs may be reduced.

#### Summary

A survey is presented of the major

factors affecting the heat economy of a beet sugar factory and an account given of the measurement, collection and processing of data by computers at the Gørlev sugar factory in Denmark since 1977 in order to make heat transfer calculations and monitor heat losses. This has permitted the optimization of the evaporator station.

## Precipitation of calcium carbonate from water, sugar solution and cane juice

By Mahendra Prasad and Ram Chandra

(Physical Chemistry Division, National Sugar Institute, India)

#### Introduction

The fundamental reaction of 1st carbonation has been extensively studied in the past<sup>1-11</sup> but, in the opinion of the authors, it still offers ample scope for further investigation. Moreover, in the literature it is suggested that, owing to its complicated nature, the mechanism of the process is yet to be fully understood<sup>12,13</sup>. We have therefore, attempted to investigate this subject in order to provide some relevant information.

The physical chemistry<sup>14-16</sup> of all processes of cane juice clarification involves the removal of nonsugars. This removal could be of organics, inorganics, precipitates, colorants or even colloids, etc. All of them are primarily governed by ionic reaction and/or an adsorption mechanism<sup>17-19</sup>. To study ionic reactions, measurement of electrical conductivity is one of the most versatile and acceptable techniques. Therefore, in this investigation, in addition to pH, absorbance and CaO, we employed conductivity measurement simultaneously during the precipitation of CaCO<sub>3</sub> in lime water, limed sugar solution and in limed cane juice in our



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laboratory with expectations that this technique could provide some deeper insight on the subject and the outcome of this investigation we report in this communication.

#### Materials and method

Chemicals used in this investigation, were refined sugar, CaCO<sub>3</sub>, EDTA disodium salt, Eriochrome Black T, murexide, buffer solutions (BDH, India), moisture-free CO<sub>2</sub> and cane juice from Co 1148 variety.

Apparatus used included a Beckman conductivity bridge (model RC-18A), digital pH meter (Toshniwal model CI-46), a Spectronic-20 absorptiometer (Bausch and Lomb) and an Ultrathermostat type NBE (Gr. Nr. 24019).

Three types of sample were investigated: (i) lime water, (ii) refined

sugar solution (15%) and (iii) cane juice. 400 ml of lime water (pH 11.86 and CaO 915 mg/litre) was saturated with CO<sub>2</sub> gas at room temperature (25°C) and atmospheric pressure. After passing CO<sub>2</sub> for one minute, a 10 ml portion of reaction mixture was withdrawn and filtered through Whatman No. 1 filter paper. The CaO content (by EDTA) and conductivity

- 1 Faurholt: *Chim. Phys.*, 1924, **21**, 409.
- 2 Roughton & Booth: *Biochem. J.*, 1983, **32**, 2049.
- 3 Faurholt: *Kongel. Veter. Landbohojskol. Arsskrift*, 1924.
- 4 Harneol & Scholes: *J. Amer. Chem. Soc.*, 1941, **63**, 1706.
- 5 Landolt-Bornstein: "Tabellen", Vol. Eng. IIIC, p. 2104.
- 6 Cuta: Unpublished experiments, 1941/44.
- 7 Brieghel-Müller & Brüniche-Olson: Private communication, 1948.
- 8 Kielland: *J. Amer. Chem. Soc.*, 1937, **59**, 1657-1678.
- 9 Herzfeld: *Z. Ver. deut. Zuckerind.*, 1899, **49**, 701.
- 10 *Wachsel Stammers Jahrbuch*, 1880, **20**, 197.
- 11 Weisberg: *Bull. Assoc. Chim. Sucr. Dist.*, 1898-99, 167.
- 12 Dedek: *Svenska Sockerfabr. Forhandl.*, 1933, 63.
- 13 Idem: *Sucr. Belge*, 1949, **69**, 73.
- 14 Bennett: *I.S.J.*, 1974, **76**, 68.
- 15 Kelly *et al.*: *ibid.*, 1973, **75**, 131-135.
- 16 Manmohan *et al.*: *Proc. 31st Ann. Conv. Sugar Tech. Assoc. India*, 1963, 167-177.
- 17 Wiklund & Lindblad: *Socker*, 1949, **5**, 157-196.
- 18 Kolthoff & Stenger: "Volumetric analysis", Chapter VIII, 1942.
- 19 Dedek: *Sugar*, 1951, **46**, (5), 21.

were determined in the clear filtrate. This procedure was followed with reaction mixture samples withdrawn at one minute intervals until the residual CaO reached a higher but constant value after falling to an initial minimum. Experiments were also carried out at the higher temperatures of 55°C and 70°C.

In the case of refined sugar, 400 ml of sugar solution was treated with 60 ml lime slurry (13°Bé). After recording pH and CaO and conductivity of the mixture, CO<sub>2</sub> was passed as above and CaO was determined in filtered samples of the reaction mixture similarly to the lime water experiments but at 5-minute intervals. The reaction was repeated at higher temperatures using the thermostat and the measurements made at these temperatures.

Experiments with cane juice were carried out with a mixture of 400 ml freshly crushed cane juice and 60 ml lime slurry (13°Bé). The initial pH and conductivity of the mixture were determined and, after passing CO<sub>2</sub> into the limed cane juice for five minutes, pH and conductivity were again measured simultaneously. From the reaction mixture a 10-ml portion was withdrawn and filtered through Whatman No. 1 filter paper. CaO content and absorbance at 420 nm of the clear filtrate were determined and this procedure repeated at 5-minute intervals. The pH and conductivity of the filtered juice were also checked from time to time and were found to be in agreement with the value determined *in situ*. Measurements at 55°C were also made as above.

## Results

### Lime water

In the experiment at 25°C the initial concentration of CaO before treatment with CO<sub>2</sub> was 915 mg/litre. When CO<sub>2</sub> gas was passed, precipitation of CaCO<sub>3</sub> occurred and the CaO decreased to a minimum (Fig. 1a) corresponding to lowest CaO (2.6 mg/litre) and then began to rise. As may be seen in Fig. 1b conductivity also fell to a corresponding minimum (140 μmho). Further saturation of lime water with CO<sub>2</sub> increased the CaO content to 75 mg/litre and conductivity of 220 μmho.

### Refined sugar solution

At 25°C, the initial concentration of CaO in refined sugar solution was recorded to be 6750 mg/litre. The

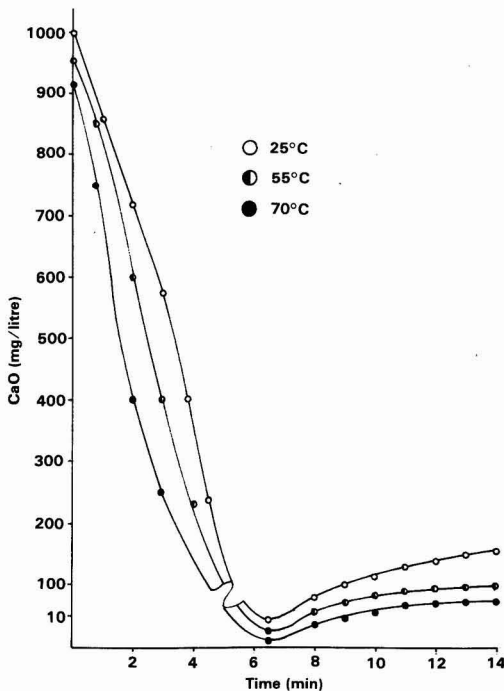


Fig. 1a. Precipitation of CaCO<sub>3</sub> from lime water

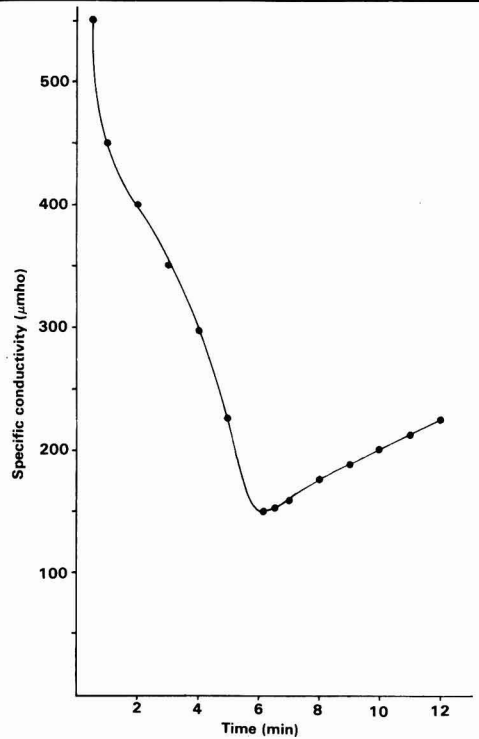


Fig. 1b. Conductivity changes during precipitation of CaCO<sub>3</sub> from lime water

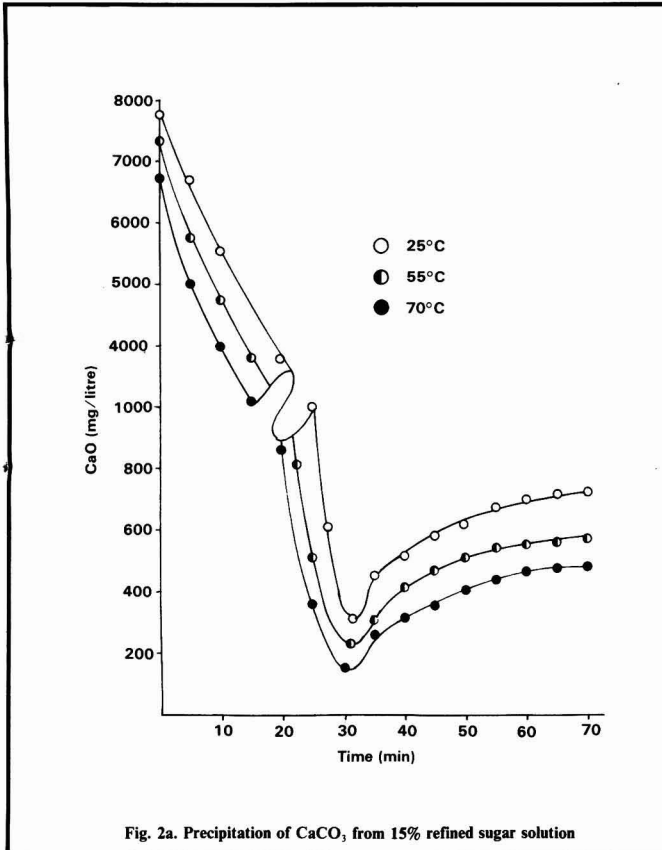


Fig. 2a. Precipitation of  $\text{CaCO}_3$  from 15% refined sugar solution

variation of CaO and conductivity in this mixture upon passing  $\text{CO}_2$  gas is shown in Fig. 2(a) and Fig. 2(b), respectively. Similarly to the lime water- $\text{CO}_2$  reaction, minima corresponding to lowest CaO (140 mg/litre) and conductivity were observed in this case also. Further saturation with  $\text{CO}_2$  increased the CaO content which tended towards a constant level of about 450 mg/litre. Similar behaviour was observed at 55° and 70°C and is shown in Fig 2. Conductivity did not reach a constant level.

*Cane juice*

At 25°C, the pH, conductivity, CaO content and absorbance of cane juice

treated with lime slurry were recorded to be 12.0, 7500  $\mu\text{mho}$ , 7640 mg/litre and 0.88, respectively. The variation in these parameters with respect to time of saturation is shown in Fig. 3 in which pH, conductivity, CaO and absorbance are denoted by the curves indicated appropriately.

From these curves it is noticeable that conductivity, CaO and absorbance all start to decrease as soon as limed cane juice is allowed to react with  $\text{CO}_2$  gas. The decrease in these parameters continues until each of them attains a minimum value; for instance, conductivity fell from 7500  $\mu\text{mho}$  to 3600  $\mu\text{mho}$ , CaO content from 7640 to 1560 mg/litre, and absorbance likewise dropped to 23% from the initial value.

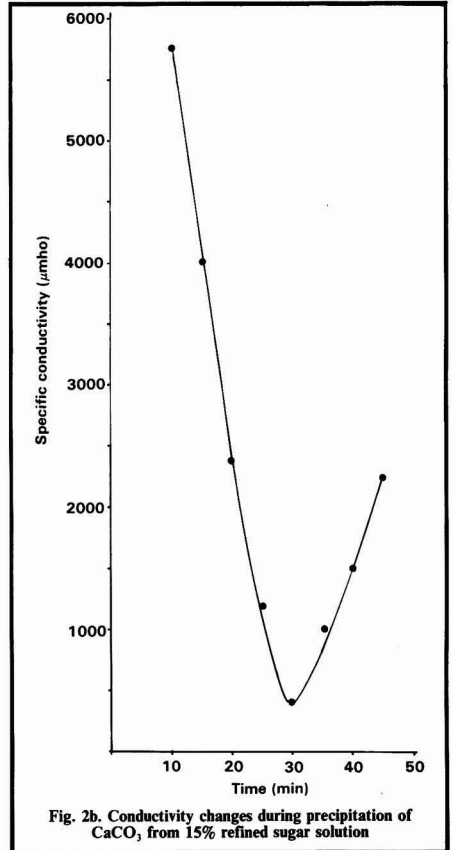
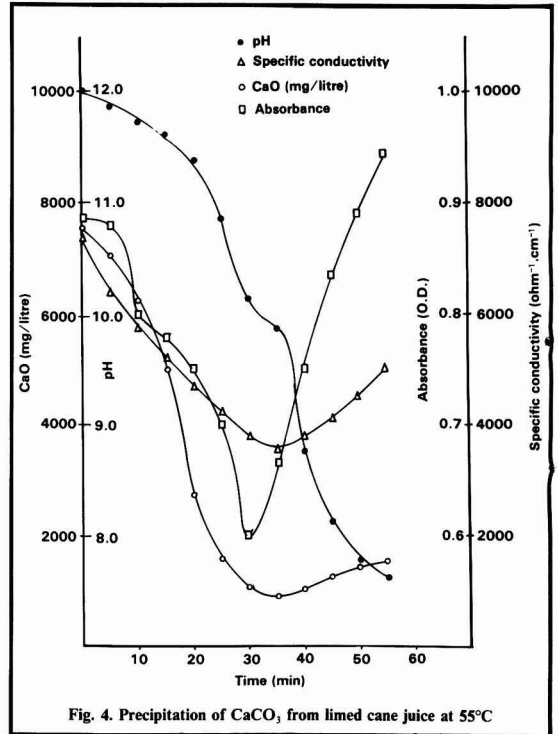
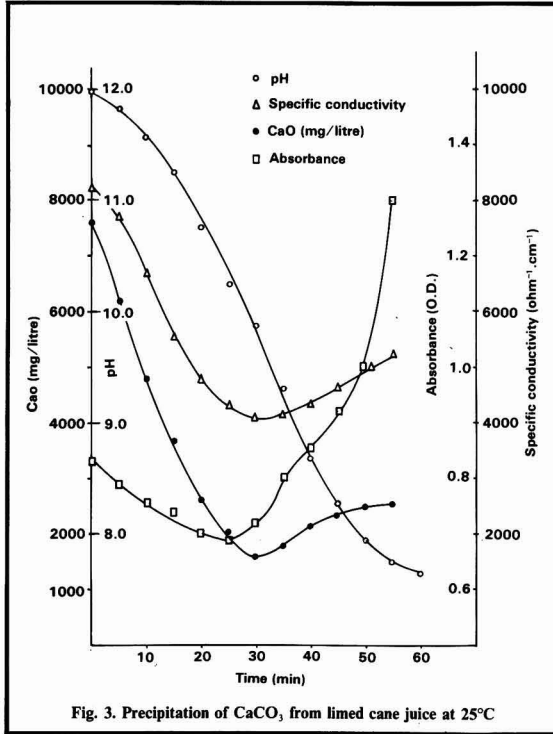


Fig. 2b. Conductivity changes during precipitation of  $\text{CaCO}_3$  from 15% refined sugar solution

Further passage of  $\text{CO}_2$  gas did not cause any further precipitation; instead rather CaO attained a higher (~38%) but constant value. Conductivity and absorbance however kept on increasing. Such variation of pH, conductivity, CaO and absorbance with duration of  $\text{CO}_2$  saturation leads to three distinct minima corresponding to each parameter. Further it is also observed that these minima overlap with respect to saturation time.

Referring to the pH curve, it may be observed that this curve did not show a minimum; rather it appears as if it is a typical weak acid-weak base titration curve. However, the minima of CaO, absorbance and conductivity are seen to correspond to the inflection



of the pH curve in Fig. 3.

Results obtained at 55°C are shown in Fig. 4. The nature of these curves appears to be identical with those at 25°C with some minor differences between the results at the two temperatures, e.g. (i) the inflection in pH at 25°C is distinctly sharper than at 55°C, and (ii) the minima at 55°C were observed at shorter duration of saturation than those at 25°C.

**Discussion**

*Minima*

The appearance of single minima in the lime water curves (Fig. 1) and the refined sugar solution curves (Fig. 2) and three different minima for CaO, conductivity and absorbance corresponding to different degrees of saturation of the limed cane juice (Figs. 3 & 4) may be understood in terms of changing concentration of free Ca<sup>++</sup> ions. This is based on the

assumption that decrease in conductivity with time of CO<sub>2</sub> saturation until a minimum is observed is in accordance with the fact that ionic concentration of Ca<sup>++</sup>, which contributes to the conductivity as well as to the precipitation of CaCO<sub>3</sub>, decreases.

The formation and dissociation of H<sub>2</sub>CO<sub>3</sub> and its reaction with Ca(OH)<sub>2</sub> is governed by a well known mechanism whose stoichiometry may be found elsewhere<sup>20, 21</sup>. This causes a net Ca<sup>++</sup> decrease in the reaction mixture. This process of removal of Ca<sup>++</sup> from lime water, limed sugar solution and limed cane juice is continued until total precipitable Ca<sup>++</sup> is removed.

Satisfactory evidence of participation of ionic calcium is provided by conductivity data. Total conductivity  $\sigma_{(T)}$  is given by the expression:

$$\sigma_{(T)} = \sigma_1 + \sigma_2 + \sigma_3 + \sigma_4 \dots$$

where  $\sigma_1, \sigma_2, \sigma_3$  and  $\sigma_4 \dots$  refer to individual conductivity contributions of different ionic species such as Ca<sup>++</sup>, OH<sup>-</sup>, H<sup>+</sup> and CO<sub>3</sub><sup>2-</sup> respectively in the reaction mixture. The contribution of H<sup>+</sup> and OH<sup>-</sup> to the ionic conductivity would be insignificant for obvious reasons.

Further,  

$$\sigma = ne \mu$$

where n is the absolute ionic concentration per cm<sup>3</sup>, e is the electronic charge in coulombs and  $\mu$  is the absolute ionic mobility. Considering the ionic mobility of all ionic species  $\sim 10^{-5}$  cm<sup>2</sup> volt<sup>-1</sup>sec<sup>-1</sup> (except for H<sup>+</sup> and OH<sup>-</sup> where  $\mu$ -values are  $36 \times 10^{-5}$  and  $20 \times 10^{-5}$  cm<sup>2</sup>volt<sup>-1</sup>sec<sup>-1</sup>, respectively), the absolute concentration of Ca<sup>++</sup> could be

20 Honig: "Principles of Sugar Technology", Vol. 1. (Elsevier, New York), 1953, p. 674.  
 21 McGinnis: "Beet Sugar Technology", 2nd Ed. (Beet Sugar Development Foundation, Fort Collins.) 1971, p. 165.

estimated and hence it is only the absolute concentration of  $\text{Ca}^{++}$  per  $\text{cm}^3$  in the reaction mixture which governs the variation in  $\sigma_{(T)}$  in Fig. 3 and Fig. 4. Thus the decreasing trend of conductivity shown in Fig. 3 and Fig. 4 suggest almost conclusively that  $\text{Ca}^{++}$  ions are exhausted as the reaction mixture becomes saturated with  $\text{CO}_2$  giving rise to the minima in the curves.

*pH versus CaO/CaCO<sub>3</sub>*

The minimum CaO in the lime water and refined sugar solution experiments as well as in the cane juice was found to occur at pH ~9.8. This is lower than that at which first carbonatation is carried out (pH ≥ 10.5). Since minima for CaO, conductivity and absorbance all fall near 9.8 this strongly suggests that the optimum pH for maximum removal of  $\text{CaCO}_3$  from cane juice should be at ~9.8. It was also observed during our experiments that the  $\text{CaCO}_3$  precipitate at pH ≥ 10.5 was not as granular as that at pH ≤ 10.0. In separate experiments while determining the dissociation constant of carbonic acid in the three systems, viz. pure water, 15% sugar solution and cane juice, it was observed rather more closely that the  $\text{CaCO}_3$  precipitate obtained at pH ≥ 10.5 did not remain granular and crystalline but rather turned thin as if it tended to redissolve in the reaction mixture. (Work employing an electron microscope for examination of the particle size and nature of the  $\text{CaCO}_3$  precipitate is in progress.)

Though the removal of CaO from the lime water and the sugar solution is little different at pH 10.50 and 10.0, its

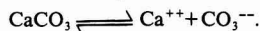
removal in cane juice greatly depends on pH as shown in Table I.

In Table II removal of nonsugars other than CaO is recorded, as reported by Jenkins<sup>22</sup>.

Nonsugar	pH	Removal (%)
Phosphate	8.60	100.0
SiO <sub>2</sub>	9.10	92.0
MgO	10.0	70.0
Fe <sub>2</sub> O <sub>3</sub>	8.65	70.0
Al <sub>2</sub> O <sub>3</sub>	8.65	100.0
Proteins	5.60	95.0
Gums	7.50	60.0
Waxy materials	7.80	88.0

*Dissociation constant of CaCO<sub>3</sub>*

The data were used to calculate the dissociation or solubility product constant of  $\text{CaCO}_3$  in lime water, in sugar solution and in cane juice, and these are given in Table III. It may be observed from this table that the higher values of dissociation constants of  $\text{CaCO}_3$  in sugar solution and in cane juice could be primarily due to the constituents present in both. The values of the dissociation constant in cane juice are considerably higher. Let us consider the equilibrium



would rise.

These values of dissociation constants at different temperature given in Table III were utilized for an Arrhenius plot (Fig. 5). In this plot, the two slopes corresponding to water and sugar solution are negative, giving activation energies of  $\text{CaCO}_3$  of 2.13 and 4.37 kcal.deg<sup>-1</sup>mole<sup>-1</sup>, respectively. In the graph for cane juice two points are noteworthy:

- (i) there is a break in the Arrhenius plot at 55°C giving two slopes which correspond to two activation energies, and
- (ii) both slopes are positive.

The activation energies below and above 55°C are 3.92 and 12.75 kcal.deg<sup>-1</sup>mole<sup>-1</sup> respectively.

These results suggest that dissociation of  $\text{CaCO}_3$  in water and in sugar solution is governed by a mechanism which is different from that of cane juice. Further, the negative slopes of the Arrhenius plot in water and sugar solution suggest that this reaction is controlled by an activation process whereas, in cane juice, the dissociation is controlled by processes of diffusion. Comparing the two activation energies in cane juice, it is plausible to infer that, below and above 55°C, the dissociation is controlled by surface and bulk

pH	Removal (%)
8.00	62.75
8.50	63.50
9.00	67.60
9.50	71.80
9.80	74.50
10.00	71.00
10.50	62.75
11.00	50.30
11.50	32.50

Temperature, °C	Solubility product constant $K_{sp}$		
	Pure water	Refined sugar solution (15%)	Cane juice
25	$2.79 \times 10^{-8}$	$3.24 \times 10^{-8}$	$7.22 \times 10^{-7}$
30	$3.16 \times 10^{-8}$	$3.89 \times 10^{-8}$	$7.24 \times 10^{-7}$
35	$3.55 \times 10^{-8}$	$3.98 \times 10^{-8}$	$6.82 \times 10^{-7}$
45	$3.89 \times 10^{-8}$	$4.78 \times 10^{-8}$	$4.22 \times 10^{-7}$
55	$4.00 \times 10^{-8}$	$5.06 \times 10^{-8}$	$3.60 \times 10^{-7}$
65	$4.36 \times 10^{-8}$	$6.31 \times 10^{-8}$	$2.02 \times 10^{-7}$
70	$4.62 \times 10^{-8}$	$5.76 \times 10^{-8}$	$1.41 \times 10^{-7}$
75	$4.45 \times 10^{-8}$	$7.08 \times 10^{-8}$	$1.22 \times 10^{-7}$

We know that cane juice contains soluble salts which tend to hydrolyse  $\text{CaCO}_3$ . Anions present in cane juice tend to react with available  $\text{Ca}^{++}$  ions to form soluble calcium salts. This process would push the equilibrium to the right which would effectively add more  $\text{Ca}^{++}$  in solution. Consequently the dissociation constant

diffusion phenomena, respectively.

Regarding the rise in CaO and conductivity after the minima, on further passage of  $\text{CO}_2$ , as seen in Figs. 1-4, precipitated  $\text{CaCO}_3$  will go into solution in the form of bicarbonate.

The increase in absorbance (colour)

<sup>22</sup> "Introduction to cane sugar technology" (Elsevier, Amsterdam) 1966, p. 184.

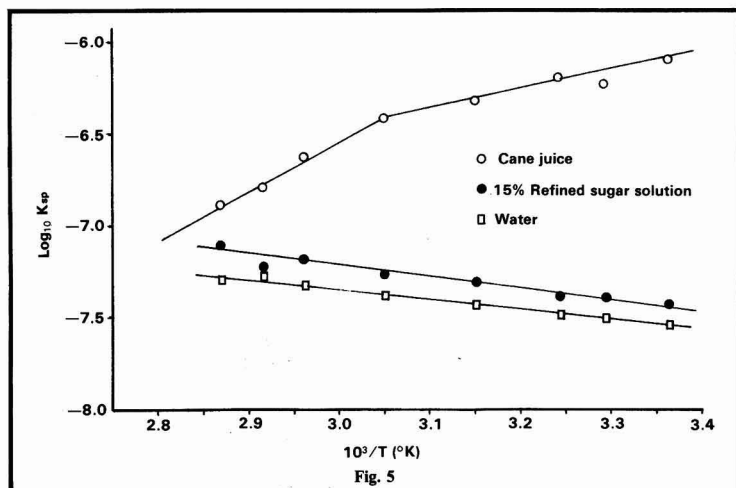


Fig. 5

beyond the minima is rather more sharp (Figs. 3 and 4, curve III); this is an indication that colorants present in the cane juice are highly pH-dependent. As pH changes from 9.8 to 8.5 absorbance rises by 20%. The fact that colour is minimum at  $\sim 10.0$  and increases with change in pH either way suggests that at least two indicator-type colorants are present in cane juice and appear to change their tautomeric form in the presence of  $\text{OH}^-$  as well as  $\text{H}^+$  ions.

#### Conclusions

(1) The precipitation of  $\text{CaCO}_3$  from lime water (I), refined sugar solution (II), and cane juice (III) has been studied employing pH, conductivity, CaO and absorbance (colour) simultaneously as reaction proceeds.

(2) During carbonatation of cane juice conductivity, CaO and absorbance decline to minima which correspond to a pH  $\sim 9.8$ , suggesting that maximum removal of lime occurs at this pH.

(3) Conductivity data provide satisfactory evidence that the minimum in the conductivity curve could also be employed as a parameter for judging the completion of the first carbonatation reaction.

(4) Solubility product constants ( $K_{sp}$ )

of  $\text{CaCO}_3$  in the three solutions are in the order:

$$K_{sp} \text{ (I)} < K_{sp} \text{ (II)} < K_{sp} \text{ (III)}$$

(5) Activation energies of dissociation of  $\text{CaCO}_3$ ,  $E_a$  (I) and  $E_a$  (II) were found to be 2.13 and 4.37 kcal.deg<sup>-1</sup>.mole<sup>-1</sup>, respectively. In cane juice, two values of  $E_a$  ( $\sim 12.75$  and 3.92 kcal.deg<sup>-1</sup>.mole<sup>-1</sup>) were obtained above and below 55°C, respectively. These data suggest that in (I) and (II) a simple activation mechanism operates whereas in III below and above 55°C,  $\text{CaCO}_3$  dissociation appears to be governed by surface and bulk diffusion mechanisms, respectively.

#### Acknowledgements

The authors express their thanks to Mr. N. R. Khariawala, Director, National Sugar Institute, Kanpur, for his keen interest in the work.

#### Summary

The precipitation of  $\text{CaCO}_3$  from lime water (I), refined sugar solution (II) and cane juice (III) was studied at different temperatures, employing pH, conductivity, absorbance and CaO measurements. Consistency of the data revealed that maximum removable CaO is precipitated at pH  $\leq 10.0$ . The solubility product constants in the three solutions appear to be in the

order  $K_{sp} \text{ (I)} < K_{sp} \text{ (II)} < K_{sp} \text{ (III)}$ . An Arrhenius plot of the dissociation constant of  $\text{CaCO}_3$  suggests that in water and in 15% refined sugar solution a simple activation mechanism operates whereas in cane juice, below and above 55°C, dissociation is governed by surface and bulk diffusion mechanisms, respectively. The activation energy of dissociation of  $\text{CaCO}_3$  in water and sugar solution was found to be 2.13 and 4.37 kcal.deg<sup>-1</sup>.mole<sup>-1</sup>, respectively, while in cane juice it was 12.75 and 3.92 kcal.deg<sup>-1</sup>.mole<sup>-1</sup> for temperatures above and below 55°C, respectively.

#### Précipitation du carbonate de calcium dans l'eau, les solutions sucrées et du jus de canne

On étudie la précipitation du  $\text{CaCO}_3$  au départ d'eau chaulée (I), d'une solution de sucre raffiné (II) et du jus de canne (III) à des températures différentes et en mesurant le pH, la conductivité, l'absorbance et le CaO. La consistance des résultats montrait que le maximum de CaO précipitable est enlevé à pH  $\sim 10.0$ . Les constantes de produits de solubilité dans les trois solutions sont dans l'ordre  $K_{sp} \text{ (I)} < K_{sp} \text{ (II)} < K_{sp} \text{ (III)}$ . Un diagramme Arrhenius de la constante de dissociation du  $\text{CaCO}_3$  suggère qu'on a affaire à un simple mécanisme d'activation dans le cas de l'eau et d'une solution de sucre à 15%, tandis que dans le jus de canne, en dessous et au dessus de 55°C, la dissociation est respectivement réglée par des mécanismes de diffusion en surface et dans la masse. Pour l'énergie d'activation de la dissociation du  $\text{CaCO}_3$  dans l'eau et dans la solution sucrée on a trouvé des valeurs respectivement de 2.13 et 4.37 kcal.deg<sup>-1</sup>.mole<sup>-1</sup>. Dans le jus de canne les valeurs pour des températures en dessous et au dessus de 55°C étaient respectivement égales à 12.75 et 3.92 kcal.deg<sup>-1</sup>.mole<sup>-1</sup>.

**Präzipitation von Calcium-Carbonat aus Wasser, Zuckerlösung und Rohrsaft**  
Die Präzipitation von  $\text{CaCO}_3$  aus



# New books

## The importance of molasses markets

M. Rico, A. W. Huguley, L. Rodríguez D., W. Kosseff and J. C. Mickus. 56 pp; 13.4 x 20.6 cm. (GEPLACEA, Ejército Nacional 373 - 1° piso, 11520 Mexico, D.F., Mexico.) 1984.

This booklet is a compilation of a series of papers on molasses marketing which were presented during the 1984 International Colloquium on Sweeteners, sponsored by the US Sugar Users Group. The papers, by the authors mentioned above, are entitled, respectively: "World molasses production and consumption", "Molasses: the United States view", "The Latin American and Caribbean producer's view", "International molasses marketing" and "Molasses: the United States user's view".

gekalktem Wasser (I). Raffinade-Lösung (II) und Rohrsaft (III) wurde bei verschiedenen Temperaturen durch Messung des pH-Wertes, der Leitfähigkeit, der Absorption und des CaO-Gehalts untersucht. Aus den konsistenten Daten ergab sich, daß das maximale entfernbare CaO bei pH 10.0 ausgefällt wird. Die Löslichkeitsproduktkonstanten in den drei Lösungen scheinen in der Reihe  $K_{sp}(I) < K_{sp}(II) < K_{sp}(III)$  zu sein. Ein Arrhenius-Diagramm der Dissoziationskonstante von  $CaCO_3$  legt nahe, daß in Wasser und 15 %iger Raffinadelösung ein einfacher Aktivierungsmechanismus vorhanden ist, während in Rohrsaft unterhalb von 55°C die Dissoziation durch Oberflächendiffusion und oberhalb davon durch Volumendiffusion bestimmt wird. Die Aktivierungsenergie der Dissoziation von  $CaCO_3$  wurde in Wasser zu 2.13 und in Raffinadelösung zu 4.37 kcal.K<sup>-1</sup>.mol<sup>-1</sup> bestimmt, während sie in Rohrsaft für Temperaturen über 55°C 12.75 und 3.92 kcal.K<sup>-1</sup>.mol<sup>-1</sup> für Temperaturen darunter beträgt.

**Precipitación de carbonato de calcio de agua, de una solución de azúcar y del**

## GEPLACEA — Programas y actividades

Anon. 58 pp; 13.5 x 21.1 cm. (GEPLACEA, Av. Ejército 373 - 1° piso, 11520 Mexico, D.F., Mexico.) 1984.

This booklet in Spanish comprises a description of GEPLACEA, the Group of 21 Latin-American and Caribbean sugar exporting countries, and lists its objectives. The areas and types of activity of the group are discussed, with a description of each of the ten programs which members undertake. These are concerned, respectively, with organization of meetings, cane agriculture, industrial efficiency, by-products, energy cooperation, international marketing of sugar and molasses, the International Sugar Agreement, dissemination of information, institutional

## jugo de caña

Se ha estudiado la precipitación de  $CaCO_3$  de agua encalada (I), de una solución de azúcar refinado (II) y del jugo de caña (III) a temperaturas diferentes y con medición del pH, de la conductividad, de la absorbancia y del CaO. La consistencia de los resultados demostró que el máximo de CaO separable se precipita a pH ~ 10.0. Los constantes de los productos de solubilidad en las tres soluciones están en el orden  $K_{sp}(I) < K_{sp}(II) < K_{sp}(III)$ . Un diagrama Arrhenius del constante de disociación del  $CaCO_3$  sugiere que un mecanismo sencillo de activación opera en agua y en una solución de 15% de azúcar refinado, mientras que en jugo de caña, encima de y debajo de 55°C, la disociación es regulado por mecanismos de difusión a la superficie y en la masa. Para la energía de activación de disociación de  $CaCO_3$  en agua y la solución de azúcar, se han obtenido valores de 2.13 y 4.37 kcal/°C/mol, respectivamente. Para el jugo de caña, los valores obtenidos están 12.75 y 3.92 kcal/°C/mol para temperaturas encima de y debajo de 55°C, respectivamente.

development and administration. Plans under each program for 1984 are summarized and the principal activities during 1983 recorded.

## The industrial utilization of sugar and mill by-products. A literature survey

M. J. Kort. 163 pp.; 20.7 x 29.3 cm. (Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban 4001, South Africa.) 1984.

This is the twenty-second report in the series of surveys prepared by Dr. Kort of the literature (including articles, reports and patents) on various aspects of sugar (both beet and cane) and factory by-products utilization. The 1843 references contained in the work have been condensed from a total of 2060 collected. By-products command the greatest attention, with a total of 959 references (of which 221 concern livestock feeding), although there have been no outstanding new developments in this field; as would be expected, ethanol continues to dominate, followed by yeast and then various acids and other products. The section on industrial uses of refined sugar contains 346 references, covering food and non-food applications and including liquid sugar. Although no new directions of research have appeared with regard to surochemistry, the section devoted to recent developments in this field highlights the value of sucrose as a renewable chemical feedstock; 326 references are given. The final chapter concerns nutrition and toxicology; the 212 references include a number of works on the subject of various diseases for which sugar is blamed, but it is emphasized that there is now sufficient scientific evidence available to counter accusations in regard to many of the disorders cited. Once again, we congratulate Dr. Kort on his excellent work—a job well done.

# Trade notices

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## Small-scale sugar factory

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Stork-Werkspoor Sugar B.V., P.O.Box 147, 7550 AC Hengelo (OV.), Holland.

A 4-page brochure from SWS gives outline information, in English, French and Spanish, on the 350 tcd white sugar factory erected at Shwenyau in Burma and successfully commissioned in November 1983. An identical factory at Kyauk Taw, also in Burma, started production in April 1984, and an adjacent ethanol distillery, of 5000 litres/day output and using the factory molasses as raw material, is under construction.

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## BMA Information

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Braunschweigische Maschinenbauanstalt AG, Postfach 3225, D-3300 Braunschweig, Germany. The latest available English edition of BMA Information contains details of various pieces of BMA equipment, including: a continuous evapo-crystallization tower erected at Wabern factory for white sugar boiling; the new BMA-Balster double solid bowl sedimentation centrifugal for sludge dewatering; a polar beet storage silo erected at Nordstemmen sugar factory which has provision for piling to a height of 9 m and, with an inside diameter of 70 m, has a maximum capacity of about 15,000 tonnes of beet; a low-temperature dryer under development for beet pulp; rotary cell-type vacuum filters; vertical crystallizers; centrifugal innovations (covering both continuous and batch machines); the advantages of falling-film evaporation; a drum-type stone separator for beet flumes; and information on a number of schemes in which BMA has participated, including expansion of Monitor beet sugar factory in the USA, supply of a yeast plant by Starcosa GmbH (a BMA subsidiary) as part of the Ben Bechir sugar complex in Tunisia, expansion of Uelzen sugar factory and modernization of the Elsdorf refinery of Pfeifer & Langen in West Germany,

supply of the first cane diffuser to be used in Indonesia (at Kedawung factory) and details of G series batch centrifugal already in operation, as well as orders placed for tower diffusers. Mention is also made of orders placed with Starcosa GmbH for a plant to produce liquid sorbitol from highly saccharified dextrose syrup in India and for a fructose syrup plant in Pakistan (broken rice being used as raw material).

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## Descaling equipment

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Scaleaway Tools & Equipment Ltd., Park Street, Foleshill, Coventry CV6 5AT, England.

Brochure D84 is the latest from Scaleaway, and illustrates the company's range of flexible shaft powered tube and surface cleaning equipment as supplied to sugar factories in a number of countries.

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## Turbine pumps

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JLC Pumps & Engineering Co. Ltd., Oxgate Farm Works, Coles Green Road, London NW2 7EX, England.

JLC turbine pumps are single-stage units which are compact, light in weight and of simple construction, yet can generate working pressures up to six times greater than can conventional centrifugal pumps of comparable size and speed. The teeth of the impeller are cut into the perimeter on both sides, creating identical faces so that the result is, in effect, two identical impellers back to back; the consequence is a free floating action which ensures long life, vibrationless and smooth flow service and the absence of axle thrust on the motor bearings. The pump can be easily dismantled for cleaning purposes and will deliver up to 300 litres/min (70 gal/min) at pressures up to 14 bar (200 psi). A wide variety of pump connexions is available. The pump is designed for application in a number of fields, including food processing, handling of corrosive liquids and effluents and use in e.g. distilleries.

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## Conveyors and elevators

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Sweet Manufacturing Co., International Division, Springfield, OH 45501, USA.

A new 6-page, 4-colour brochure in Spanish describes the Sweet range of bucket elevators, conveyors, conveyor support systems and towers.

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## Centralized lubrication

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G. Martin, Dépt. Graissage Central de la S.A.M.M., 2 route de Dampierre, 78280 Guyancourt, France.

Centralized lubrication equipment manufactured by G. Martin for a wide range of industries and applications is described in a brochure available from the above address.

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## Powder processing group

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The British Steam Specialities Group plc have announced their acquisition of Babcock Gardner Ltd. and Tourell Gardner Ltd. which are to be incorporated into Kemutec, the BSS Group's Powder Handling and Process Equipment Division. Kemutec was formed in 1983 by the merging together of KEK (suppliers of grinding and sieving plant such as for icing sugar to British Sugar plc) and Mucon (pneumatic conveying specialists). Tourell Gardner Ltd. specialize in equipment for the confectionery industries, particularly for chocolate processing.

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## Fischbein 75th Anniversary

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Cje. Fischbein S.A., of Belgium, the world's largest bag-closing machinery manufacturer, celebrated their 75th anniversary with a 3-day conference at which they officially launched three new products: a twin-thread portable bag sticher, a corrosion-resistant portable bag sticher, and a closing machine for pinch-bottom bags (the company's first venture into non-sewing bag-closing equipment). Since introducing their first portable bag sticher in 1946, Fischbein have sold more than 200,000 units throughout the world, with more than 10,000 heavy-duty static sewing units for closing burlap, paper or plastic bags.

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## Juice pumps

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Sigmund Pulsometer Pumps is supplying 62 Hydrostream split-case and Unistream and end-suction pumps to handle juices and process liquids in the new sugar factory under construction as a part of a major project in the Monegal district of Sri Lanka. The scheme will involve growing of sugar cane on an area of some 10,000 hectares.

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## Turbo-generator order from Kenya

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ASEA Stal AB (formerly Stal-Laval), of Sweden, have received an order for a TGB 8, 1500-kW back-pressure turbo-generator to supply electricity in the state-owned sugar factory of Nzoia Sugar Co. Ltd. in Kenya. This is the third steam turbine to be sold to the African sugar industry by ASEA Stal in 1984.

# Brevities

## Rhizomania in the US<sup>1</sup>

The southern European sugar beet disease rhizomania was found in some California beet fields in 1983. The fungus disease attacks the root system, reducing beet size and resulting in lower yields and sugar recovery. While rhizomania has had little effect on the 1984/85 California beet crop, there is considerable concern about its impact on future crops. The industry is searching for fungicides to control the disease and California plant breeders are trying to produce rhizomania-tolerant and resistant sugar beets.

## Ivory Coast sugar factory conversions<sup>2</sup>

Following a World Bank-sponsored survey of the Ivorian sugar industry, the government has decided to convert the Sereboue sugar complex to the production of rice and rice seeds, while the Katiola complex, previously announced<sup>3</sup> as to be closed, will produce rice and cotton, although its sugar operations will not cease completely.

## Sales of Amstar HFS facility<sup>4</sup>

Agreement has been reached for the sale of Amstar Corporation's Corn Sweetener Division in Dimmitt, Texas, to American Fructose Corporation, a subsidiary of American Maize Products Co., in a deal estimated at about \$50 million.

## Sugar surplus problems for Spain<sup>5</sup>

Part of the 1984/85 beet crop may be left unharvested if an agreement on how to dispose of the current surplus cannot be reached soon. The exact figure for the current surplus has not been published but industry sources believe it to be 350,000 tonnes in the hands of the government plus 100,000 tonnes held by the industry. Disposal of surplus stocks poses serious difficulties as exports will have to be subsidized at around 60 pesetas per kg, assuming a world price of 23 pesetas/kg. One of the problems is that sugar beets have again been grown without contracts, while there is no limitation on HFS manufacture, which has greatly affected sucrose demand. The current beet crop is expected to reach 4,828,000 tonnes, some 600,000 tonnes above the planned figure and this includes 525,000 tonnes grown without a contract.

## New Pakistan sugar factory

Construction has started of a factory for Al-Asif Sugar Mills Ltd. at Garho in the province of Sind. This will be Pakistan's 40th sugar factory and will cost 350 million rupees (£19,440,000) including a foreign exchange component of about 65 million rupees (£3,610,000). About 80% of the machinery will be made locally by Ittefaq Foundries Ltd., Lahore, who also supplied the largest capacity cane sugar factory in the country, Ittefaq Sugar Mills Ltd. at Sahiwal, of 4000 t.c.d. capacity. Al-Asif Sugar Mills Ltd. is scheduled for trial and commercial runs in October 1986. Its initial design capacity is 2000 t.c.d. but it will in due course crush more than 3500 t.c.d. In a normal season the sugar

factory will crush about 375,000 tonnes grown on just over 10,000 hectares, and will produce about 30,000 tonnes of white sugar.

## S.I.T. Meade Award, 1984

The Meade Award for the best paper presented to the 1984 Meeting of Sugar Industry Technologists Inc. has been given to Leif Ramm-Schmidt and Goran Hyoky of Finnish Sugar Company for their paper "New resin decolorization station at Finnish Sugar Porkkala refinery". The Award plaques will be presented at the 1985 SIT meeting to be held in Saint John, New Brunswick, Canada, during June 2-5.

## International Sweetener Colloquium, 1985<sup>6</sup>

At the next colloquium of the US Sugar Users Group, to be held in Palm Springs, California, during February 18-21, a number of sessions will include presentations varying from "A financial analyst's perspective of investment opportunities in the sweetener market" to "By-products". Three interesting sessions will discuss "The future for international co-operation in sugar", "US sugar policy—its international effects and policy objectives for 1985 and beyond", and "Competition among sweeteners".

## Taiwan sugar factory for Indonesia<sup>7</sup>

A successful test run was recently completed by Taiwan Machinery Manufacturing Corporation of machinery and equipment for a complete sugar factory for export to Indonesia. The factory, of 3000-4000 tonnes/day capacity, is the first to be exported from Taiwan.

## Tate & Lyle contract for Brazilian refined sugar<sup>8</sup>

It has been reported that, as part of a package deal, Tate & Lyle was to acquire 36,000 tonnes of refined sugar from Brazil in 1984 and thereafter will buy around 120,000 tonnes each year for the following nine years. The quantity will represent the output from factories in the state of Alagoas which have recently installed refining processes supplied by the UK company.

## Rumanian sugar industry expansion<sup>9</sup>

New sugar factories have been put into operation recently at Navodari and Babbad in Dobruja as part of the program to increase processing capacity and production. The factories have a daily beet processing capacity of 2000 tonnes and other factories of similar capacity are about to be completed at Calarasi, Draganesti-Olt and Murgeni. In 1985 total processing capacity is expected to reach 100,000 tonnes of beet per day so that the whole harvest can be processed in about 100 days. It is planned to increase the beet area from the current 300,000 hectares to 350,000 ha for the 1985 crop.

## Fiji-Portugal sugar agreement<sup>10</sup>

Fiji is to supply Portuguese refiners with 28,000 tonnes of raw sugar annually for four years from 1985 under a recently-signed agreement. The

contract is said to be worth about 3 million Fiji dollars a year at present world sugar prices. The Fiji industry hopes the contract tonnage will be added to Fiji's annual quota of 156,000 tonnes for supply to the EEC if and when Portugal is admitted to the Community.

## US sugar imports<sup>11</sup>

US sugar imports under quota in the 1983/84 quota year totalled 3,108,893 short tons, against 2,888,599 tons in the corresponding period a year earlier. The 1983/84 quota was set at 3,050,000 tons.

## Thailand sugar expansion<sup>12</sup>

The initial operation of a new cane sugar factory (Wang Kanai Sugar, of 12,000 t.c.d. capacity) in early 1984 and the expected opening of an additional new factory (United Farmer and Industrial Co., of 15,000 t.c.d. capacity) in the coming season are believed to have encouraged a slight increase in cane area despite expected unattractive cane prices for the 1984/85 crop.

## Bagasse paper plant in Pakistan<sup>13</sup>

Pakistan plans to set up its first newsprint factory, capable of producing 66,000 tonnes a year of newsprint from bagasse, according to the official news agency. A feasibility study has been prepared for the federal government and the factory is to be set up at Kamalia in the Punjab province with technical help and machinery from Canada, France and West Germany. Pakistan, presently importing 35,000 tonnes of newsprint annually, will be the third Asian country after India and Indonesia to produce newsprint from bagasse.

## Entrepôt trading in Sri Lanka<sup>14</sup>

For the first time, a shipment of 12,000 tonnes of sugar was re-exported in October to Bangladesh by E. D. & F. Man (Sugar) Ltd., of the UK, bringing to the Port Authorities of Colombo foreign exchange earnings equivalent to 5 million rupees. Colombo's location, port facilities and competitive labour and infrastructure costs make it a favourable point for entrepôt trading and other multinational companies are expected to follow Man's example.

- 1 U.S.D.A. *Sugar & Sweetener Outlook & Situation Rpt.*, September 1984, 4.
- 2 *World Sugar J.*, 1984, 7, (3), 24.
- 3 *I.S.J.*, 1984, 86, 181.
- 4 *Sugar y Azúcar*, 1984, 79, (9), 7-8.
- 5 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 545.
- 6 *World Sugar J.*, 1984, 7, (4/5), 34.
- 7 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 549.
- 8 C. Czarnikow Ltd., *Sugar Review*, 1984, (1723), 191.
- 9 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 569.
- 10 *World Sugar J.*, 1984, 7, (4/5), 29.
- 11 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 571.
- 12 *Amerop-Westway Newsletter*, 1984, (133), 12.
- 13 *Reuter Sugar Newsletter*, October 5, 1984.
- 14 *Standard Chartered Review*, November 1984, 35.

**Morocco beet and cane crops, 1983<sup>1</sup>**

Morocco's sugar beet area in 1983 amounted to 66,340 hectares, from which 2,589,000 tonnes of beets were harvested, giving a yield of 39.02 tonnes/ha. The cane area was 9400 hectares and, with a yield of 78.18 tonnes/ha, the harvested sugar cane crop amounted to 7,349,000 tonnes.

**Uruguay HFS plant<sup>2</sup>**

The new high fructose syrup production company Agro-Industrias La Sierra S.A. is to promote corn planting to obtain raw material for its plant which was completed in July 1984. Once in full production the plant will process 90-100 tonnes of corn per day, equivalent to about 70 tonnes of HFS. The plant can operate nearly 340 days per year, which means a capacity of about 20,000 tonnes of HFS from 30,000 tonnes of corn.

**Reallocation of ACP sugar quotas<sup>3</sup>**

The EEC Commission has reallocated the 25,500 tonnes of supply quota sugar cut from the Trinidad quota recently<sup>4</sup>. It is proposed to allocate 8000 tonnes to the Ivory Coast, 5000 tonnes to Zimbabwe, 2000 tonnes to the Congo and 1000 tonnes to Kenya, while a reserve of 9500 tonnes will be allocated by the ACP countries themselves.

**Argentina beet sugar production<sup>5</sup>**

Sugar beet production was started on a small scale in Entre Rios province in 1984. Local sources report total beet sowings at 1000 ha to be processed into sugar in a factory to be completed in late 1984 or early 1985. Sugar production from the first crop is estimated at 4000 tonnes but the production capacity of the factory will be about 20,000 tonnes/year. It could, in the future, be used to process the beets to yield anhydrous alcohol for mixture with gasoline as a fuel.

**PERSONAL NOTES**

Mr. Jacques Dupont de Rivaltz de St. Antoine retired in April 1984 as Director of the Mauritius Sugar Industry Research Institute after 28 years service. After graduating from the Mauritius College of Agriculture in 1945, he studied Chemical Engineering at Louisiana State University and returned to Mauritius as Lecturer in Sugar Technology and Engineering at the College. He joined MSIRI as Head of the newly established Sugar Technology Division in 1956, was promoted to Assistant Director in 1968 and Director in 1980. He will continue to serve as a Consultant to the Institute for the next two years. Jacques de St. Antoine has actively represented Mauritius in ICUMSA and the ISSCT and has carried out many investigations during his service and we wish him a happy retirement. He has been replaced as Director by Dr. Claude Ricaud, Assistant Director of the Institute. Dr. Ricaud joined MSIRI in 1955 as a Scientific Assistant and from 1978 was responsible for the Divisions of Plant Breeding and Weed Agronomy and Cultural Practices as well as that of Plant Pathology of which he had previously been the Head.

**Colombia sugar industry problems<sup>6</sup>**

Colombia's sugar industry is undergoing the worst depression in the past 12 years. Demand is slack both at home and abroad, and a cut in the US quota as well as low world market prices are reducing earnings. Colombian sugar exports are expected to have fallen from 300,000 tonnes in 1983 to 180,000 tonnes last year and production in 1984 was reduced to 1,200,000 tonnes from 1,340,000 tonnes in 1983. Growers in the Cauca Valley are replacing some of their cane with soya which thrives in the area and continues to enjoy strong domestic demand.

**International Symposium on sugar and alcohol**

Copersucar, São Paulo's sugar and alcohol producers cooperative which accounts for 40% of Brazil's sugar and alcohol output, is to stage its first international symposium on sugar and alcohol in São Paulo during June 24-28, 1985. The symposium is expected to bring together technologists, business leaders and government officials from all five continents. The following subjects will be discussed: "Alcohol as a government program", "Technological advances in sugar and alcohol production", "Costs and pricing of sugar and alcohol", "International and national viewpoints on marketing of sugar and alcohol", "Technology of sucrose-based chemicals", "Competition from alternative sweeteners" and "Alcohol as a fuel additive to reduce pollution". Delegates will have the opportunity of acquainting themselves with the state of the art of Brazilian technology, based since 1975 on the national alcohol program (Proalcool). Further information may be obtained from Copersucar, P.O. Box 5691, Rua Boa Vista 280, São Paulo, Brazil 01014.

**Indian sugar industry expansion proposals<sup>7</sup>**

The Indian Planning Commission has proposed an increase in the sugar industry's annual licensed capacity to 13.26 million tonnes during a five-year national development plan due to start on April 1, 1985. The Commission said in a report that it expected parliament to approve the plan by the end of 1984 with only slight changes. The industry's annual licensed capacity stood at 8.5 million tonnes at the end of February 1984 but it was planned to increase by 13% to 9.62 million tonnes by the end of the current five-year plan which will end on March 31, 1985. According to the report, the planned expansion of the industry's capacity during 1985/90 should help India to export a minimum of one million tonnes of sugar per year. The balance will be used for domestic consumption and building-up of stocks.

**Iran sugar production and consumption, 1976/84<sup>8</sup>**

Between 1976/77 and 1981/82 there was a decline in the area sown to sugar beet in Iran, from 201,000 to 137,000 hectares, but subsequently the area expanded again and for 1983/84 was estimated at 168,000 ha. Beet sugar production fell from 654,732 tonnes to 404,067 tonnes, white value, but rose to an estimated 550,000 tonnes in 1983/84. The recovery has

been assisted by more favourable beet prices; previously these had not kept pace with inflation or production costs. There were 34 beet sugar factories in operation in 1983/84 whereas there were only two cane sugar factories, although there are plans for extending cane sugar manufacture in Khuzestan province. Cane sugar outturn at the Haft Tappeh factory has remained fairly steady, at 74,076 tonnes in 1976/77 and an estimated 72,000 tonnes in 1983/84, while Karun started in 1977/78 and has since reached a production level estimated at 140,000 tonnes in 1983/84. During this period, consumption has risen from 1,070,300 to 1,248,270 tonnes; since sugar rationing was introduced in 1980 per caput consumption has fallen from 37.5 to 30.0 kg and this has limited offtake. Domestic sugar production therefore covered about 50% of consumption between 1977/78 and 1982/83 but has since increased by a further 10%.

**US sugar import fee<sup>9</sup>**

On December 19, the 20-day period ended which sets the initial fee for the first calendar quarter. The spot price during this period averaged 21.2825 cents per pound which, when subtracted from the market stabilization price of 21.5700 cents, results in an initial fee of 0.2875 cents. This is the first time there has been a fee since October 1, 1982, when it was reduced to zero. Should the average spot price during a 10-day period during the first quarter of 1985 average below 20.57 cents, there will be an interim fee increase of 1.00 cents/lb which will be added to the quarterly fee.

**EEC sugar withholding in 1985**

The French Sugar Market Intervention Board (FIRS) has forecast that around 600,000 tonnes, white value, of EEC C-sugar will be carried over at the end of the current 1984/85 campaign into 1985/86<sup>10</sup>. This C-sugar or non-quota sugar receives no export subsidy and is unlimited in quantity. At the end of the 1983/84 campaign a total of 214,000 tonnes of sugar—mostly C-sugar—was carried over. In its latest monthly report the Board said a total of 1,340,000 tonnes of C-sugar is expected from 1984/85 production, compared with just 950,000 tonnes the previous season. This variation arises from the fact that the C-sugar is the residue from total production in the campaign, which depends on many factors including area, weather, etc., after deduction of the fixed quantities of A-quota (to meet estimated Community requirements) and B-quota sugar (27 1/2% of the A-quota as "insurance" against crop failures).

- 1 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 617.
- 2 *Amerop Westway Newsletter*, 1984, (132), 19.
- 3 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 633.
- 4 *I.S.J.*, 1984, 86, 293.
- 5 *Amerop Westway Newsletter*, 1984, (132), 16.
- 6 F. O. Licht, *International Sugar Rpt.*, 1984, 116, 638-639.
- 7 *World Sugar J.*, 1984, 7, (4/5), 29.
- 8 *Zuckerind.*, 1984, 109, 1017-1022.
- 9 C. Czarnikow Ltd., *Sugar Review*, 1984, (1732), 238.
- 10 *Public Ledger*, January 5, 1985.

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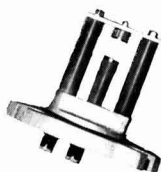
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